K19/K38/K50 船用柴油机

K19/K38/K50 Marine Engines

操作和维护保养手册

Operation and Maintenance Manual

零件号 Part No.4061368 Rev06

重庆康明斯发动机有限公司
CHONGQING CUMMINS ENGINE COMPANY Ltd.

重庆康明斯 K19/K38/K50 船舶柴油机

使用及保养手册

零件号：4061368

Cummins
CCEC

前　言

本说明书适用于重庆康明斯发动机有限公司现生产的为船舶应用的K系列直列式和V 型柴油发动机。对发动机的使用和保养过程进行了详细的叙述，所以，该资料为用户提供了最好的服务。

为了鉴别一台发动机的型号，要核查其铭牌的日期和生产流水号。下面例举识别发动机的实例：

KT19-M4

K 为发动机类型，亦称 K 系列
T 代表蜗轮增压
A 表示中间冷却（简称中冷）
19 表示发动机排量（升）
M 表示为船舶应用
4 表示发动机功率范围

该手册为使用保养手册，维修发动机需由经过特殊训练的人员进行，并可以在重庆康明斯发动机有限公司或经销商处进行全面维修。

特别说明

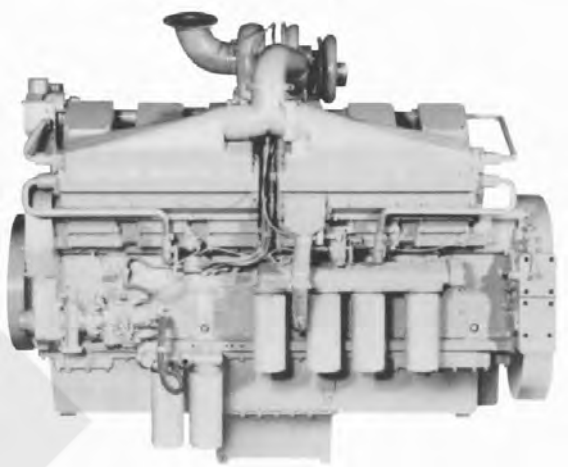
根据 SOLAS 公约要求，对发动机高压油泵到喷油器的外部高压燃油管路须有防漏套管，而康明斯发动机公司 NT855、K 系列发动机采用的是该公司专利技术的 PT 燃油系统,其为低压燃油泵，它提供给喷油器的供油压力最大不超过 2MPa(300PSI)，燃烧所需的喷射高压是在缸盖里的喷油器中产生。故 SOLAS 公约对燃油套管的此项要求不适用康明斯发动机公司的 NT855、K 系列(包括 K19、K38、K50)发动机。

详情可参见 MR0004-关于重庆康明斯 NT、K 系列发动机 PT 燃油系统的特别说明。

The SOLAS part I chapter II-2 part B requirement that external high pressure fuel delivery lines between the high pressure fuel pump and fuel injectors shall be protected with a jacketed piping system when the pressure exceed 20 bar.
The Cummins PT fuel pump is a low pressure pump.The injection pressure necessary for combustion is supplied by the injectors in the cylinder head.The Cummins engine NT855、K19、K38、K50 series models,both propulsion and auxiliary use this low pressure fuel delivery system and therefore do not require the jacketed fuel lines.

Check to MR0004(Explanation for PT fuel system of CCEC NT & K series engine) for detail.

KTA19-M



KTA38-M

船用发动机功率标定

标定条件：功率标定的条件采用的是 ISO8665 标准条件；大气压 100kPa[29.612 in.Hg]，环境温度 25℃[77°F]，相对湿度 30%。推进轴功率反映的是扣除齿轮箱损失后的净功率，约为额定功率的 97%，功率定义按 IMCI 程序执行。

燃油消耗量误差不超过 5%是使用 35°API， 29℃[80°F]时的比重为 838.9g/L[7.001lb/U.S.Gal] 16℃[60°F]时，低热值为 42,780kj/kg
[18,390Btu/lb]的燃油得出的。

持续功率：可持续全负荷不间断使用，功率标定参照 ISO3046。
典型应用：远洋型船舶，如拖网渔船、货船、拖船、内河深水拖船、打捞船。

重载功率：用于持续使用的变负荷工况，每 10 小时里的全功率使用限在 8 小时以内，降功率使用应以第于额定转速 200rpm 或以下的转速进行，是 ISO3046 规定的燃油截止功率，每年使用时间不能超过 5000 小时。
典型应用：排水型船舶，如近海拖网渔船、围网船，以及船速较慢且发动机转速和负荷稳定的拖船，乘用轮渡和客船。

中等持续功率：用于持续使用的变负荷工况，每 12 小时里的全功率使用限制在 6 小时以内降功率使用应以第于额定转速 200rpm 或以下的转速进行，是 ISO3046 规定的燃油截止功率，每年使用时间不能超过 3000 小时。
典型应用：滑水型渡轮、高速渔船、近岸服务船、发动机转速和负荷周期性变化的（非货运）短途快艇。

间冲功率：用于间歇使用的变负荷工况，每 8 小时里的全功率使用限制在 2 小时以内，降功率使用应以第于额定转速 200rpm 或以下的转速进行，是 ISO3046 规定的燃油截止功率，每年使用时间不能超过 1500 小时。
典型应用：滑水型船舶，如军用艇、警用艇、租赁船和某些渔船。

高输出功率: 用于变负荷工况，每 8 小时里的全功率使用限制在 1 小时以内，降功率使用应以第于额定转速 200rpm 或以下的转速进行，是用于休闲、非营业场合，每年使用时间不能超过 300 小时。
典型应用：休闲类船舶，如运动艇、摩托艇、巡航船。

BHP：ISO8665 中定义的英制燃油截止功率马力，燃油温度 40℃[104°F]。
Metric Hoseponer：ISO8665 中定义的公制燃油截止功率马力，燃油温度 25℃[77°F]。

船用辅机功率标定

常用功率：常用功率标定是应用于提供船舶上电器或应急情况时的电力。具有 10%的备用功率储备，满足 ISO3046 中过载功率（常用功率）和燃油截止功率（11%）的要求。环境温度低于 38℃[100°F]时功率无需修正。

10%备用功率只能每 12 小时内使用 1 小时。

以上均基于 ISO8528 进行标定。

目　录

使 用 说 明

发动机的操作者在发动机的使用过程中必须承担照管发动机的责任。这里有为数不多的一些规则需要操作者加以遵守，以使康明斯柴油机为您提供最好的服务。

船 用 发 动 机

新发动机和大修过的发动机的磨合

新发动机在最初的 100 工作小时内使用是非常关键的。它直接影响到发动机及其零部件的使用寿命。尽管康明斯发动机在出厂发运前已在测功机上进行了几小时的运转，但操作者在最初的 100 工作小时内按下列条件操作，则是必不可少的。

最初的 100 工作小时操作如下：

1. 避免发动机长时间怠速运转或在最大马力下工作超过 5 分钟。
2. 养成操作时密切注视发动机仪表的习惯，如果机油温度达到 250℉[121℃］或冷却液温度超过 190℉[88℃]时应关小油门。
3. 在走合期间内，每 10 小时检查一次机油平面。

发动机起动前的说明-首次或季节性保养后起动

加注燃油系统

1. 向燃油滤清器中加注清洁的 0 号柴油（GB252），柴油规格应符合第 3 部份所述的规范。卸下燃油泵吸油管，用干净的润滑油 2 ~3 盎司[50~60 毫升]润滑齿轮泵齿轮。
2. 检查燃油箱，并在其注人足够的清洁的 0 号柴油，见第 3 部份的“燃油规范”。
3. 如果在一些保养工作中影响到喷油嘴、气门或其它部分的调整，在起动发动机前一定要检查这些部份是否调整适当。

加注润滑系统

注：对于带有涡轮增压器的发动机，从增压器上卸下机油进油管，加 2~3 盎司（50~60 毫升）干净的润滑油润滑轴承。再装回机油输油管。

1. 向曲轴箱中加注机油至机油尺上有油为止。润滑油规格见第 3 部份。

2. 对于 KT/KTA19 型发动机，卸下机油冷却器壳前部的螺塞（图 1-1）。KT/KTA38 型发动机，卸下机油滤清器头部的螺塞（图 1-2）。

注意：不要从旁通滤清器处加注发动机的润滑系统。

3. 将手动或电动注油泵油管从干净的润滑油源连接在加注点上。（润滑油见第 3 部份）。

4. 加注润滑油直至达到机油压力 30 磅/英寸 ^{2} [207 千帕]。

5. 转动发动机至少 15 秒钟（关闭燃油截流阀或拆下燃油管以避免起动），在这期间保持外来机油压力最低为 15 磅 / 英寸 ^{2}[103 千帕]。

6. 照第 2 步拆下注油管，并装回螺塞。

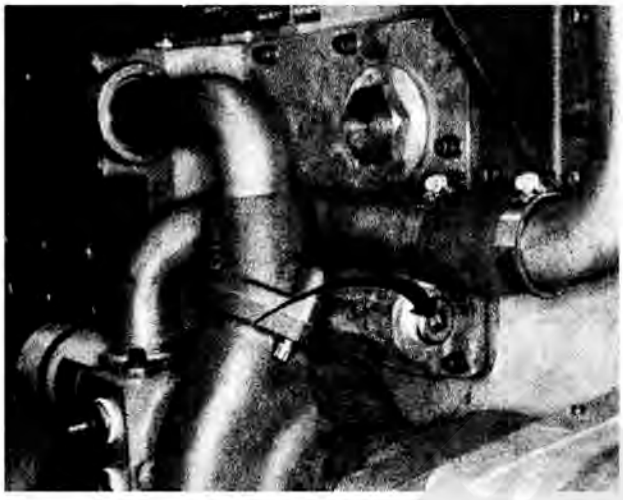


图 1-1　KT/KTA19 润滑系统注油点

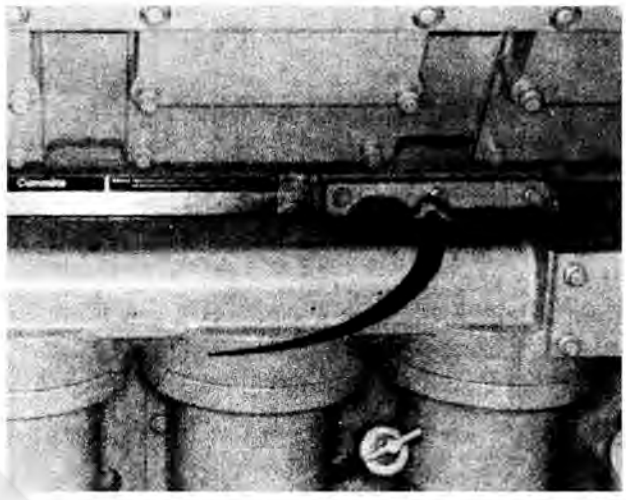


图 1-2　KT/KTA38 和 KTA50 润滑系统注油点

机油尺计量标记

所有的船用发动机发动时机油尺都是没有计量标记的，因为发动机的安装角度是在安装中才确定的，尽管给发动机注入了一定量的机油，但是机油尺还是应刻标记，以保证在发动机安装角度位置处机油平面正确。

在上述条件下，机油尺被丢失，没有原始标记或发动机安装角度变化，都需按下列步骤重新标刻机油尺刻度标记。

1．当发动机安装在船上而船又在水中时，卸下机油盘的放油螺塞，或用吸油泵，排除全部的机油，装回放油螺塞。

注意：由于油从发动机内部的油道和上部位置处流出，有时积贮在机油盘内，因而机油盘内留有任何机油将引起机油尺标记刻度错误。

2．要新发动机上有标明机油盘高和低容量的标签。如果标明的容量有疑，请查机油盘容量表 1-1。

表 **1-1**：机油盘容量

发动机	机油盘容量	
	高位容量加仑（升）	低位容量加仑（升）
KT/KTA38	30[114]	23[87]
KTA50	40[152]	32[122]
KT/KTA19	10[38]	8.5[32]
KTA19-M3/M4	18[72]	16.6[64]

所列的容量仅指机油盘而言，润滑系统的总容量是随滤清器大小和机油管路长度而变化的。

3．按机油盘的低位容量的机油注人发动机。

4．等 5 分钟或更多的时间，让机油流到机油盘中。如果发动机或机油的温度低于 40℉[4℃]，则需等更长的时间。

5．机油尺插人油尺管内使之全部落座，保持 5~10 秒钟，然后慢慢地拔出机油尺。

6．在机油尺上所示的油平面处，用电笔蚀刻出标记。标记深度不得超过 0.010 英寸[0.24 毫米 mm]。在标记上方蚀刻“L”。

7．再按机油盘的高位容量的机油量加人足够的机油。

8．重复第 4、5、6 步，在第二标记处上面蚀刻“H”或“高”位记号。

9．起动发动机，怠速运转 3 分钟，停下发动机，再将机油加到高位刻度。这增加的油是滤清器和机油管路所需的。

以上步骤仅是根据机油盘的容量来确定机油尺标记的。不能与包括油道、机油管和滤清器在内的总润滑系统容量和混淆。

加注船用齿轮箱（重庆康明斯不提供）

船用齿轮箱是一单独的部件，有其自身的润滑，按生产厂推荐的方法注油入齿轮箱壳内。起动发动机，短暂地作倒、顺车运转。

注意：如果变速箱或齿轮箱要使用发动机机油，则应向各自的生产厂了解这些部件所要求的机油粘度。大多数齿轮箱厂推荐单级粘度机油。

生水泵(海水泵)加水

旋涡型水泵要求事先加水。若水泵体内故意排完水，水泵不会在起动后自行泵水。泵体加水是在连接进水管前进行。

检查进气管接头

检查进气管各连接处，卡箍是否松动、软管或硬管是否有龟裂、穿孔或磨破，是否有软管断裂或其它损伤。拧紧卡箍或按需要更换零件，保证进气系统气密，确保全部空气都通过空气消音器或空气滤清器。

检查发动机冷却液：

1. 卸下膨胀水箱盖，检查发动机冷却液液位，添加冷却液，并检查水滤器。见第 3 部份的冷却液规范。
2. 检查管子、软管接头等处的四周是否有冷却液渗漏，并按需要纠正。检查水泵泄水孔是否有渗漏，渗漏表明密封件已磨损或损坏。

检查燃油管路和接头

目检燃油外管路，是否有渗漏并按需要拧紧接头。

警告：燃油、润滑油泄漏或渗漏易引起火灾。

起动发动机

起动发动机需要在准确的时间内向燃烧室供给适当数量的干净的空气和燃油。

注意：为保护发动机及零部件，起动时在怠速油压未达到前，不得提高转速。

正常起动程序

1. 打开海水阀，让生水流过热交换器和船用齿轮箱机油冷却器。
2. 将油门调整在怠速位置。
3. 将船用齿轮箱置于空档。
4. 按下起动按扭或将开关锁匙转到“起动”位置。

注意：为防止起动机发生损坏，连续起动发动机的时间不得超过 30 秒钟。如果发动机在头 30 秒钟内不能着火，须等 1~2 分钟后再起动。

5. 在发动机运转几分钟以后，停下发动机并等 5 分钟待机油流回到机油盘中。再检查一次发动机机油平面，如需要予以添加，使机油平面达到机油尺上的高（H）标记处。机油平面的下降是由于机油滤清器和机油冷却器吸收了一部份机油所致。

注意：在机油平面低于低标记（L）或高于标记（H）时决不可起动发动机。

外部渗漏

检查是否有机油外部渗漏，按需要用拧紧螺栓、接合面处、接头或更换垫片和"O"型封密圈来纠正。检查机油尺和加油管盖，是否紧固。

发动机预热

当发动机起动后，在曲轴和轴承之间，活塞和气缸套之间重新建立起油膜需要一段时间。各运动件间最适宜的间隙只有在发动机零件达到正常工作温度以后才能得到。

在加负荷前，允许发动机以 800~1000 转/分运转 4~5 分钟。在以后的 10~15 分钟内或在水温未达到 160~165℉[71~74℃]前，转速应控制在额定转速的 75%左右运转。

发动机转速

怠速

在大多数应用中发动机怠速都是在 550~650 转/分内，然而有附加负荷时，则要求有较高转速，以求平稳地过渡。

额定转速

所有康明斯发动机均装有调速器以防止速度超速。

调速器有两个功用：第一，当油门在怠速位置时，供给发动机所需要的怠速油量；第二，当发动机转速超过最高额定转速时，越过油门并切断燃油供应。

持续负荷

对于持续负荷下的运转，发动机调速器通常调整在降低转速和降低燃油消耗处，因此降低巡航速度是不必要的。

仪表板

用仪表板操作

操作者应一直注视仪表板，观察发动机的运转性能。

使用转速表

转速表指示出发动机转度，并且是发动机负荷和性能的最好指示器。

发动机额定转度是最高的转速，经正确调整过的一只调速器能使发动机在全负荷下运转，在高怠速（无负荷）条件下，发动机转速将稍超过额转速（一个小百分数）。

发动机机油温度表

机油温度表在全负荷下的正常读数应为 212~240℉[100~116℃]。

注意：机油温度的突然增高，如果不是因负荷的增加所引起，那就预示很可能有机械故障，应立即进行检查。

在发动机预热期间，应逐步增加转速，直到机油温度达到 140℉[60℃]时为止。连续地或长时间地在机油温度低于 140℉[60℃]下怠速运转将引起曲轴箱中的机油稀释和产生酸质、油泥，从而加速发动机的磨损。

机油压力表

机油压力表指示出润滑油压力或润滑系统里的机械故障。操作者应注意到油压的降低就立即关闭发动机。正常的发动机机油压力列于表 1-2 中。

表 **1-2** 发动机机油压力

发动机型号	怠速转速（转/分）	最小压力 磅/英寸^2（千帕）	额定转速（转 / 分）	额定压力 磅 / 英寸^2（千帕）
KT/KTA38-M	625	15[103]	1800/1950	45~70[310~482]
KTA50-M	625	15[103]	1800/1950	40~70[276~482]
KT/KTA19-M	625	15[103]	1800/1950	45~70[310~482]

注：个别发动机的机油压为可能与上述的正常机油压力有出入。当新发动机投入使用时，应观察并记录机油压力，作为以后判断发动机工作状况变化迹象的参考（起动时机油压力高属正常现象）。

冷却水温度

冷却水温度在 165~195℉[74~91℃]之间是最理想的，此时缸套达到能支持燃烧的适当温度，发动机的工作零件得到了均匀的膨胀，从而获得了最佳油膜间隙。见"发动机预热"部分。

过热则需作机械调整，因为这可能是水泵皮带松或磨损、冷却系或热交换器阻塞、海水泵进水口阻塞等引起。发动机冷却液的最高温度不得超过 200℉[93℃]。

发动机停车

停车前发动机要怠速运转几分钟

停车前发动机怠速运转 3~5 分钟相当重要，可以让润滑油和冷却水带走燃烧室、轴承和轴等部位的热量，对涡轮增压发动机尤其重要。

涡轮增压器中的轴承和油封，均要受排气高温的影响。发动机在运转时，这些热量由循环的机油带走，但是，如果发动机突然停车，增压器温度可能升高 100℉[56℃]之多。过热的结果将会使轴承咬死或油封失效。

不要使发动机怠速运转时间过长。

长时间怠速运转对发动机是不利的，因为燃烧温度过低，使燃油不可能完全燃烧。这将引起喷油嘴喷孔和活塞环积碳。

如果发动机冷却液的温度变得太低，一些未燃烧的柴油将冲刷气缸壁上的润滑油，并稀释曲轴箱中的机油，使发动机中的所有运转零件受到润滑不良的危害。

发动机停车

通过关掉钥匙开关或转动手动截流阀（如果用户自己安装）来关掉发动机，钥匙开关控制电动截流阀，只要截流阀上的控制旋钮不是锁在开启位置，并掉钥匙开关总可以使发动机停车。

注意：当发动机停车时决不要将钥匙开关或控制旋妞放在使阀打开的位置或在运转的位置上。高位油箱将使柴油流入气缸，从而引起液力锁紧。

任何零件发生故障应立即停车

由于机警的操作者注意到了警报信号（机油压力突然下降，声音不正常等）并立即停下发动机，从而使许多发动机得到挽救。任何耽误将导致发动机进一步的损坏。

寒冷气候下的防护措施

1．在寒冷气候下工作的发动机，推荐使用永久型带有防锈剂的添加剂，详见第 3 部份。

2．为了完全放掉气缸体和气缸盖中的冷却水，打开或卸下缸体、机油冷却器、热交换器、水泵进水管接头、海水泵、船用齿轮箱机油冷却器和排气管上的放水开关或放水螺塞，在冰冻气候下发动机及附属设备中没有彻底放水将产生重大损坏。

航行日志或工程师报告

如果操作者要获得最满意的使用效果，则发动机必须保持最佳的机械状态。发动机调整等工作可以让重庆康明斯公司操作。同时康明斯的服务工程师需用从发动机操作者处得到发动机的运行报告，以便于更好的维护。

日常或航行报告的有力记载将可能帮助排除许多故障，并得到及时修理。

下列各项都应记录在报告上：

1．润滑油压力不足
2．燃油压力不足
3．水温异常
4．发动机噪声异常
5．烟度过浓
6．起动困难
7．燃油消耗过量
8．润滑油消耗过量
9．船用齿轮箱过热
10．振动异常

保 养 说 明

保养是降低运用成本的关键。一台柴油机需要定期按保养表进行保养，以使它保持有效的运转。预防性保养是最容易、最经济的保养。它使保养部门可以在合适的时间进行工作。

保 养 日 程 表

使用建议的保养日程检查表

下页所列的检查表可用任何复印机复制。进行检查的人员在每项作业完成以后可直接在表中打上记号。当整栏（A 栏、B 栏、C 栏等）检查项目都打上了记号以后，直到下一次检查到期，发动机才需再进行保养。

所提供的一份详细的零部件检查表有几个检查周期；并且新提出的保养日程表是以工作小时或使用期为基础的。

应以检查表为依据制订一份保养日程表；得出一份能适应特殊工作情况的保养程序。

保养日程表的变动

必须按发动机的实际工作环境定保养日程表。对已制订的日程表要作任何改动，需要事先作工作环境分析。润滑油的分析应是制定保养日程表初稿的重要因素，修改或延长日程表周期前对它要进行分析研究。

发动机不使用时的储存

如果发动机停用三或四星期（最多六个月）不保养，又不会很快就投人下一次使用，应采用一些专门的预防措施以防止锈蚀。请与最近的重庆康明斯销售商接洽或查看修理手册中有关发动机储存程序方面的说明。

保养日程检查表

船　　名	发动机序列号
技　　工	小 时 ，（升）
用　　时	检 查 结 果
零件订货编号	日　　期

重庆康明斯船舶柴油机　　对照每项操作进行保养

A 级 检 查	B 级 检 查	C 级 检 查	D 级 检 查	季 节 性 级 检 查	其　它
每日检查和每天加油 ☐ 检查船舶航行日记 ☐ 检查发动机 ·机油平面 ·冷却液平面 ·空气进气系统 ☐ 检查机油平面 船用齿轮箱 海水泵 ☐ 日检发动机有无渗漏、损坏、皮带是否松弛或磨损，软管是否有漏损和发动机声音是否正常 ☐ 放出燃油滤清器/油水分离器中的沉淀物 ☐ 在航海日记中记下所有运转的温度和压力	重复 A 级检查 ☐ 更换发动机机油 ☐ 更换滤清器 ·全流式机油滤清器 ·发动机机油旁通滤清器 ·发动机燃油滤清器 ☐ 检查冷却液 ·检查发动机冷却液 DCA 浓度，需要时更换芯子和补充 DCA。 ☐ 清洗或更换 ·曲轴箱通风器（除 KT/KTA-2300,KTA-3067 除外）。 ·空气滤清器芯 ☐ 清洗空气消声器 ☐ 检查热交换器锌塞	重复 A、B 级检查 ☐ 调整气门和喷油器	重复 A、B 级检查 ☐ 清洗并校准喷油嘴和燃油泵 ☐ 修理或更换下列总成： 水泵 ☐ 检查或（和）修理下列总成 增压器 硅油减振器	秋季 ☐ 如需要，更换软管 ☐ 清洗发动机和船用齿轮箱 ☐ 拧紧安装螺钉 ☐ 检查曲轴端隙 ☐ 坚持安全控制系统 如需要，准备发动机过冬贮藏。	+ 船用齿轮箱 + 海水泵 电气设备 + 交流发电机 + 蓄电池 + 仪表 + 信号传感器 + 起动电机 + 开关 + 转速表 + 电压调节器 + 日用燃油柜 + 油门和传动钢绳
周　　期					
小时数日历	图表法或 250 小时 6 个月	1500 小时 1 年	4500 小时 2 年	+对这些组成部件中，请参照制造商所告知的维护步骤	
注意：1．保养日程，小时或日时间，那个先到就按那个执行，在六个月的时间里，当小时数小于 1/3 时建议使用正常的日历周期。 2．任何时候冷却系统应当完全被放净或充满冷却液的，采用表 3-7 中所列的 DCA 服务滤芯和 DCA-AL 预加滤芯。					

“A”级保养检查

定期完成保养日程表上规定的下列检查。

每日检查航行日志

比较和正确理解航行日志，并且接着采取实际的措施，将消除绝大部份故障而不需要进行紧急修理。

检查发动机

检查机油液面

1．用发动机上的机油尺检查机油平面。为了得到精确的读数，机油平面应在发动机停车机油流回到机油盘后检查。机油尺应保持和原装的机油盘配对。尽可能地保持机油液面接近高位“H”标记处。

注意：当机油液面低于低位标记“L ”或高于高位标记“H”时决不要操作发动机。

2．如果需要添加与发动机中质量和牌号相同的机油，详见第三部份。

检查冷却系统

保持冷却系统加满到工作平面，每天或每次加注燃油时检查冷却液液面。检查冷却液消耗的原因。检查冷却液平面只有在冷却系统冷却后进行。

检查进气管各连接处

检查进气管各连接处，卡箍是否松动，软管或硬管是否有龟裂、穿孔或磨破，是否有软管断裂或其它损伤，拧紧卡箍或按需要更换零件，保证进气系统气密。确保全部空气均通过空气消音器。

外观检查

检查是否有外部空气漏人，冷却液或机油渗漏。拧紧螺钉，连接处、接头等或者按需要可更换垫片。检查机油尺和加油管盖，看是否紧固严密。

检查损坏情况

检查燃油系统等，包括燃油泵的错误调整或碰伤的情况，检查全部连接处有无渗漏或损坏。

检查驱动皮带

视检皮带是否松驰。如果存在皮带打滑现象，应按下列方法进行调整。

皮带张紧度

1．对不大于 1/2 英寸[12.7mm]宽的皮带，使用 ST-968 或 ST-1274 皮带张力计，对大于 1/2 英寸[12.7mm]宽的皮带使用 ST-1138 皮带张力计，见表 2-1。

2．对 K 系列发动机，使用 ST-1274 或 ST-1293 皮带张力计。张紧度如表 2-1 所示。

表 **2-1**：皮带张紧度（磅）

皮带宽度（英寸）	皮带张力计	* 新皮带张紧度（±10）	**磨合后皮带张紧度（±10）
标准"V"形皮带			
1/2	ST-968	140	100
	ST-1274	140	100
11/16	ST-1138	140	100
3/4	ST-1138	140	100
复式 V 形皮带 6 筋	ST-1293	150	130

*新皮带必须重新张紧到表中所列的"磨合后皮带张紧度"一栏中的数值。

**使用过的皮带应重新张紧到表中所列的"磨合后皮带张紧度"一栏中的数值。

重新调整新皮带

所有的新皮带在运转 1 小时或 1 小时多以后都将变松，因此必须重新调整到"皮带张紧度"的要求。

皮带的安装

如果皮带出现磨损或损坏，应按下列方法进行更换：

1. 一般总是用缩短皮带轮之间的中心距的方法以便不费力地装上皮带。决不可将皮带滚越皮带轮装上去，或用螺丝刀之类的工具撬上去。这两种方法均会损坏皮带和导致早期损坏。
2. 一般总是成组地更换皮带。在同一组皮带中，皮带嵌入的深度差不应大于 1/16 英寸[1.6mm]。
3. 皮带轮的不对中度在两皮带轮中心之间不应超过每英尺[0.3m]1/16 英寸[1.6mm]。
4. 皮带不应沉入皮带轮槽的底部，也不应高出皮带轮槽上边缘 3/32 英寸[2.4mm]。
5. 不要让皮带碰擦任何相近的零件。
6. 调整皮带至合适的张紧度。

排气系统

检查排气系统接头有无泄漏和损坏

1. 检查排气岐管的各种接头有无排气泄漏。
2. 检查所有的排气管接头处的气密性。
3. 如果是水冷排气管，检查所有的接头和管子有无渗漏和腐蚀。

排出燃油滤清器内的沉淀物

卸下燃油滤清器底部的放油螺塞，放出水和沉淀物。如果没有螺塞，可卸下滤芯检查是否有水和沉淀物。并用清洁的燃油注入和更换滤芯。

燃油/水过滤分离器

在检查燃油箱时，如发现油箱中的水较平常多，安装一个水分离器是必要的。

请与最近的重庆康明斯销售商接洽，以取得符合要求的弗列加 [Fleetguard] 油水分离器。

放油塞位于一些燃油滤清器壳和燃油箱的底部。未装满油的油箱中，生成的冷凝水多于满油箱中的冷凝水。所以，油箱应尽可能保持接近于加满状态。从喷油嘴中流回的温暖的燃油将加热燃油箱中的燃油。如果在寒冷气候下油箱油面低，油箱的上部不能被流回的温暖燃油所加热，从而增加了水蒸汽的冷凝倾向。在暖和的气候条件下，燃油箱和燃油都是暖的。但是在夜间，冷空气使油箱温度下降的速度远远快于燃油温度下降的速度，这再一次增加了水蒸气的冷凝倾向。

航行日志或工程师报告

如果操作者要获得最满意的使用效果，就必须保持发动机的最佳机械状态

每天航行日志的比较和理解将可能消除许多故障，并得到及时修理。

日记中要记录温度，压力和与发动机运转有关的数据。

注意：禁止机油泄漏。例如在美国，如果这样的泄漏会引起表层水质产生一层油膜或光泽层，污染，或者会在水表面下层生成污水或乳化，则美国水质污染控制条例规定禁止机油泄漏，或有含油的水冲洗到航行水域和美国的邻近区域，违者将遭到重罚。

“B”级保养检查

B 级检查

在每作一次“B”级保养检查时，要完成全部的“A”级检查项目，还要加上下列项目。

坚持定期“B”级保养检查时，对发动机完善保护方面是非常重要的。发动机运转（包括负荷因数和燃油消耗）的直接结果是污染润滑油。

注：如果放掉了机油盘中的润滑油后来修理发动机，则重新加进去的油，必须采用新的润滑油，而不能再用从机油盘中放出的油。

润滑油更换周期

1. 机油更换周期是用“图表法”来决定的。此法是根据燃油消耗量和润滑油添加量来决定更换周期。“图表法”见下面所述。

2. “图表法”上的时间周期为 250 小时或 6 个月。

3. 决定机油更换周期的另一个方法是通过采用机油分析来确定。参见“润滑油分析”一节。

图表法

润滑技术的改进使得重庆康明期发动机用户有可能成功地延长机油更换周期，这样可降低保养成本。

注：在更换机油时，更换全流式机油滤清器、旁流式机油滤清器（如果使用的话）和燃油滤清器。

润滑油更换周期根据下列可变因素而定：

1. 每小时燃油消耗量。
2. 每小时机油消耗量。
3. 滤清系统。
4. 润滑系统容量。

下列曲线图被用来确定发动机的合适的机油更换周期。

润滑系统的总容量（加仑）可以通过机油盘（高油位）、全流式滤清器和旁流式滤清器的容量相加而求得。总的润滑油容量应修正到最接近的整数加仑数，见下面的例子。

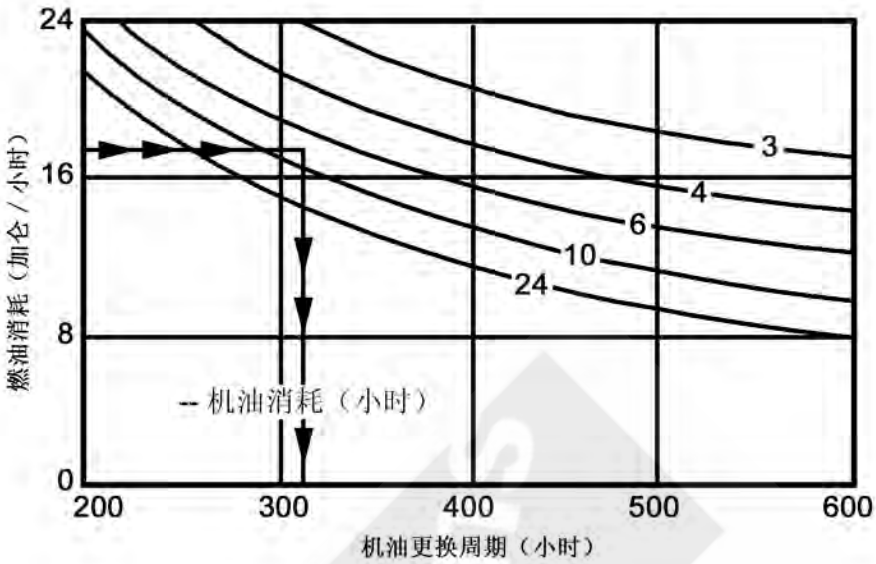
注：康明期发动机公司不赞成机油更换周期超过 600 小时，因此，曲线被限制在 600 小时内，不得延伸。

KT/KTA19 船用发动机		
机油盘容量	10 加仑	37.9L
全流式机油滤清器（2）	1.16 加仑	4.4L
旁通式机油滤清器（1）	0.53 加仑	2.0L
系统总容量	11.69 加仑	44.25L

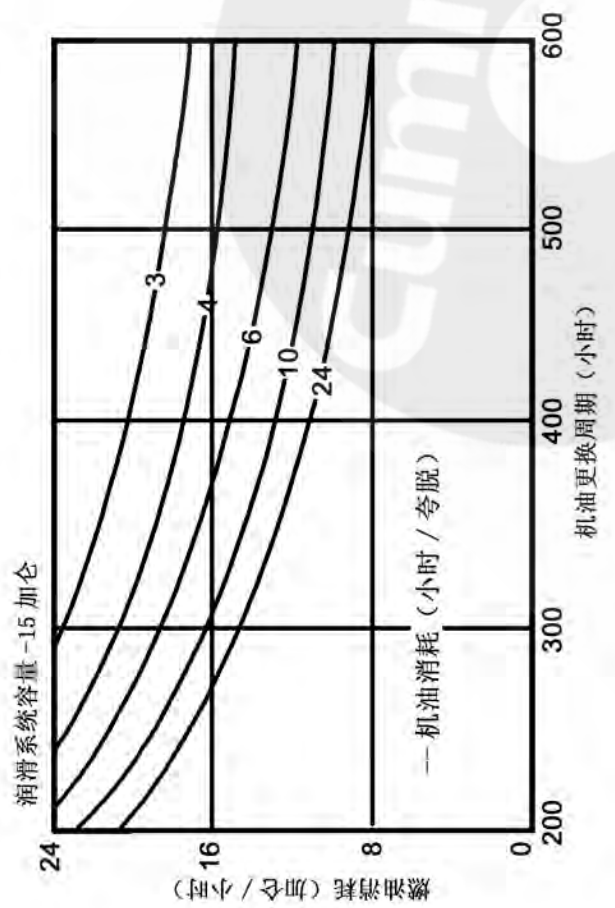
例：带有 750 型旁通式滤清器的 KT/KTA19 船用发动机	
润滑系统容量：	16 加仑
燃油消耗：	17.5 加仑
机油消耗：	8 小时/夸脱
推荐机油更换周期：	310 小时

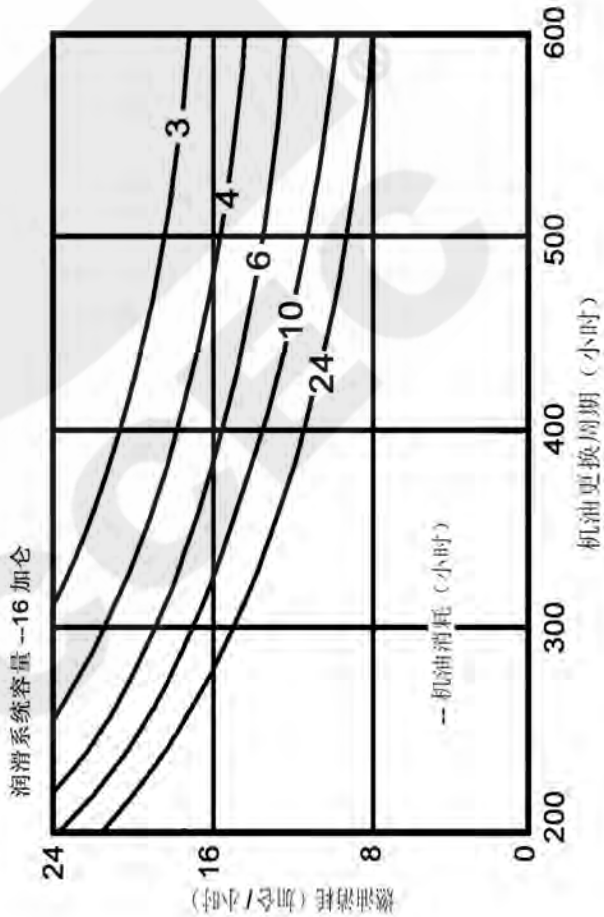
1 加仑=3.7853 升

1 夸脱=0.9463 升



带有旁通式滤清器的增压发动机





润滑油分析

决定何时更换润滑油的另一个方法是通过实验室进行机油分析。如果滤清器，机油品种或等级更换了，应进行一系列新的试验。

开始时，每消耗 100 加仑（380L）燃料已消耗 400 加仑（1520L）后或每工作 20 小时（已工作 100 小时后）要做一次润滑油分析，查到分析表明需要进行第一次更换轨油。

润滑油的分析试验

在对润滑油进行分析时应按下表检查它的性质。这些方法在美国材料试验协会手册中有详尽的说明。

润滑油性质	试验编号
在 100℉和 210℉[38℃和 99]时的粘度	ASTM-D445
沉积物	ASTM-D893
水分	ASTM-D95
酸碱值	ASTM-D664

机油更换的一般限制

1．最小粘度（稀释限度）：被试机油粘度降低了一个 SAE 等级，或相当于至少含有 5%（按容积计）燃油的这一点。

2．最大粘度：被试机油粘度增大了一个 SAE 等级，或在 210℉[99℃]时粘度增大 10%或在 100℉[38℃]时增大 25%。

3．沉积物含量：戊烷不溶物正常含量为 1.0~1.5%，苯不溶物正常含量为 0.75~1.0%。

4．酸值：最大总值为 3.5。

5．水分：最大为 0.2%。

6．添加剂减少量：最大为 25%。

注意：如果在上面试验中发现有任何金属屑或在滤清器中发现有此类东西，应找出根源并采取正确的措施，以免发生故障。

更换发动机机油

保养日程表中所规定的“B”级检查中的机油更换是指通常使用情况而言。

1．起动发动机使之达到工作温度，停机，从机油盘底部卸下放油螺塞，放出机油或从机油盘中抽油（图 2 -1）。

2．将放油螺塞装回，螺塞扭紧扭矩：60~70 英尺-磅[81~95 牛·米]；

3．向曲轴箱中加注机油至机油尺上的“H”高位标记处。

4．起动发动机，目检有无漏油现象。

5．停下发动机，等 15 分钟待机油流回到机油盘中以后，重新用机油尺检查机油平面。如需要，予以添加。

注：使用的润滑油应符合第 3 部分所列规格，并应装备重庆康明斯滤清器。

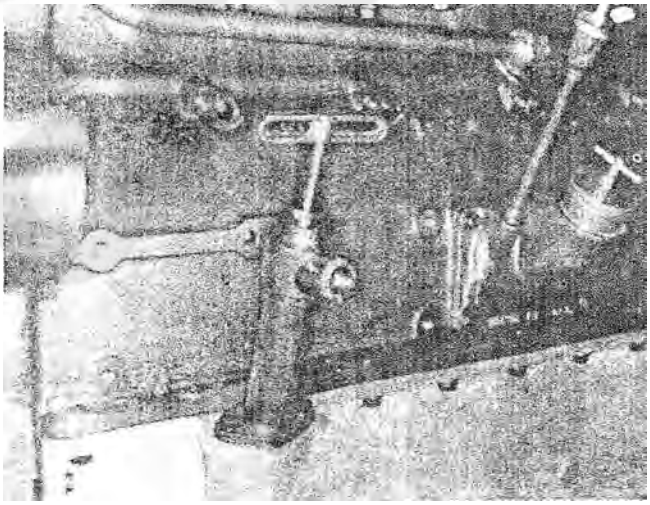


图 2-1　（N1074）手动抽油泵

机油、燃油滤清器的使用和维护

机油滤清器的使用与维护

机油在柴油机中，因不断被柴油机零部件的磨损微粒和外界落入的杂质所污染，同时，因受柴油机发热零部件的热辐射而氧化产生了可溶于机油中的酸性物质和不可深的胶状沉淀物（凝胶或乳胶）而变质。这些杂质和污染物对柴油机是有害的，不滤除机油中这些杂质和污染物，机油中的硬质粒子就会增加柴油机零部件的磨损，堵塞润滑油道；酸性物质对合金轴瓦产生腐蚀性磨损；胶质会使活塞与活塞环、气门与气门导管等零件之间发生胶结，甚至柴油机不能正常运转，使机油的使用期缩短。经验证明，柴油机机油盘中机油的固态杂质总量低于0.15%时，对柴油机的危害尚不大，但达到或超过0.5%时，则将大大加速柴油机零部件的磨损。

为了及时清除机油中的机械杂质和胶状沉淀物，延长机油的有效使用期，在柴油机的润滑系统中设置机油滤清器。

柴油机的最长寿命除取决于正确选择和使用润滑机油等外，还取决于选择和使用合适的机油滤清器、燃油滤清器及选择合适的更换周期。所有的重庆康明斯柴油机均装配有全流式机油滤清器、旁流式机油滤清器和燃油滤清器。它们均是纸质滤清器芯的、旋转拆装式的滤清器总成，总成一次性使用和更换。其结构简单，滤清效率高，更换方便，无需对滤清器芯进行清理和维修，从而使柴油机的保养大大简化。

滤清器堵塞的情况有以下几种：

①污染过度堵塞。柴油机机油中的燃烧积炭、氧化产物和燃烧产物等超过机油的容纳极限时，便出现这种堵塞，其表现形式是在滤清器纸滤芯上覆盖有一层稠密的松散的油泥，引起堵塞的原因可能是柴油机机油更换周期过长、维护保养差或曲轴箱中的燃烧废气量过高等等；

②机油分散力水削弱堵塞。当柴油机冷却液泄入曲轴箱中时，就会产生潮气，这种冷凝的潮气削弱了机油中的分散剂的作用，从而使油烟和炭灰粘在一起并形成沉淀。其表现形式是沿滤清器纸滤芯波褶方向附有较坚固的、光泽的油泥，引起的原因是冷却液泄入柴油机曲轴箱和柴油机在寒冷气候条件怠速成时间过长等。

③添加剂析出堵塞。机油中有柴油机冷却液或潮气，因而引起机油中添加剂析出或从溶液中分离而引起堵塞。其表现形式是滤清器滤纸呈灰色或扭曲变形、纸褶断裂等，主要由泄入曲轴箱中的柴油机冷却液或曲轴箱中的潮气引起的。

④凝胶或乳胶堵塞。其表现形式是在滤清器纸褶有上奶油状的、类似凝胶的物质，主要由泄入柴油机中的冷却液污染了机油而引起的。

⑤氧化特堵塞。因柴油机机油稀释、受柴油机高温辐射或使用了不能抵御一般柴油机条件的机油而形成不能被机油溶解的氧化物引起的。其表现形式是堵塞时的滤清器呈红色（烟灰等沉积物）。

⑥磨料（磨削）堵塞。因机油中存有大量磨损物质而引起的，主要与柴油机磨损、损坏、润滑系统中进入大量的灰尘和脏物等引的。

旁流式机油滤清器

旁流式机油滤清器（又称分流式机油滤清器或细滤清器）并联在柴油机润滑油路中，并在滤清器座上设计、加工某一尺寸的节流孔来限制通过滤清器的机油流量，让一部分机油通过旁流式机油滤清器过滤后流回机油盘。其目的是滤除全流式滤清器没有过滤掉的、影响柴油机磨损的尺寸较小的颗粒，以便控制柴油机的机油污染水平，进而阻止柴油机的磨损。这种滤清器在10分钟内才对所有的柴油机机油过滤一次。

由于通过这种滤清器的机油流量比较小，允许有较大的流量阻力，因而这种滤清器的过滤精度较高，一般可达5-10μm。

重庆康明斯柴油机所装用的这种滤清器的纸滤芯为层叠盘片式滤芯，它所使用的滤纸是长纤维纸浆制成的，纸质较细，流量较小，过滤细度较小。因而其过滤精度较高。

注意：不允许用旁流式机油滤清器代替全流式机油滤清器使用。

有些用户对旁流式机油滤清器的作用不甚了解，认为既然柴油机上已经装有全流式机油滤清器，用不用旁流式机油滤清器对柴油机影响不大，同时又认为每250小时更换滤清器，增大了柴油机的使用成本，因此常常

不注意定期更换滤清器。

当使用旁流式机油滤清器时，柴油机各零部件的磨损量明显减少。事实上，当使用旁流式机油滤清器时，柴油机的磨损与柴油机中无脏物时的磨损水平几乎相当。

复合工机油滤清器兼具有全流式和旁流式机油滤清器的功能。

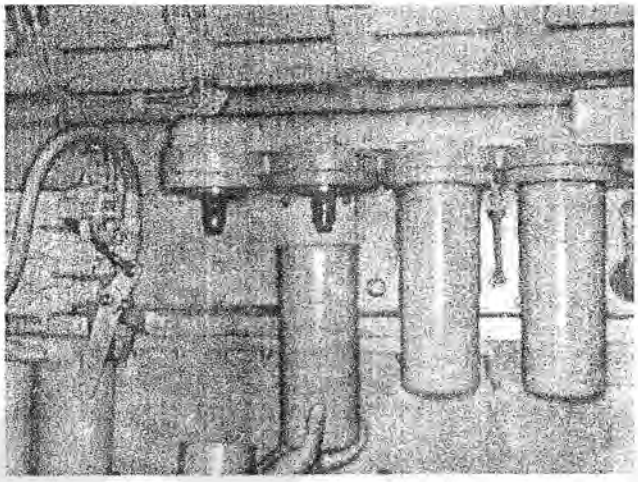


图 2-2　卸下旋装式润滑加滤清器

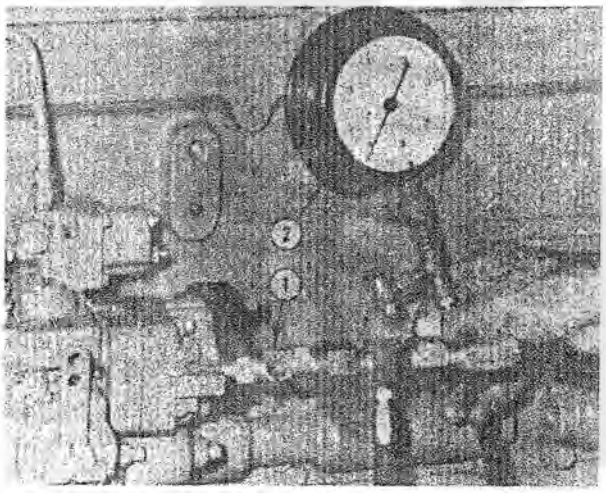


图 2-3 检查燃油泵阻力图

2-4　更换燃油滤清器

燃油（或柴油）滤清器

柴油机燃油中如果有铁锈、泥沙、灰尘、蜡晶体、水等，将引起燃油泵中的齿轮泵、喷油器的精密偶件等的磨损。为了使柴油机燃油泵和喷油器（嘴）受到的污染物减低到最小的限度，每一台柴油机均安装了优质的燃油滤清器。在正常的使用周期内，这种滤清器在品质和性能上能防止灰尘、柴油中的固体石蜡等杂质和柴油中含有的水分、腐蚀性液体等进入柴油机燃油泵和喷油器（柴油机燃油系统中的水是引起柴油机燃油系统维修问题的主要原因之一）。

重庆康明期柴油机燃油滤清器有两种，即轻型滤清器（燃油/水份离滤清器）和重型滤清器，轻型燃油滤清器外形尺寸小，容量小，流量也较小，适用于功率在 700HP 以下的重庆康明斯柴油机；重型燃油滤清器外形尺寸大，容量大，流量较大，适用于功率在 700HP 以上的重庆康明斯柴油机。

由于滤清器使用一定时间之内就会变脏乃至堵塞，因此应定期更换重庆康明斯柴油机所使用的机油和燃油滤清器。机油和燃油滤清器的更换周期除了根据重庆康明斯柴油机维修保养手册中根据机油和燃油的消耗曲线来确定之外，也推荐汽车等每运行 16000 公里（汽车或公路用车）、250 小时（非公路用车）或六个月时（无

论哪个先到就执行）进行更换。

更换机油和燃油滤清器的方法和程序如下：

①从柴油机上拆下已经堵塞的滤清器，然后将其扔掉。拆卸时可以使用旋装式滤清器板手；

②向将要装柴油机的机油滤清器（燃油滤清器）加注规定的润滑机油（燃油或柴油）；

③将已加油的滤清器静置半分钟后，再向滤清器中加油；

④重复步骤③多次，直至确信滤清器中的空气全部排出、滤清器已充满机油或燃油为止；

⑤在滤清器密封圈上端面涂上一层薄薄的柴油机润滑机油油膜，之后，将滤清器安装到滤清器座上去，旋转滤清器直到其密封圈与滤清器座面接触；

⑥再将全流式机油滤清器、旁流式机油滤清器和燃油滤清器分别旋转 3/4~1 和 1/2~3/4 圈（带矩形和锥形密封圈的机油滤清器的安装扭矩分别为 45~50ft-1bs 和 15ft-1bs[61~68 和 20.5N.m]），注意不要拧得过紧。

注意：绝对不允许将未加油的滤清器直接装到滤清器座上，否则将引起柴油机烧瓦、曲轴抱死、零件干磨擦而磨损、损坏等一系列严重问题。

燃油滤清器中，因油的比重较水轻，因而水沉积在滤清器下部，油在水之上。放水时，先旋松滤清器底部的塑料旋塞，滤清器随即先卸压，然后首先流出来的是水，后流出来的是油，待估计滤清器中的水已基本放完时，立即装上螺塞或旋紧塑料旋塞。

推荐使用的发动机冷却水/防冻液

1、 柴油机用冷却水

所有的水均具有腐蚀性，而且矿物质含量较高的水不能用作柴油机冷却液。

推荐使用 pH 值等于 7 的、总硬度不大于 150PPM 的软水(如蒸馏水、去离子水、可饮用的自来水或雨水等)作为柴油机的冷却水。

当水的总硬度大于 150PPM 时，则应采取加热煮沸法等方法对冷却水进行软化处理，使其总硬度降低到 150PPM 以下。

2、 柴油机用防冻液

在气温低于 0 ℃的地方，应使用有效的防冻液。

推荐使用满足美国 GM 6038-M 标准要求的乙二醇型低硅酸盐防冻液(防冻液中的硅酸盐、氧化物和醋酸的含量分别不高于 1000PPM、5PPM、100PPM)作为重庆康明斯柴油机的防冻液。

选用防冻液时，应选择比使用地区的最低气温低 10 ℃左右的冰点的防冻液。

注意： **① 使用前的防冻液存储时间不得超过两年；**

② 不允许使用代防漏剂的防冻液，以免影响柴油机所带的水滤器的正常工作；

③ 当柴油机冷却系统中使用了防冻液时，冷却液中的 DCA4 或者 DCA4+添加剂浓度不得超过每加仑发动机冷却液 2 个单位添加剂(1 加仑=3.785 升)；

④ 当防冻液中含有重庆康明斯发动机公司认可的 DCA4 或者 DCA4+化学添加剂时，防冻液的更换周期推荐为 400,000 公里。

⑤ 不推荐使用未经重庆康明斯发动机公司认可的、含有诸如防腐蚀、穴蚀添加剂的防冻液。

⑥ DCA4 与 DCA4+紧添加剂含量梢有差异，但可以相互替代使用。

推荐使用的 DCA4 或者 DCA4+化学添加剂

重庆康明斯发动机有限公司推荐使用满足美国康明斯发动机公司工程标准 10518-05↔冷却系统添加剂货源鉴定方法≈或重庆康明斯发动机有限公司工程标准 CF120291↔重庆康明斯柴油机干式化学添加剂试验方法≈的 DCA4 或者 DCA4+化学添加剂 及含有 DCA4 或者 DCA4+的水滤器。如不能购得此 DCA4 或者 DCA4+添加剂及相应的水滤器，则允许使用经重庆康明斯发动机公司认可的 DCA2 化学添加剂及相应的水滤器，但 DCA2

型化学添加剂不能与 DCA4 或者 DCA4+型化学添加剂混合使用，否则会引起严重的发动机问题。

不推荐使用未经(重庆)康明斯发动机有限公司认可的任何其它类型或品牌的化学添加剂或防蚀剂、缓蚀剂等。

DCA4 或者 DCA4+添加剂及相应的水滤器供应商应对其产品的质量和性能负责。

DCA4 或者 DCA4+化学添加剂的作用

防穴蚀

DCA4 或者 DCA4+化学添加剂溶解在发动机冷却液/防冻液中，在发动机工作过程中，其不断地在湿式汽缸套水侧表面形成致密的、坚固的保护膜，防止零件表面金属被氧化、腐蚀或剥离，保证汽缸套、发动机水泵叶轮等零件不被穴蚀等。

防腐蚀

DCA4 或者 DCA4+化学添加剂中具有储备碱值，其溶解在发动机冷却液/防冻液中将使冷却液/防冻液呈弱碱性，使其既能控制零件的电化腐蚀，也能中和冷却液中的酸性物质，而达到防止腐蚀的目的。

防积垢

抑制和防止发动机冷却液/防冻液中的矿物质、油泥、消耗的添加剂等沉积于传热零件表面，防止零件因不均匀的热量分布而导致气缸盖炸裂等。

消泡(沫)/防泡(沫)

在发动机工作过程中，溶解在发动机冷却液/防冻液中的 DCA4 或者 DCA4+化学添加剂可以不断地消除、抑制冷却液中产生的有害空气泡或泡沫，防止冷却液/防冻液酸化变质，防止冷却液/防冻液传热效率降低。

发动机冷却液测试包

1　检测冷却液中 DCA4 或者 DCA4+添加剂浓度的必要性

在发动机工作过程中，伴随着发动机工作时间的延长，冷却液/防冻液中 DCA4 或者 DCA4+添加剂在不断地被消耗或稀释，冷却液中的添加剂成分在不断地减少。添加剂浓度降低到某一极限值以下时，将严重影响到冷却系统零部件乃至整台发动机的正常工作。

另外，冷却液/防冻液中添加剂浓度高于某一极限值以上时，也将对发动机重要零部件有很大影响。

只有冷却液/防冻液中添加剂浓度在一定范围内时，才能保证冷却系统乃至整台发动机的正常工作及预期的寿命。因此，应定期对发动机冷却液/防冻液中添加剂浓度进行必要的检测，并根据检测结果对冷却液进行必要的维护和处理。

2　冷却液测试包

重庆康明斯发动机有限公司推荐采用美国弗列加 (Fleetguard) 国际公司生产的 CC2602M 或重庆康明斯发动机公司的 3165449(等效于 CC2602M)冷却液测试包来检测发动机冷却液/防冻液中 DCA4 或者 DCA4+添加剂的浓度。

上述测试包是可以测试冷却液/防冻液中的钼酸盐和亚硝酸盐的浓度以及防冻液的冰点的三合一的测试包，在使用此测试包时，只要执行简单的三个浸泡步骤，即可完成一个冷却液样品的全部测试过程。另外，该测试包采用的是公制图表，便于在中国使用。

此测试包还可以用于测试 DCA2、DCA2 与 DCA4 或者 DCA4+的混合物以及其它类型化学添加剂的浓度。

注意：该测试包有效期一年，因此，请注意使用与保存。

发动机冷却液添加剂浓度检测及其控制

1　何时对发动机冷却液/防冻液进行测试？

当出现下列情况时，应对发动机冷却液/防冻液进行 DCA4 或者 DCA4+化学添加剂浓度测试：

- 冷却液出现大量流失时
- 浓度超过 0.8(DCA4 或者 DCA4+)单位/升(冷却液)时
- 每次更换机油时
- 每年至少测试两次以上

2　测试步骤

- 用塑料杯取一定数量的发动机冷却液，并待其冷却至 10～50℃后进行测试。
- 用测试包中的注射器从上述塑料杯中吸入冷却液，并将其注入到测试包中的小塑料杯中，直至小塑料杯中盛满半杯冷却液为止。
- 从测试包的试纸筒中取一条试纸，每次将试纸条上的一个粘贴纸片浸入冷却液中，经过 45～75 秒钟浸包时间后取出，并将其与试纸筒身上所印的标准表的颜色相对照。经过这样三次简单的浸泡步骤，即可分别确定冷却液样品中的钼酸盐浓度、亚硝酸盐浓度和防冻液的冰点。
- 试验完备，清洗、干燥取样杯和注射器等。

具体的操作步骤及注意事项请参见测试包中所附带的使用说明书。

3　DCA4 或者 DCA4+添加剂浓度推荐控制表

冷却液中 DCA4 或者 DCA4+浓度 (DCA4)单位/升(冷却液)	需要采取的措施
＞0.8	● 在冷却液浓度降至 0.8 单位/升以下之前无需更换 DCA4 或者 DCA4+维修水滤器 ● 不必向冷却液中加入 DCA4 或者 DCA4+添加剂 ● 在下一次换油周期时，测试冷却液的 DCA4 或者 DCA4+浓度
0.3 ～ 0.8	● 在每一换油周期时更换维修水滤器
＜0.3	● 更换维修水滤器 ● 向每升冷却液中加入 0.3 单位 DCA4 或者 DCA4+添加剂

注意：如果在每一换油周期更换了含有 DCA4 或者 DCA4+的维修水滤器，而且用重型汽车冷却液补充了损失的冷却液，则应将冷却液中的 DCA4 或者 DCA4+浓度提高到 0.5～ 0.8 单位/升之间。

4　每一维护周期需要的 DCA4 或者 DCA4+量

(重庆)康明斯发动机公司针对不同的发动机维护周期及不同规格的冷却系统提供了含有不同剂量 DCA4 或者 DCA4+添加剂的水滤器。下表是每一维护周期所需要的 DCA4 或者 DCA4+量。

4.1　对于具有较小容量(1-76 升)的冷却系统，所需要的 DCA4 或者 DCA4+量见下表：

公里	小时	维修水滤器(DCA4 单位数)				
40000	625		WF 2070(2)	WF 2071(4)	WF 2073(8)	WF 2074(12)
32000	500		WF 2070(2)	WF 2071(4)	WF 2072(6)	WF 2073(8)
24000	375		WF 2070(2)	WF 2071(4)	WF 2071(4)	WF 2072(6)
16000	250		WF 2070(2)	WF 2070(2)	WF 2071(4)	WF 2071(4)
8000	125			WF 2070(2)	WF 2070(2)	WF 2070(2)
维护周期		容量,升	1-19	19-38	38-57	57-76

推荐发动机每工作 250 小时作为一个维护周期。

4.2 对于大容量的冷却系统，可以采用维修水滤器和 DCA4 或者 DCA4+干式添加剂或液体组合来达到所需要的 DCA4 量

发动机冷却	加入的 DCA4 或者 DCA4+单位数	
系统的容量 升	250 小时 (维修周期)	500 小时 (维修周期)
79-114	10	15
117-189	15	25
193-284	20	40
288-378	25	50
382-568	40	75
572-757	50	100
761-946	65	125
950-1135	75	150
1139-1325	90	175
1329-1574	100	200

5 DCA4 或者 DCA4+维修水滤器

(重庆)康明斯发动机公司提供下表所列维修水滤器

DCA4 型水滤器 零件号	DCA4+型水滤器 零件号	(上海)弗列加公司 零件号	DCA4 或者 DCA4+ 单位数
3318157	3100303	WF 2070	2
3315116	3100304	WF 2071	4
3318201	3100305	WF 2072	6
3315115	3100306	WF 2073	8
3316053	3100307	WF 2074	12
3318318	3100308	WF 2075	15
3318319	3100309	WF 2076	23
		WF 2077	无

6 DCA4 液体

(上海)弗列加公司可以提供下表所列 DCA4 液体。

零 件 号	DCA4 单位数	液 体 升 数
DCA60L	5	0.5L
DCA65L	20	2L
DCA70L	40	4L
DCA75L	200	19L
DCA80L	2200	208L

注意：这些液体的使用，请参照随零件所附的使用说明书进行。

发动机冷却系统的维护和保养

1．冷却系统的清洗

为了使发动机冷却系统保持清洁，在更换发动机冷却液后或发动机大修后，必须对发动机冷却系统进行清洗。

常用的清洗剂有乙二酸(草酸)、硫酸氢纳、碳酸氢钠等碱性清洗剂和硫酸、盐酸等酸性清洗剂。应根据实际情况决定选用酸性清洗剂或者碱性清洗剂(碱性清洗剂用于清除冷却系统的凝胶、 "锡花"、"油渣等"，酸性清洗剂用于清洗冷却系统的油泥等)。

如果采用酸性清洗剂对发动机冷却系统进行清洗，则在清洗之后应对冷却系统进行中和清洗，以防止残留的酸腐蚀冷却系统零部件。

清洗剂的剂量：按照每 30～57 升发动机冷却液加入 0.91kg 碱性清洗剂，或者按照每 30 升发动机冷却液加入 0.45kg 酸性清洗剂。

清洗方法如下：

① 排净冷却系统中的冷却液；
② 将预先配制好的清洗溶液加入发动机冷却系统，并在柴油机最高的空载转速下运行半小时；
③ 排净冷却系统中的清洗溶液；
④ 向发动机冷却系统加入适量的酸性清洗剂和柴油机冷却系统补充用水，起动发动机，待冷却液温度升至 85 ℃时，使发动机持续运转 5 分钟；
⑤ 排净冷却系统中的清洗溶液；
⑥ 向发动机冷却系统中加入清洁的软水，之后，使发动机持续运转 5 分钟；
⑦ 排净冷却系统中的冷却液；
⑧ 如果发动机要进行正常的工作或作业，则向发动机冷却系统中加入软水和防冻液(如需要),同时在柴油机上装上预加水滤器,并确保冷却系统具有每加仑(3.785 升)发动机冷却液含有 1 单位 DCA4 或者 DCA4+化学添加剂。

2． 冷却系统的维护保养

随着柴油机工作时间的延长，柴油机冷却液中的各种化学添加剂由于完成防腐蚀、穴蚀等任务而不同程度的消耗，这是比较正常的情况。但如受到柴油机冷却液被稀释或大量损耗，则将导致冷却液中的化学添加剂大量损失。一旦添加剂消耗过量，就可能引起冷却液中添加剂浓度低于规定的最低推荐浓度，就可能引起零部件腐蚀、穴蚀等，严重影响柴油机的可靠性、耐久性和经济性等。因此，要求对柴油机冷却液中的添加剂的浓度进行严密监控，并对柴油机进行正确的维护和保养。

维护保养方法：

⑴ 净化柴油机冷却系统

新柴油机使用前或柴油机大修后，应按照上面所述的方法对柴油机冷却系统进行清洗。

发动机清洗完毕之后,即可根据所使用的柴油机的冷却系统水容量向冷却系统中加入适量的软水和/或防冻液，待加满后，起动发动机运行约 5 分钟，以完全排除残存在冷却系统中的空气。之后，再向冷却系统补充软水和/或防冻液至规定的水容量或水位。

⑵ 首次向冷却系统中加注 DCA4 或者 DCA4+化学添加剂

在柴油机冷却液中首次使用 DCA4 或者 DCA4+时，要确保每加仑(3.785 升)发动机冷却液含有 1 单位 DCA4 或者 DCA4+化学添加剂的比例。这一比例可以用添加剂单位数比较接近的预加水滤器来达到，也可使用预加水滤器加干式的或液态的 DCA4 或者 DCA4+来达到。

下表是 DCA4 或者 DCA4+预加水滤器选用表

柴油机冷却系统容量		预加水滤器 零件号	DCA4 或者 DCA4+添 加剂单位数	每加仑冷却液的 DCA4 或者 DCA4+ 添加剂单位数
加仑**	升			
4 – 8	15 – 30	3315115 或 3100306	8	2.0 – 1.0
8 – 15	30 – 57	3318318 或 3100308	15	1.88 – 1.0
15 – 23	57 – 87	3318319 或 3100309	23	1.92 – 1.0
21 – 30	80 – 114	(2*)3318318 或 3100308		1.43 – 1.0
31 – 50	117 – 190	(4*)3318318 或 3100308		1.94 – 1.2
51 - 100	193 - 380	(4*)3318319 或 3100309		1.8 – 0.92

* 表示水滤器数量

**本文所提到的加仑均指美制加仑

⑶ 使用中的柴油机冷却系统维护和保养

在重庆康明斯柴油机的第一次"B"级保养时，应将预加水滤器更换为工作(或维修) 水滤器。在以后的每一次"B"级保养时，都要换装水滤器工作(或维修)芯子。

如在柴油机使用过程中，因冷却系统泄漏或溢出而损失了冷却液，则需要向冷却系统补充一定量的 DCA4 或者 DCA4+化学添加剂。需要补充的 DCA4 或者 DCA4+化学添加剂量可以用下列公式进行估算：

A = B (C – D)

这里：A----需要补充的 DCA4 或者 DCA4+化学添加剂剂量，克

B----柴油机冷却系统水容量，升

C----DCA4 化学添加剂标准含量，5.99 克/升；DCA4+化学添加剂标准含量，3.12 克/升

D----所测的冷却液中 DCA4 添加剂的含量，克/升

⑷ 定期清洗柴油机冷却系统

柴油机冷却液在使用过程中，容易出现下列问题：防冻液中的乙二醇氧化变质成极具腐蚀性的有机酸、DCA4 或者 DCA4+化学添加剂沉淀、冷却液被泄入其中的机油和燃烧废气污染、冷却液中的矿物质浓度升高等，因此，不能无限期地使用已加入柴油机冷却系统中的冷却液，而应定期更换冷却液并清洗冷却系统。

一般情况下，推荐柴油机冷却液使用期限为一年，而对于一个经过滤清和定期维护保养的冷却液，其使用时间可以延长至两年。

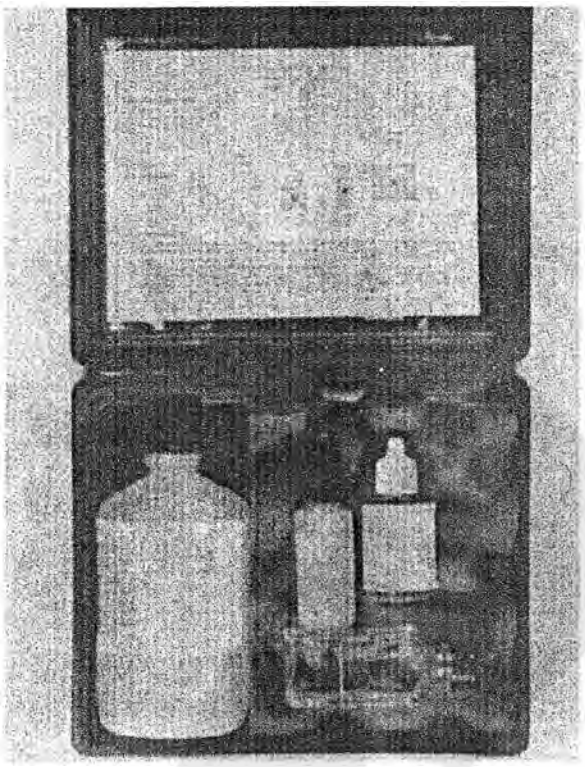


图 2-5 （N12021）DCA 冷却液试验包

图 2-6 （N12022 ）混合瓶

散装贮存的补充用冷却液

散装贮存的补充用冷却液应按下列程序混合和贮存。

1． 放尽贮存罐中的液体并加以清洗，以除去任何杂质。

2． 按贮存罐的装载容积计算水和防冻剂（如果需要使用的话）的数量。例如一个 500 加仑〔1892 升〕的贮存罐，若按 50:50 比例配制冷却液时需要 250 加仑（946 升）的水和 250 加仑〔946 升〕的防冻剂。

3．将贮存罐的总容量（加仑）乘以需要的 DCA 浓度，在上例中，对 50:50 的冷却液，每加仑要 1.5 盎司（每升要 12 毫升）的 DCA。1.5 盎司/加仑乘以 500 加仑〔1892 升〕得到 DCA 的总需要量是 750 盎司〔46 磅 14 盎司〕〔21.3 公斤〕。

4．先将水加到贮存罐中，在连续搅动中每次加少量的 DCA 直至全部溶解。水温应超过 50℉[10℃]。

5．如要用防冻剂，就在最后加，继续搅动以保持配制好的冷却液在溶解状态。若不搅动或循环，DCA 和防冻剂都会沉积在罐底。循环的办法是用一只水泵不断地从罐底吸出 DCA 和防冻剂，再从上面注人液体。可以分别从冷却液的液面、中部、罐底取样，分析防冻剂和（或）DCA 的浓度，以检查搅动是否足够均匀。

水滤器的使用和维护

水滤器的作用

（1）减少穴蚀和抑制腐蚀

向柴油机冷却系统补充最有效的化学剂，维护冷却液具有合适的添加剂浓度，减少柴油机缸套、水泵叶轮等零件穴蚀和抑制水泵叶轮及其壳体，冷却系统弯接头和管子以及热交换器、散热器、机油冷却器、中冷器管子用期端盖等零部件的腐蚀。

（2）保持冷却液具有合适的酸碱性或 PH 值；

（3）防止堵塞和积垢。

用化学物质软化冷却液，防止在传达室热零部件水侧表面形成积垢而引起缸盖炸裂，活塞环磨损严重等，

防止沉淀物堵塞热交换器和散热器管子及缸体和缸盖中的冷却液通道。

（4）减少磨损

滤除冷却液中的泥芯砂、淤泥、机油、矿物性水垢、铁锈、变质的添加剂沉淀物和密封件碎块等杂质，减少水泵轴与水泵壳体之间、缸套缝隙密封圈、水泵水封（端面密封）、调（节）温器与调温器壳体以及调温器密封圈等零件的魔损。

（5）可以用来诊断发动机故障并确定故障发源处。

（6）抑制变脏

通过对发动机冷却液中的泥芯砂、淤泥、机油、矿物质水垢、变质的添加剂沉淀物等的过滤呵以抑制调温器、水温传达室感器和水加热器零件表面变脏。

（7）水滤器的存在，本身可以提醒用户保护好冷却系统，并向冷却液中补充化学添加剂，对冷却系统进行良好的维护保养；

旋装式水滤器的使用和更换

对冷却系统进行正确维护、保养的关键之一就是使用水滤器，许多发动机操作者认为向冷却系统加入清洁水和化学添加剂后，就没有必要再使用水滤器了。这种观点是不正确的，因为污物是发动机所固有的，它与使用优质的冷却水无关。

不正确使用优质水滤器将引起下列问题：

（1）在水泵密封表面及缸套表面形成沉淀或使这些零件鳞片化（及腐蚀）；（2）冷却系统零部件腐蚀、磨损、堵死调温器等；

（3）堵塞机油冷却器、散热器和中冷器管子、冷却系统管和水道；

（4）在传热表面形成油性沉淀物。

注意，在发动机工作过种中，随着其工作时间的延长，发动机冷却液中的化学添加剂在不断地被消（损）耗和稀释，亦即在不断地减少。因此，用户要定期检测发动机冷却液在的 DCA 的浓度。

在重庆康明斯柴油机的第一次“B 级”保养（或更换机油）时，必须将水滤器预加芯子更换成水滤器工作（或维修）芯子。在以后的每次“B 级”保养检查时都要换装水滤器工作（或维修）芯子，但下列两种情况例外。

①如在水滤器芯子更换期间向冷却系统加入了配制的冷却液，则应用水滤器预加芯子进行更换；

②每一次排净冷却液后，应安装水滤器预加芯子。

更换冷却液后的新发动机或大修后的发动机，其初次使用的水滤器，使用时间（或寿命）一般推荐为 100 小时或 5000 公里，正常的水滤器使用时间则按每种型号的发动机的 B 级保养要求进行，亦即每使用 250 小时（可六个月）或 16000 公里后予以更换。

更换水滤器的方法程序如下：

①关闭水滤器进、出水管上的两个放水开关或闸阀；

②从柴油机上拆下添加剂已经耗尽的水滤器，然后将其扔掉。拆卸时可以使用旋装式滤清器扳手；

③在滤清器密封圈上端面涂上一层薄薄的柴油机润滑机油油膜，之后，将滤清器安装到滤清器座上去，旋转滤清器直到其密封圈与滤清器座面接触；

④再将滤清器旋转 3/4-1 圈即可，拧紧力矩为 40N.m（30ft-1b）。

当水滤器安装好后，如暂不使用水滤器或更换水滤器时，则应将水滤器进、出水管路上的闸阀（或开关）关闭，使用时才打开这两个闸阀（或开关），并将其旋至最大的开度。

清洗／更换曲轴箱通风器和空气滤清器

根据用途不同，重庆康明斯柴油机所用的空气滤清器有轻型空气滤清器和重型空气滤清器两种。轻型空气滤清器的滤清效率、纳污能力分别在 99.5%和 6.4g/1.s 以上，适用于环境空气含尘量较低的工况下工作的所有

重庆康明斯柴油机发电机组和船舶推进（主、辅）用柴油机（机组），主要由空气滤清器帽、壳体和一个滤清器芯等组成；重型空气滤清器的滤清效率和纳污能力分别在 99.90%和 53g/1.s 以上，适用于在环境空气中高含尘量的特殊工况工作的建筑工程机械（如推土机、挖掘机、装载机等）、矿用汽车和非公路用特种牵引车辆（如矿用自卸汽车、石油勘探与钻采机械等）、农林及水利工程机械（如伐木牵引车、水泵动力机组等）、铁道建筑机械（如铁路起重塔吊）等，重型空气滤清器主要由滤清器壳体、两级（或内、外）空气滤清器芯和旋流管组等构成，空气从旋流管组（或预滤器）壳体周围的小孔沿着切线方向进入各旋流管（或旋风管），旋流管通过管内的导流叶片而使气流产生强烈的旋流，在旋流和反向过程中，由于离心力的作用，空气中夹杂着的水和灰尘等粒度较大的杂质颗粒便被甩向旋流管的管壁及其下面，再落入空气滤清器的积尘盘内，再从集尘盘内间隙地或经常性的排出尘土。气流再由旋流管下方反向，流过其通气管，之后再进入空气滤清器壳体，通过微孔外滤芯（或主滤芯）将残存的轻质粉尘过滤后进入内滤芯（或次滤芯、安全滤芯），最后从安全滤芯出来的清洁的空气经增压器增压和（或）中冷器冷却后就进入柴油机燃烧室参加燃烧。

对于重型空气滤清器，使用过程中，应经常打开积尘盘出尘口（必要时，还可拆下积尘盘），放掉积聚的尘土等，不允许积尘盘积聚较多的尘土。间隔期长短需视使用环境的大气中尘土含量多少而定。

空气滤清器使用一段时间后，滤清器芯就会变脏，滤清器的进气阻力也会随之增大，当空气滤清器的进气阻力增大到 625kPa 以上时，柴油机将因得不到足够的空气供应而将产生排气早冒黑烟、动力不足等问题。

用户可以通过观察装在空气滤清器后的进气管上的空气阻力指示器来判断空气滤清器的堵塞情况，即如当空气阻力指示器的指示窗口由正常情况下的绿色变成红色，则表明滤清器进气阻力超过限定值，需要对其进行清理或更换。

一旦出现空气滤清器堵塞，就应该立即停机清理或更换空气滤清器芯，而后应近空气阻力指示器端头的橡皮塞复位。可按下列程序来清理滤清器芯。

1.轻敲空气滤清器芯端盖，将滤清器芯上积聚的尘土振落；

2.打开积尘盘出尘口，放掉积聚的尘土；

3.打开滤清器端盖，将滤清器芯拉出来；

4.用干净的布或橡皮塞堵住滤芯两端，然后再用压力不大于 0.2~0.3Mpa 的干燥压缩空气沿滤清器芯斜角方向或者从滤芯内向外吹净滤清器芯表面。

注意：

①不允许用油或水清洗空气滤清器芯，否则滤芯孔隙被堵塞，增加空气阻力；同时柴油易被吸入气缸，造成装后起动飞车；

②旋流管与其壳体固定在一起，是不可拆的，清洗时可用热碱水清洗干净，并用清水冲洗后再用压缩空气将其吹净；

③重型空气滤清器的内滤清器芯（即为安全滤清器芯）是不能清理的。

当出现下列问题时，就必须更换空气滤清器（外）滤芯；

1.空气滤清器（外）滤芯已破损；

2.装上清理后的滤清器芯时，进气阻力指示器又指示为红色；

3.滤清器芯的清理次数已达到五次。

注意：对于重型空气滤清器，当其外滤清器芯破损或清理次数达到五次时，就必须更换其滤清器芯。

网格式滤芯通风器

1．卸下将盖（图 2-8.1）紧固到通风器本体（5）上去的翼形螺母（6），平垫圈和橡胶垫圈。

2．取下盖子，向上取出滤芯（2）、挡汽板（3）和衬垫（4）。

3．在规定的洗涤溶剂中清洗所有金属件和橡胶件。然后用压缩空气彻底吹干。

4．检查橡胶密封垫，必要时更换之。检查本体和盖子，看有无碎裂、碰瘪或破损；丢掉不能用的零件。

5．将清洗过的或新的滤芯（图 2-8.2）和清洗过的挡汽板（3）装上通风器本体（5）。

6. 将橡胶衬垫（4）装进盖子（1 ），将盖子总成放到本体（5）上。
7. 装上橡胶垫圈、平垫圈和翼形螺母（6）；拧紧。

图 2-7　安装 DCA 旋装式水滤器

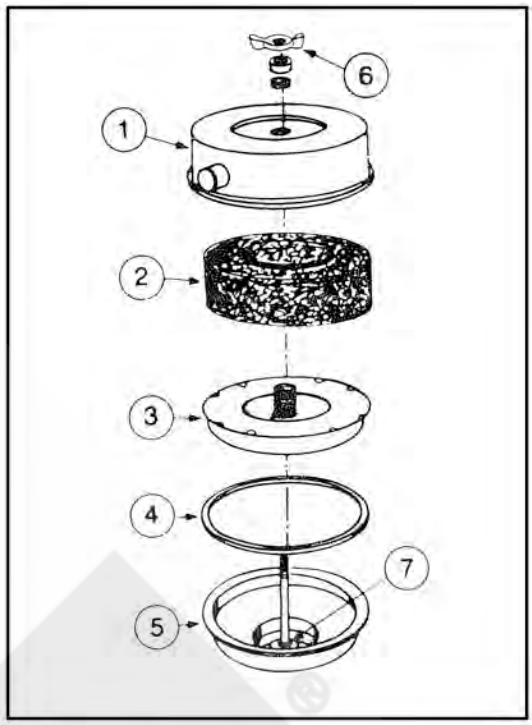


图 2-8　曲轴箱通风器—带档气板的滤芯

清洁消音器

1. 拆下消音器。
2. 用蒸汽清洁消音器。将蒸汽喷嘴对准消音器的出气侧，使污垢从气体流动的反方向流出。
3. 安装消音器时应注意更换衬垫。

更换锌棒

拆下热交换器或船用齿轮冷却器里的锌棒。如果锌棒小于原始尺寸的 1 半，则立即更换新的锌棒。

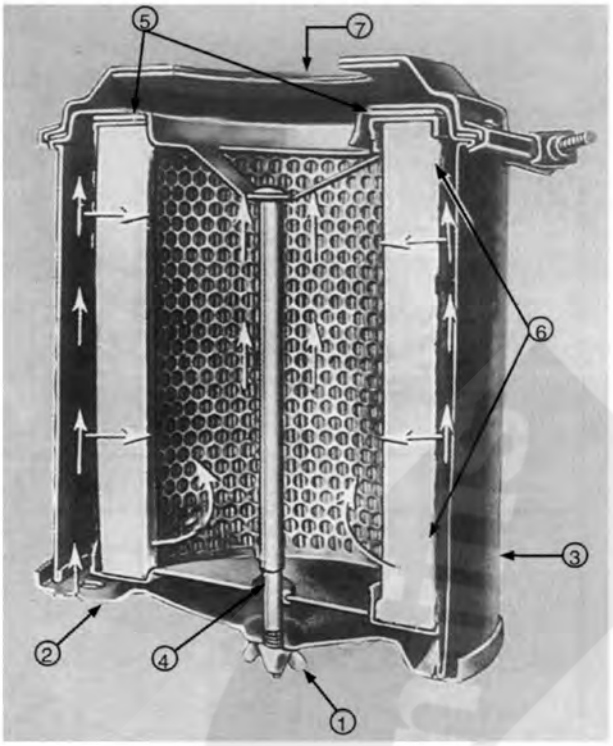


图 2-9　干式空气滤清器

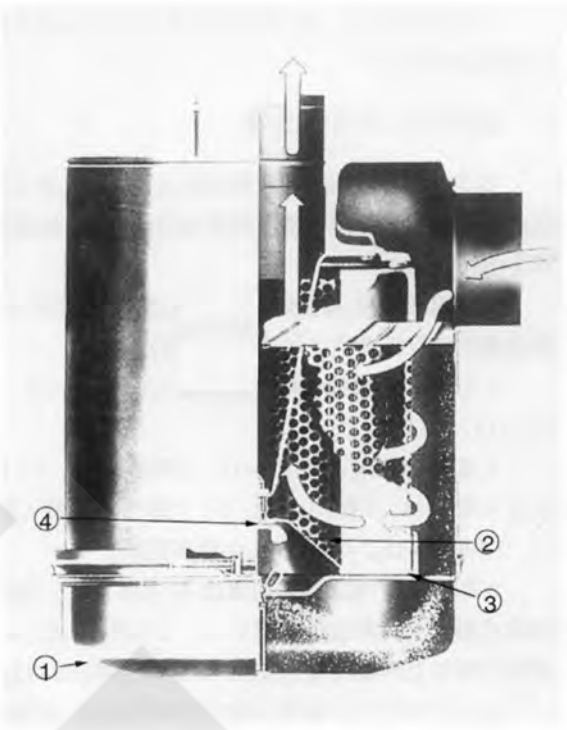


图 2-11　重型空气滤清器

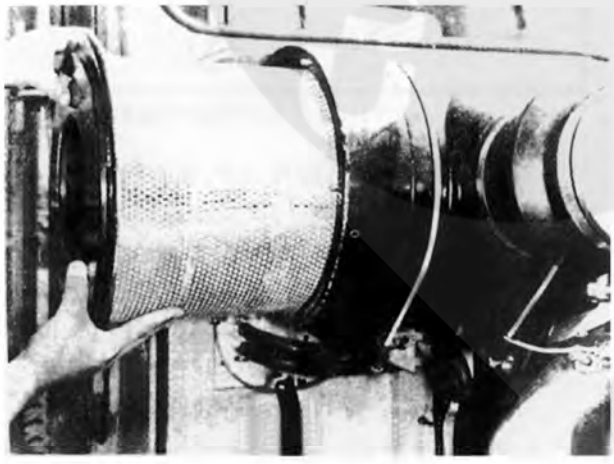


图 2-10　更换空气滤清器芯子

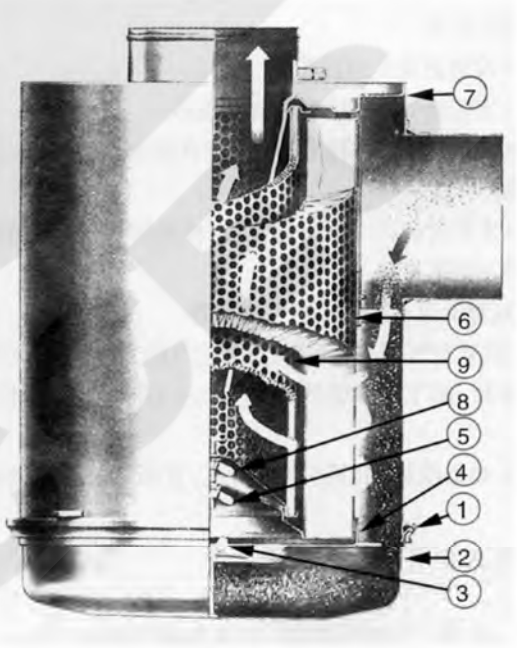


图 2-12　重型空气滤清器(双芯)

“C”级保养检查

每次进行“C”级保养检查时，先要完成所有“A”级和“B”级检查，然后进行下列检查。

清洗发动机

用燃汽或高压热水，采用安全的方法清洗有灰尘的发动机或配套部件。所有的电子元件和导线应防止受清洗喷嘴的冲击。

调整喷油嘴和气门

要使发动机能正常运转，必须始终保持喷油嘴和气门调整正确。这两项中一项控制发动机的进、排气，另一项控制进人气缸的燃油。

必须按下列所述进行调整。

温度调整

下列温度条件使发动机各部件达到所必须的稳定状态，以保证准确的调整。

“冷调”的定义

发动机应当在要进行调整的环境温度下不工作（至少四小时），以达到一个稳定温度。

“热调”的定义

1．油温最小为 190℉[88℃]，水温最小为 185℉[85℃]时按热调数值调整喷油嘴和气门。

2．若没有机油温度计，则使发动机在额定转速和载荷下或在高怠速下至少运转 20 分钟，然后立即进行调整。

KT/KTA19 型发动机的喷油嘴和气门调整

发动机盘车

1．拆下轴上的锁销（图 2-13），将轴压人直到盘车齿轮的驱动齿轮啮合。

2．按旋转方向转动曲轴直到气门调整标记与箭头对准。

图 2-13　KT/KTA19 上的盘车位置

3. 进行所有的气门和喷油嘴调整。调整完毕后，分离盘车机构，重新将锁销装入安全锁槽中去。

注意：在转动曲轴时，必须确保盘车齿轮与驱动齿轮完全啮合，以免损坏牙齿。不得用风扇来驱动曲轴。

气门调整标记位置

气门调整标记位于附件驱动皮带轮上（图 2-14），这些记号是刻在前盖板的凸台上的。有些发动机上调整标记要通过 PTO 外壳上所开的孔才能看到（图 2-15）。

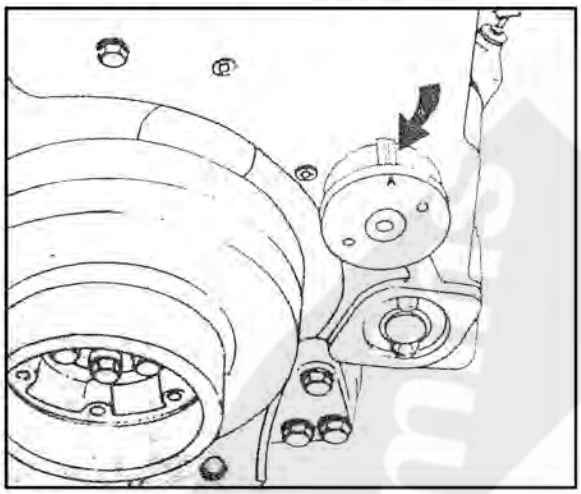


图 2-14 KT/KTA19 发动机附件驱动轮子上"VS"标记

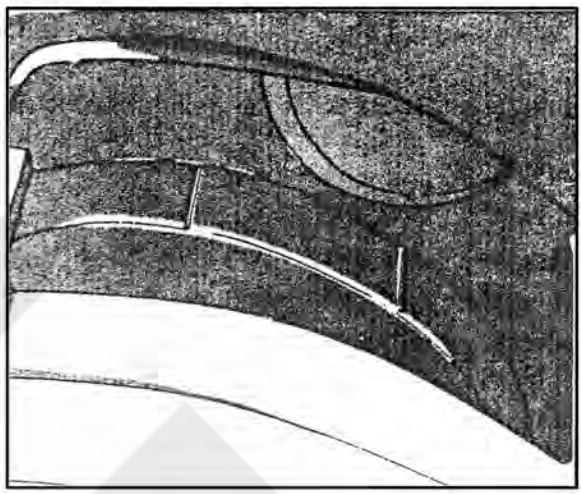


图 2-15 KT/KTA19 发动机飞轮上"VS"标记

调整喷油阻（千分表法）

转动曲轴直到附件驱动皮带轮上的"A"标记和齿轮室盖上的箭头对准（图 2-14，图 2-15 和图 2-16）。在此位置上检查第二和第五缸的气门摇臂，摇臂松动的缸进行调整气门，对应的第三或第四缸调整喷油嘴，见表 2-3。

表 2-3 喷油嘴和气门调整位置

盘车方向	皮带轮位置	调整气缸位置	
		喷油嘴	气门
开　始	A	3	5
向前到	B	6	3
向前到	C	2	6
向前到	A	4	2
向前到	B	1	4
向前到	C	5	1
发火顺序：1-5-3-6-2-4			

注：不能在同一气缸上既调整喷油嘴又调整气门。

1. 将 3375007 千分表和支架装好，使接长杆位于柱塞上方，并接触到柱塞的顶部，但没有碰到摇臂。

注：由操作者用 3375010 摇臂扳杆扳动摇臂（图 2-17），注意柱塞行程，如果柱塞行程不在表 2-4 的规定值内，则从下列第 2 步开始进行调整。

表 2-4 柱塞行程调整极限

喷油嘴柱塞行程英寸〔毫米〕	气门间隙英寸〔毫米〕	
调整值	进气	排气
0.304±0.001[7.72±0.03]	0.014[0.36]	0.027[0.69]

2. 松开喷油嘴调整螺钉上的锁紧螺母。

3. 拧下调整螺钉直到柱塞接触到喷油嘴杯底，再拧下 15 °，使其挤出油杯中的全部油。

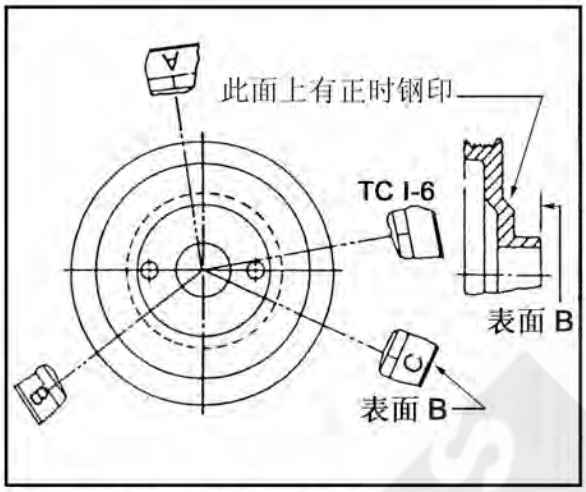


图 2-16　附件驱动皮带轮上的标记

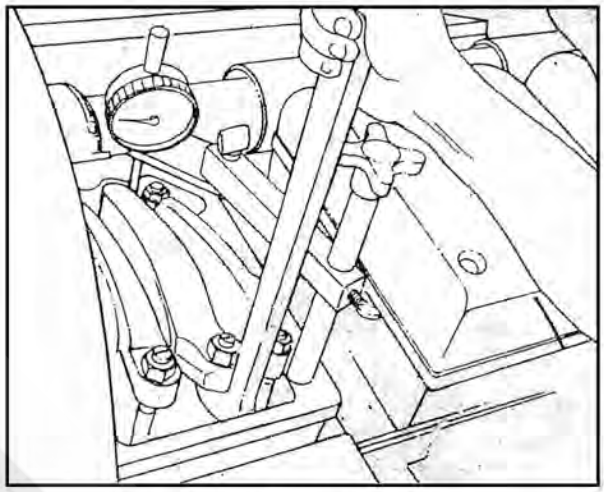


图 2-17　用 3375010 扳动摇臂

4．至少拧回调整螺钉 1/2 圈，再拧到底，将千分表指针调零（0）。

注意：不要过分拧紧调整螺打，这将损坏油杯。

5．拧回调整螺钉直到柱塞行程在表 2-4 上的规定之内（图 2-18）。

6．固定调整螺钉，用 40~45 英尺-磅[54~61 牛·米]的扭矩拧紧锁紧螺母。

注：当使用 ST-669 扭力扳手接头时，锁紧螺母扭矩为 30~35 英尺-磅[41~47 牛·米]，（图 2-19）。

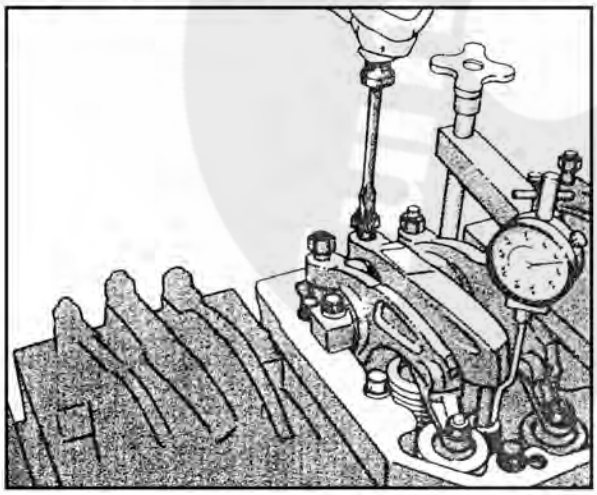


图 2-18 调整喷油柱塞行程

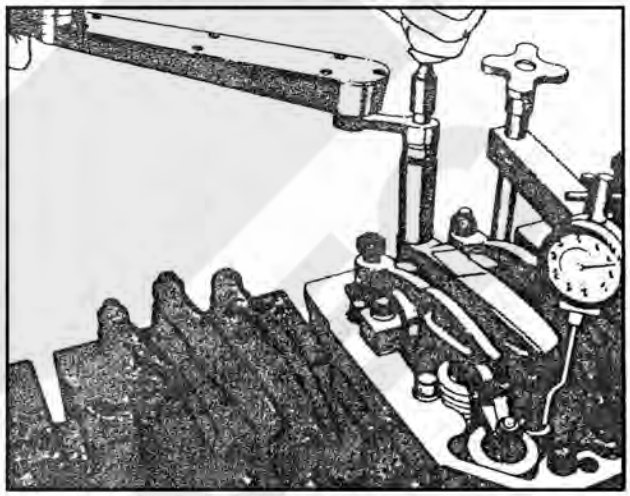


图 2-19 用 ST-669 拧紧锁紧螺母

调整丁字压板

注：2004 年后生产的发动机采用了改进型的压板，不再需要调整。

1．松开十字头调整螺钉上的锁紧螺母，并将调整螺钉退出一圈。

2．用手轻轻压在十字头接触面上，以使十字头和气门杆接触，拧下十字头调整螺钉，直至它接触到气门杆，固定调整螺钉，用 25~30 英尺-磅[34~41 牛·米]的扭矩拧紧锁紧螺母。

注：当使用 ST-669 扭力扳手接头时，锁紧螺母扭矩为 22~26 英尺-磅[30~35 牛·米]。

3．用线规检查十字头和气门弹簧座之间的间隙，图 2-20,1,2，最小间隙为 0.025 英寸[0.64 毫米]。

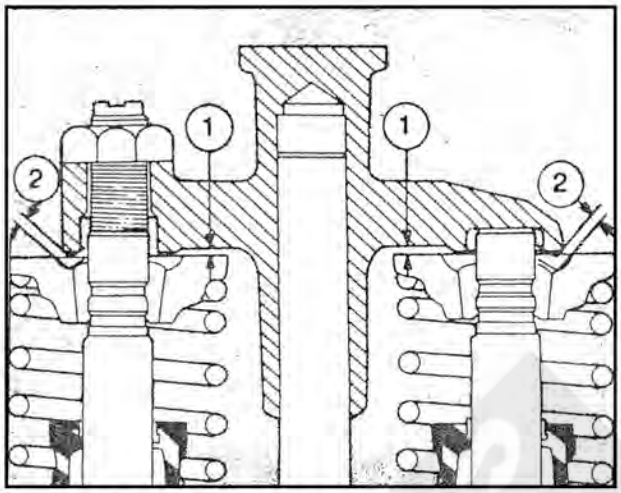


图 2-20　气门弹簧座与十字头之间的间隙

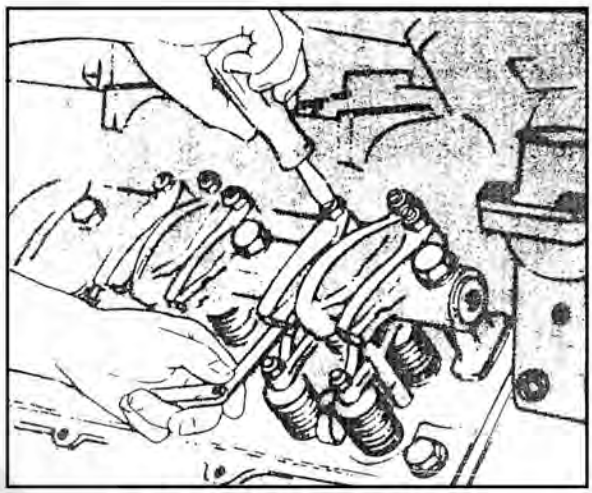


图 2-21　调整气门间隙调整气门

调节气门

注：调整喷油嘴和调整进、排气门是在同一"VS"标记曲轴位置进行。气门调整是在其气门摇臂都松动的那缸进行。

1. 松开进、排气门调整螺钉上的锁紧螺母。
2. 在摇臂和十字头接触面向插入合适的厚薄规（图 2-21），气门间隙见表 2-4。
3. 拧下调整螺钉，使其摇臂接触厚薄规。
4. 固定调整螺钉，用 40~45 英尺-磅[54~61 牛·米]的扭矩拧紧锁紧螺母。

注：当使用 ST-669 扭力扳手接头时，锁紧螺母扭矩为 35~40 英尺-磅[47~54 牛·米]。

5. 固定十字头，用 3375008 扳手以 47~49 英尺-磅[64~66 牛·米]的扭矩拧紧锁紧螺母。

注：按旋转方向转动曲轴，保证气门和喷油嘴按发火顺序调整正确，表 2-3。

KT/KTA38 和 KTA50 型发动机喷油嘴和气门调整

盘车位置

盘车机构可以安置在飞轮的左侧或者右侧（图 2-22），在盘车机构上方的开孔"A"或"C"的盖板必须卸下，以观察飞轮上的"VS"气门调整标记。

1. 卸下轴上的锁销，压下轴直到盘车齿轮与驱动齿轮啮合。
2. 按旋转方向转动曲轴，直到对准气门调整标记。

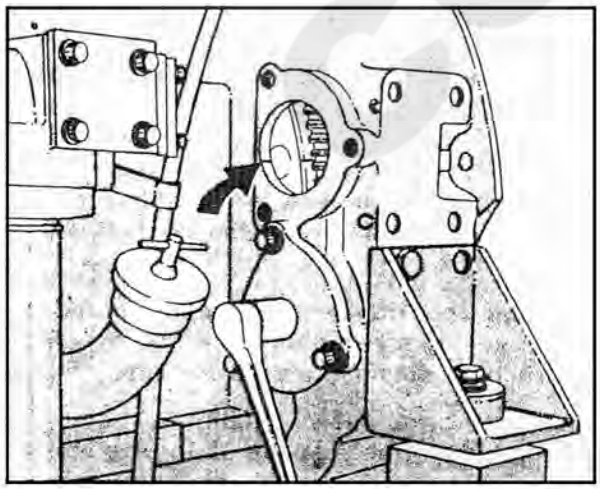


图 2-22 盘车机构位置"C"

3．调整全部喷油嘴和气门。当调整结束后，脱离盘车齿轮，将锁销装入轴的安全锁槽内。

注意：当旋转曲轴时，要确保盘车齿轮与驱动齿轮完成啮合，否则将损坏齿轮齿牙，不得扳动风扇来转动曲轴。

气门调整标记位置

“VS”气门调整标记可能从三处看到，在对准了一个标记时，可调整同一气缸上的喷油嘴和气门。

注：必须将曲轴旋转两整圈才能调整好所有的喷油嘴和气门。

1．当从左侧缸体撬转曲轴时，在飞轮壳“C”孔看到飞轮上的正时标记“VS”必须和飞轮壳上的刻线对准，（图2-30）。

2．可在减震器上看到“VS”标记时，使正时标记和齿轮室盖上的箭头对准。（图2-23）。

3．从右侧缸体撬转曲轴时，在飞轮壳“A”，孔上看到飞轮上的正时标记“VS”必须和飞轮壳上的刻线对准。（图2-24）。

注：要保证飞轮上的“A”正时标记和飞轮壳上的“A”标记配对。“C”标记和“C”标记配对。见图2-25 和图2-26的气缸布置和发火顺序。

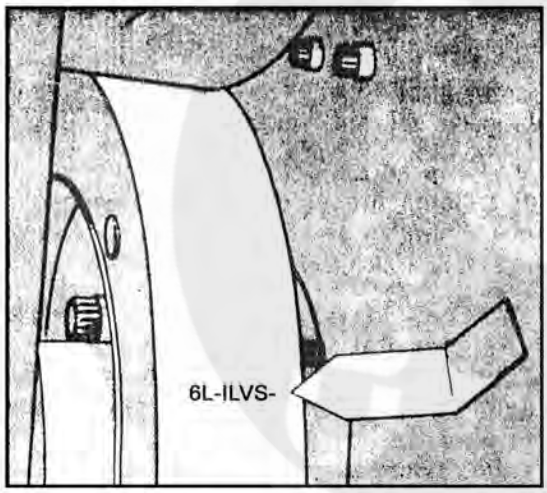


图2-23　减振器上的“VS”标记

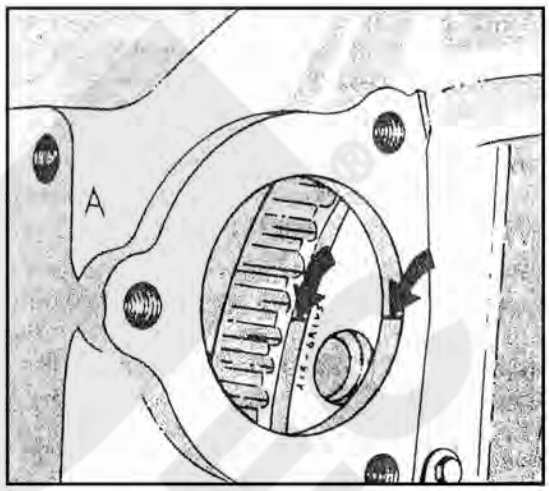


图2-24 “A”处的“VS”标记

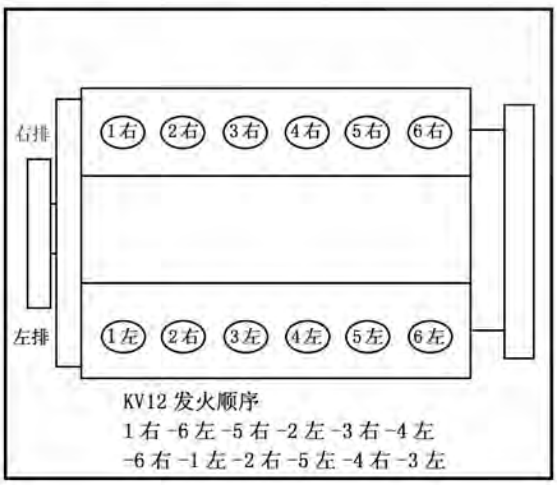


图2-25　KV12 气缸布置

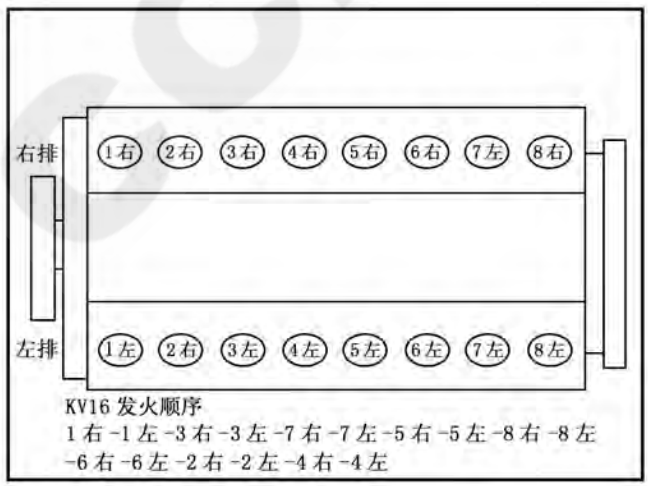


图2-26　KV16 气缸布置

调整喷油嘴（千分表法）

1．按旋转方向转动曲轴，直到相应的气门调整标记和飞轮壳上的刻线对准或减振器上的气门调整标记和齿轮室盖上的箭头对准。

注：在调整喷油嘴和气门时，任一气门调整标记均可作为开始点。两个气缸中，哪一个气缸的一对气门都处于关闭状态（摇臂可以自由上下）的，就是可以调整喷油嘴柱塞行程和气门的气缸。

2．安装好 3375004 千分表和支架，使接长杆位于喷油嘴柱塞顶上（图 2-27）。确保接长杆装在千分表杆上而不和摇臂接触。

3．用摇臂扳杆 3375010 将摇臂压向喷油嘴，直到柱塞下降到油杯底部，以挤出杯中油膜（图 2-28）。让柱塞回升，再压到底，并将千分表调零（0）。检查接长杆是否与柱塞顶部接触。

4．移开摇臂扳杆，转动调整螺钉表到千分表所示的行程读数符合表 2-5 规定。

5．用摇臂扳杆再压下柱塞，然后放开摇臂扳杆；千分表所示柱塞行程读数必须符合表 2-5 的规定范围。

6．直到完成柱塞自由行程检查后，才能卸下千分表。

表 2-5：柱塞行程调整极限

喷油嘴柱塞行程英寸[mm]	气门间隙英寸（毫米）	
调整值	进气	排气
0.308±0.001[7.82±0.03]	0.014[0.36]	0.027[0.69]

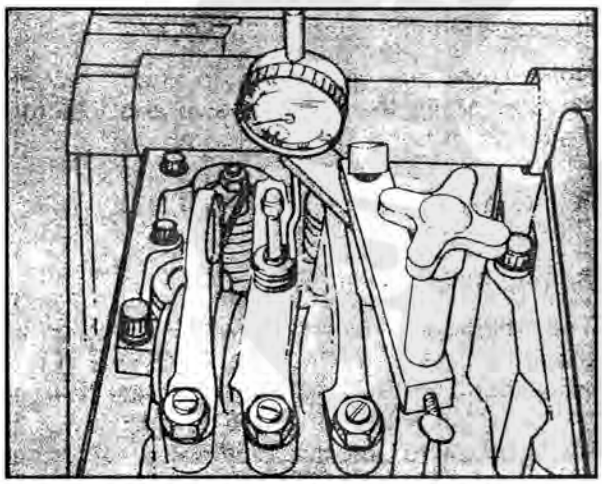


图 2-27　千分表接长杆与柱塞接触

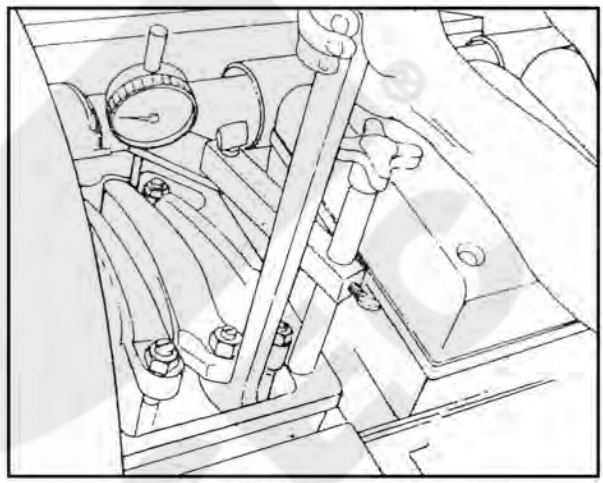


图 2-28　用 3375010 扳动摇臂

检查喷油嘴柱塞自由行程

为了避免喷油嘴传动系过载而早期损坏，按下列步骤检查柱塞的自由行程。

1．用摇臂扳杆将柱塞压到底，检查千分表读数；必须为“0”。松开摇臂扳杆。

2．将摇臂调整螺钉从调整位置退出 1/2 圈，拧紧锁紧螺母。

3．检查千分表接长杆是否与柱塞顶部接触，盘动发动机，记录柱塞自由行程总量。柱塞自由行程必须在 0.330~0.338 英寸[8.38~8.59mm]之内。

注：在调整喷油嘴和气门时，柱塞自由行程超过第 3 步规定范围的气缸必须交换摇臂总成和凸轮从动件总成，直到达到正确的范围为止。如果交换零件达不到正确的自由行程，则安装新零件。

4．松开调整螺钉，按喷油嘴柱塞行程调整一节中第 3、4 和 5 步所述再调整柱塞行程。

5．用 ST-669 扭力扳手接头固定调整螺钉，用 30~35 英尺-磅[41~47 牛·米]的扭矩拧紧锁紧螺母。如果没有用 ST-669 扭力扳手，可用螺丝刀固定调整螺钉，用 40~45 英尺-磅[54~61 牛·米]的扭矩拧紧锁紧螺母。

6．拧紧锁紧螺母后，像检查调整那样再扳动柱塞几次；如果需要可能再调整。

7．卸下千分表支架。

调整丁字压板

丁字压板的调整方法与 KT/KTA19 型发动机的丁字压板相同。

注：2004 年后生产的发动机采用了改进型的压板，不再需要调整。

调整气门

1. 在应调整的气门摇臂和十字头之间塞进规定厚度的厚薄规。见表 2-5 的气门间隙。

注：在发动机左排缸体，排气门是每个气缸盖上靠发动机前方的一对，在右排缸体上，排气门则是每个气缸盖上靠发动机后方的一对。

2. 拧下调整螺钉直到摇臂正好接触到厚薄规（图 2-29），用锁紧螺母时调整螺钉锁紧在这个位置上。

3. 当用 ST-669 扭力扳手接头固定调整螺钉时，拧紧锁紧螺母扭矩为 30~35 英尺-磅 [41~47 牛·米]，（图 2-30）。如果没有使用 ST-669 扭力扳手接头，可以用螺丝刀固定调整螺钉，拧紧锁紧螺母扭矩为 40~45 英尺-磅[54~61 牛·米]。

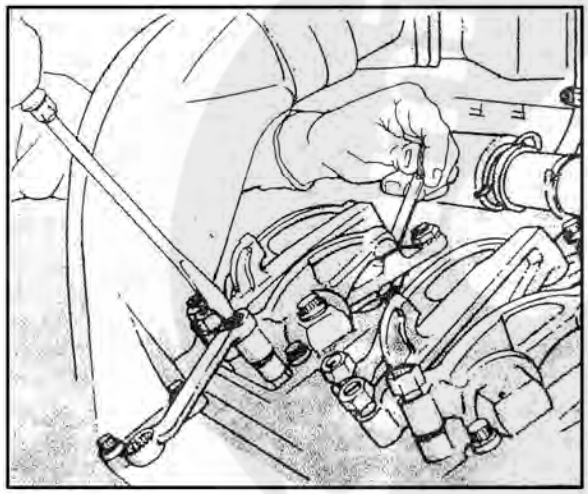


图 2-29　调整气门间隙

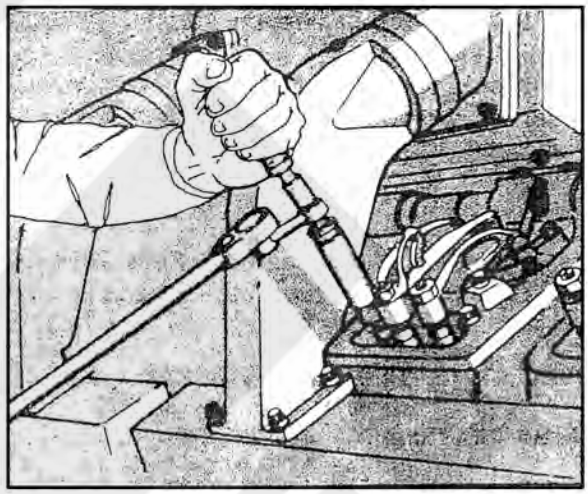


图 2-30　用 ST-669 扳手拧紧锁紧螺母

“D”级保养检查

在每次“D”级保养检查中，除要完成全部“A”级、“B”级和“C”级的检查外，还要进行下列检查项目。这些项目中的大多数是应当由重庆康明斯分销商或经销商来完成的，在他们那里能得到康明斯修理手册，其中有全部说明。

清洗和校准喷油嘴

定期清洗和校准喷油嘴可能避免向燃烧室供油发生阻滞。由于校准工作需要专用工具，所以大多数船主和船队认为让重庆康明斯分销商去完成清洗和校准喷油嘴工作将是较为经济合算的。

要参照 3379071 号通告及其修订版来清洗和较准喷油嘴。

将要清洗的喷油嘴从 KT/KTA19、KT/KTA38 或 KTA50 型发动机上拆下来后，从喷油嘴或喷油嘴“孔”上卸下密封座（图 2-31）。清洗、检查喷油嘴，并视需要予以更换。

注意：在每个喷油嘴“孔”里只能有一个密封座。在一个喷油嘴上使用超过一个密封座时，就会改变喷油嘴伸出长度使得燃烧恶化。

图 2-31　喷油嘴密封座

清洗和校准燃油泵

如有需要，检查燃油泵的校准，请从附近的重庆康明斯分销商或经销商取得数据。

修复或更换下列部件

检查水泵

检查水泵有无晃动和渗漏润滑脂。必要时换装已修复好并润滑过的部件。

检查/在必要时安装修复的部件

下列总成在这次检查中都应加以检查。可以有这几种选择：检查后继续使用，按修理手册的规定进行修复，换上新件，或由分销商/经销商提供的更换件，或由重庆康明斯柴油机翻修公司提供的部件。

检查涡轮增压器

检查涡轮增压器轴承间隙

检查轴承间隙。检查时不需将增压器从发动机上拆下，使用一个千分表测量转子轴的端隙，用厚薄规测量径向间隙（图 2-32）。

检查程序

1. 从涡轮增压器上卸下排气管和进气管，将转子总成的端头暴露出来。

2. 从前板（压缩机叶轮端）卸下一个紧固螺钉并换上一个长螺钉。将千分表装在长螺钉上并使千分表接头抵住转子轴端面。轴向推动轴，记下千分表的读数。K 系列发动机使用的是 HC5A/HX80 增压器，端隙应为 0.002-0.049 英寸[0.051-0.125 毫米]。

   a. 将叶轮推向腔筒一侧。

   b. 用厚薄规检查叶轮尖端和腔筒之间的间隙。HC5A/HX80 间隙为 0.0191-0.0294 英寸[0.485-0.746 毫米]。

3. 压缩机叶轮，只检查径向间隙。

4. 如果端隙超过规定，将这台涡轮增压器从发动机上卸下，换装一台新的或大修过的增压器。

5. 将排气管和进气管装上涡轮增压器。

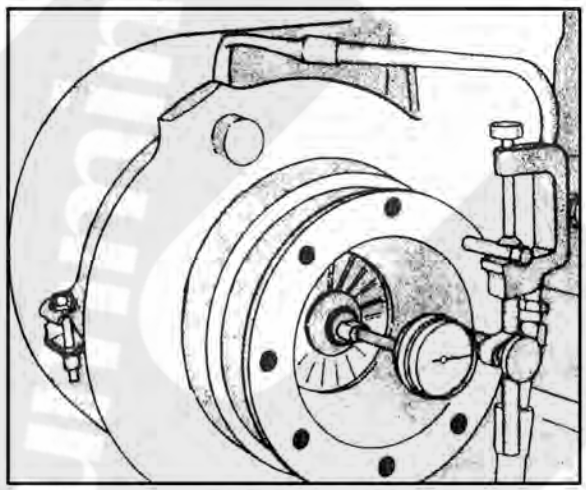


图 2-32　检查涡轮增压器轴承端间隙

检查减振器

硅油减振器

检查减振器有无液体渗漏、碰瘪和晃支。目检减振器厚度，看有无变形或减振器前盖板有无高起。

1. 如果减振器周围空间太小无法进行目检，用手指摸前盖板内侧和外一圈，如果发现有变化或变形的地方，拆下减振器并接下述程序检查。

2. 将减振器前后表面分成四个等分的区域来清除油漆、垢物和烟灰。用油漆溶剂和细纱布清除表面。

3. 使用千分尺来测量和记录按第 2 步清除过的减振器厚度，测量也是按上述等分的四个区域分别进行，并且是在距前盖板外边的 0.125 英寸[3.18mm]处测量。

4. 如果在四个区域所测量的厚度值彼此相差超过 0.010 英寸[0.25mm]时，就要更换减振器。

季 节 性 保 养 检 查

季节性保养检查总是在每季或一年的开始进行。如果发动机在连续使用，则每年要检查二次。一般需要更经常地检查。

清洗冷却系

冷却系必须清洗以使其工作正常。系统中的水垢降低了它从水套吸收的热量和向热交换器排出的热量。使用清洁的水以避免堵塞热交换器和缸体中几百条细小的水道。

化学清洗

为了保证冷却系统有效工作的最佳方法，就是用 DCA 水滤器防止铁锈和水垢形成。如果选用了 DCA，则冷却系统必须进行化学清洗。使用一种好的冷却系统清洗剂，如硫酸氢钠或草酸，然后是中和剂和冲洗。

检查软管

由于发动机润滑油软管或船用齿轮箱润滑油软管破损，可能会导致机油供给量减少，或者会使机油喷射到炽热表面可能引起着火，这样就会导致发动机的更大损坏。

对全部软管必须经过目检来保证：

1. 不得有腐蚀或擦伤痕迹。
2. 软管支撑正确。
3. 软管或接头处不得有渗透和泄漏。
4. 软管或接头不得与发动机任何零件、船用齿轮箱、发动机安装件和壳体摩擦或粘接。
5. 抱箍安装平行，不得使软管弯曲或扭曲。

这些检查应在发动机运转的条件下进行，在检查中不应对转管施加扭转或弯曲力，因为在维修完成后柔性管会“重新复位”。增压器和排气系统的隔热罩也应检查，以保证全部热表面都被盖住，减少机油直接飞溅到热表面的可能性。

清洗发动机/船用齿轮

用认可的溶液来清洗，并彻底吹干。

拧紧发动机安装螺栓和螺母

发动机安装螺栓偶尔也会松动使得发动机悬挂装置和支架很快磨损。拧紧所有安装螺栓和螺母，损坏的更换，丢失的补上。如果需要再检查船用零件对螺旋桨轴的同轴度。

检查曲轴端隙

新的发动机或大修过的发动机的曲轴端隙应符合表 2-16 的规定。磨损了的发动机端隙如果超过表上的磨损极限，就不能使用。

如果发动机拆开进行修理，止推环磨损超过 0.018 英寸[0.46mm]装不上时，就装上新的止推环。

检查端隙的办法是将千分表指针抵住减振器或皮带轮的端面，（图 2-33），然后抵住减振器或皮带轮的内部和前盖来撬动。当发动机装在船上并和船用齿轮箱装在一起时，必须有端隙（如表 2-6 所示）。

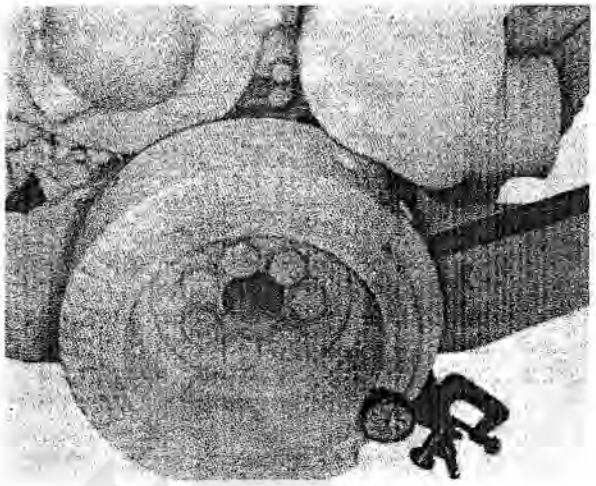


图 2-33　检查曲轴端隙

表 2-6 曲轴端隙-英寸[mm]

发动机（排量英寸）3	新的最小值	新的最大值	磨损极限
1150（19L） 2300（38L） 3067	0.004[0.10] 0.005[0.13]	0.017[0.43] 0.017[0.43]	0.021[0.53] 0.020[0.51]

检查安全控制

发动机安全控制应被钩连到蜂鸣器或其它报警装置上。

检查高水温控制

1. 拆下水道中的感应件。
2. 当水被加热到触发控制温度时接通电流，检查浸入水中的温度计。
3. 大约在 200℉[93℃]时蜂鸣器应发响。

发动机储存

在冬季储存发动机前应完成下列项目：

1. 将燃油箱注满清洁的柴油。
2. 检查全部软管和皮带，若需要则更换。
3. 检查锌塞，若需要则更换。
4. 放干机油并再注满。更换机油和燃油滤清器。
5. 密封全部润滑油道各开口、加注口和呼吸盖出口。
6. 检查发动机冷却系统，保证永久性防冻剂和防锈剂的合适浓度。
7. 盖住所有的进气系统开口，以防止灰尘进入。
8. 切断蓄电池电源，以防电源消耗。电池可在发动机定期起动时再接上。

在发动机从储存转人连转时，要完成下列项目的保养。

1. 清理发动机外部的全部灰尘。

2. 拆除全部的纸盖、胶盖和包封。

3. 检查发动机冷却系统中永久性防冻剂和防锈剂浓度。

4. 更换发动机机油和机油滤清器。

5. 检查全部的软管和皮带是否有裂纹、损坏和硬化，若需要则更换。

6. 检查锌塞，若需要则更换。

7. 目检发动机，看是否有发动机机油、海水和冷却液泄漏。检查和清洗生水泵吸水管处的过滤器。打开生水管路中的全部阀门。

注意：当进气和润滑油系统还密封时不得起动发动机。

8. 起动发动机，观察润滑油压和生水流动是否正常。

规 格 与 扭 矩

充分提供清洁和高质量的燃油、润滑油、润滑脂和冷却液是保证发动机长寿命和高性能方法之

润滑油、燃油、润滑脂和冷却液

润滑油的作用

重庆康明斯发动机中使用的润滑油必须是多功能的。必须具有下列主要作用：

润滑：在运动零件之间提供油膜润滑，以减少摩擦和磨损。

冷却：作为传热介质从临界面上带走热量。起冷却作用。

密封：充填缸壁、气门杆表面不平处和在涡轮增压器的油封中起密封作用。

清洗：使污物悬浮于其中，不致在发动机零件表面形成积垢。起清洗作用。

此外，润滑油还必须有下列作用：

阻尼和缓冲作用：特别对于高应力零部件如齿轮和推杆等。

防止氧化和腐蚀：对零件起保护作用。

当发动机内的润滑油失去上述功能时，必须给予更换。润滑油损耗很少，但会污染，从而不能起保护发动机的作用。润滑油污染是发动机运转的正常结果。因为在发动机运转期间，许多污物会进人到润滑油中。它们是：

发动机燃烧副产物-燃油不完全燃烧生成的沥清烯、碳烟和酸类。

酸、积炭和积垢：由于润滑油裂化分解或氧化而生成。

污物：通过进气、燃油以及在加润滑油或更换润滑油时进人发动机的污物。

润滑油必须加有添加剂，以防止上述各种物质污染。添加剂一般有：

清净剂和分散剂：使不溶性物质保持悬浮状态，以便润滑油通过滤清器时过滤掉或者在更换润滑油时随之一起放出，这样可防止在发动机中形成积垢和积炭。

抗氧化剂：使润滑油保持化学稳定性，防止形成酸类而腐蚀金属表面和在发动机停用期间产生锈蚀。

其他添加剂：使润滑油在接触负荷较高的表面保持润滑能力，防止拉毛和刮伤，控制泡沫和防止空气在润滑油中滞留等。

润滑油特性分类

有关发动机润滑油的特性分类和性能、使用要求参见重庆康明斯工程公告 3165408 。

磨合润滑油

对于新的或大修后的重庆康明斯发动机不推荐采用专门的磨合润滑油。磨合时使用的润滑油与正常运转时相同。

推荐的粘度

润滑油粘度是润滑油流动阻力的一个尺度。汽车工程师学会订有按粘度区分的发动机油类别。表 3-1 是各种级别润滑油的粘度范围。能满足低温标准（-18℃[0℉]）的润滑油后面带有“W”。符合高、低温性能要求的润滑油称为多级润滑油或多粘度级润滑油。

多级润滑油一般用加人改善粘度指数的添加剂来配成的。用添加剂后，可推迟低粘度基油在发动机运转温度下发生的稀释。在重庆康明期发动机上推荐使用符合 API 规范标准的多级润滑油。

注意：若发动机润滑油使用于变速器或齿轮箱，则各制造厂家应该联系关于这些部件对润滑油的粘度和成份要求。

康明斯公司和重庆康明斯发动机有限公司推荐使用具有表 3-2 所示粘度等级的多级润滑油。表 3-2 是在各种环境温度下推荐的粘度，只有此表列出的数值才是推荐的粘度级。

康明斯公司发现应用多级润滑油，有利于控制润滑油耗损，在保持高的工作温度下润滑作用的同时改善发动机的冷起动性能，还可降低燃油耗。康明斯公司和重庆康明斯发动机有限公司不推荐用单级润滑油。如果没有多级润滑油，允许用单级润滑油代替。

注意：当选用单级润滑油时，润滑油的使用温度必须在表 3-3 规定的范围内。

选择润滑油粘度级的首要原则在发动机油底壳中的润滑油历经的最低温度。如果润滑油粘度选得过高会造成流动不畅，在冷机起动时或起动后轴承会由于缺油而发生故障。根据发动机油底壳温度，改用低粘度级应达到表 3-2 所列范围的下限。

表 3-1：SAE 各级润滑油的粘度

SAE 粘度级	粘度范围 兆帕秒：mPa·S (厘泊，cP)在-18℃（0℉）时		毫米 ^{2}/秒；mm^2/S （厘沲，cSt）在 100℃（212℉）时
	最大	最小	最大
5W	1250	3.8	-
10W	2500	4.1	-
15W	5000	5.6	-
20W	10000	5.6	-
20	-	5.6	小于 9.3
30	-	9.3	小于 12.5
40	-	12.5	小于 16.3
50	-	16.3	小于 21.9

1. SAEJ300d 使用推荐书
2. lmPa.S=1cP
3. 1mm^2/S=1eSt

表 3-2：康明斯公司推荐的润滑油粘度级及其相应的环境温度

SAE 粘度级*	环境温度**
推荐级	
10W~30	-25~35℃[-13~95℉]
15W~40	-10℃或更高[14℉或更高]
20W~40	0℃或更高[32℉或更高]

*SAE-5W 矿物油不可使用

**对于温度始终低于-25℃[-13℉]的地方应参阅表 3-4

表 3-3：代用润滑油	
10W	-25~0℃[-13~32℉]
20W	-5~20℃[23~68℉]
20W~20*	-5~20℃[23~68℉]
20	-5~20℃[23~68℉]
30	4℃或更高[39℉或更高]
40	10℃或更高[50℉或更高]
*20W~20 润滑油虽则符合两种润滑油的粘度级，但不应看作多级润滑油	

重庆康明斯发动机有限公司推荐国产 15W~40、5W~30 多级润滑油和代用油 11 号、14 号中增压柴油机机油。

合成润滑油

柴油机的合成润滑油，原先是用合成碳氢化合物加酯类混合配成。这些基油是用低分子量材料起化学反应制成，用以生成具预期性能的润滑油。

合成润滑油是为极端环境条件用途而研制的。环境温度最低可达-45℃[-50℉]。最高允许 205℃[400℉]。在这样的极端条件下，石油基的润滑油（矿物油）不能满意地工作。

康明斯公司和重庆康明斯发动机有限公司推荐，在环境温度始终低于-25℃-13℉]的地区运转的，应使用合成润滑油。只要合成润滑油符合相应的 API 用途分类和粘度级，合成润滑油可用在环境温度较高的场合。

重庆康明斯发动机上使用合成润滑油时推荐的换油期仍与石油基润滑油时相同。

南北极地区用油

对于在温度始终低于-25℃[-13℉]的环境条件下使用和停车无保暖装置的发动机，润滑油性能应符合表 3-4 规定。符合这些性能要求的润滑油一般均有合成基的。只要合符在 100℃[212℉]时的最小粘度，可使用 SAE5W 粘度级的合成润滑油。

表 3-4：南北极地区用油规范	
参数（试验方法）	规范
性能	API 分类 CC/SC 级
质量标准	API 分类 CC/CD 级
粘度	在-35℃[31℉]，最大 10,000mPa,s
	在 100℃[212℉]，最小 4.1m^2/S
流点（ASTM D-97）	至少比预期的最坏环境温度还要低 6℃[10℉]
硫酸盐灰份（ASTM D-834）	最大 1.85%（按重量计）

润滑脂

康明斯发动机公司推荐使用满足 MIL-G-3545 规格的润滑脂，但具有钠或碱皂增厚剂的润滑脂外。可与润滑油供应商联系，得到满足这种规格的润滑脂。

注意：不得将不同牌号的润滑脂混在一起，这样会导致轴承损坏。润滑脂过多和润滑脂不足同样有害。

重庆康明斯发动机有限公司推荐用符合上述性能要求的国产润滑脂。

试验项目	试验程序
高温性能	
滴点℉	ASTM D2265，最小 350
轴承寿命，在 300℉的小时数，10,000 转/分	＊FTM331，最小 600
低温性能	
扭矩，克·厘米	ASTM D1478
0℉起动	最大 15,000
0℉运转	最小 5,000
防锈、防水能力	
防锈试验	ASTM D1743 通过
防水，%	ASTM D1264 最大 20

试验项目	试验程序
稳定性	
油分离，%，在 212℉下 30 小时	＊FTM321 最大 5
针入度	
起作用	ASTM D217 250~300
氧弹试验，磅/英寸 ^{2} 压力降	ASTM D924
100 小时	最大 10
500 小时	最大 25
腐蚀试验	＊FTM5309 通过
臧物量，颗粒/厘米 ^{3}	＊FTM3005
25 微米	最多 10
75 微米	最多 25
125 微米	无
橡胶膨胀	FTM3606 最大 10

＊FTM 即 Federal Test Method Standard 联邦试验方法标准第 79la 号

燃油

康明斯柴油机能使用低价而有高能量的 2 号柴油。经验证明，康明斯柴油机使用他符合表 3-5 规格的柴油也能取得满意的效果。

重庆康明斯发动机有限公司推荐用国产 0 号或 10 号轻柴油（GB252），见表 3-6。

表 3-5：推荐的燃油特性

性能指示	推荐规范	一般说明
粘度（ATMD-445）	1.3~5.8 厘沲[1.3~5.8mm/S] 在 104℉[40℃]	当燃油"浓度"或粘度适当时，喷油系统的工作效率才是最高的。康明斯的燃油系统适用于符合 ASTM 1-D 或 2-D 性能要求的柴油。
十六烷值（ASTM D-613）	最小 40，在寒冷天气或长时间低负荷使用时宜用效高的十六烷值不超过 1%（质量百分比）	十六烷值是燃油的起动性能和暖械性能的指标。
硫含量（ASTM D-129）		柴油中各种硫化物的含量是不同的。高流燃油的一种实用中和方法是与 API 的 CD 类机油配合使用。
活性硫（ASIM D-130）	铜带腐蚀 在 122℉[50℃]3 小时后不超过 2 号级值	燃油中的某些硫化物是活性腐蚀剂，以 122℉[50℃]3 小时腐蚀试验标定为 3 级或更高级值的燃油可能会引起腐蚀问题。
水和沉淀物（ASTM D-130）	不超过 0.1%（体积百分比）	燃油中的水和固体杂质含量一般分为水和沉淀物。在将燃油加人油箱时宜先经过滤。如果燃油箱不加满，在温度变化时会有水蒸汽凝结在油箱内。燃油泵和喷油器进油接头的滤芯、滤网一有积污必须清洗或更换。这些滤网和滤清器在使用过程中，若采用低质燃油或脏油时会逐渐堵塞，因而需要缩短更换期。
残碳（Ramsbottom ASTM D524 或 Conradson ASTM D-189）	在 10%残留物中残碳的重量百分比不超过 0.25%	发动机中柴油积碳的倾向可用确定燃油蒸发 90%以后的 Ramsbottonl 或 Conradson 残碳来衡量。
闪点（ASTM D-93）	至少 125℉[52℃]如高于 125℉则按法定温度	闪点是足以使燃油挥发以至在油面上方形成燃油空气混合气的燃油温度。
密度（ASTM D-287）	在 60℉时比重为 42~30 ° API[15 ° 时 0.816~0.876g/cm^3]	比重说明燃油所含密度能量成份的高低。1 加仑高密度（低 API 比重）的燃油比低密度（高 API 比重）的燃油含有更多的热量。
始凝点（ASTM D-97）	低于燃油预期使用环境的最低温度 10℉[6℃]	燃油的始凝点是开始出现石腊晶体的温度。石腊晶体可以看燃油的混浊度来检查。石腊晶体将会使滤清器堵塞。
灰分（ASTM D-482）	不超过 0.02%质量百分比	几乎在所有石油产品中都可发现少量不可燃金属物质，通称灰分。
蒸馏试验（ASTM D-86）	蒸馏曲线应圆滑和连续	在低于 680℉[360℃]时燃油应蒸发 90%以上，在低于 725℉[385℃]时燃油应全部蒸发。

表 3-6 中华人民共和国产品-轻柴油规格（GB252）

牌号 / 主要性能	+10	0	10	35
十六烷值溜出温度℃	≥50	≥50	≥50	≥43
50 %	≤300	≤300	≤355	≤300
90 %	≤355	≤300	≤350	-
粘度				
厘池	3~8	3~8	3~8	2.8~8
恩氏	1.2~1.67	1.2~1.67	1.2~1.67	1.15~1.67
凝点℃	+10		-10	-35

冷却液

水应当是清洁而没有腐蚀性化合物，如氯化物、硫酸盐和酸。水应当略呈碱性，其 PH（氢离子浓度）值在 8.5 到 10.5 之间。任何适于饮用的水按下述方法处理后就可用于发动机。井水或泉水经煮沸沉淀处理后也可使用。

维护发动机上的弗列加（Fleetgard）DCA 水滤清器。滤清器对冷却系旁通出一小部份冷却液进行滤清，其滤芯必须定期更换。

1．在夏季，不用防冻液，向系统中加水。

2．在冬季，选用一种防冻液（带防漏剂的除外），根据气温需要配加清水。

注：有些防冻液还含有防漏添加剂，如惰性无机纤维、聚合物粒子或姜根等。这种防冻液不能和水滤清器合用，因为滤清器将会滤出这些添加剂并使滤芯堵塞而失效。

3．按第 2 部分规定装上或更换 DCA 水滤清器。

投入现役的新发动机必须配备 DCA 水滤清器

1．从工厂运来的新发动机装有 DCA 预加滤芯的水滤清器。这种滤芯可与清水或除 Methoxy Propanol 防冻剂以外的所有水久型防冰冻剂都是相容的。关于 Methtoxy Propanol 预加法见表 3-7。

2．在第一次"B"级检查中（更换润滑油期），DCA 预加滤芯必须换以工作滤芯，见表 3-7。

3．在以后的每个"B"级检查中更换 DCA 工作滤芯。

a．如果在滤芯更换期之间要补充冷却液，应当使用预先处理过的冷却液，见"补充冷却液规范"。

b．每次将冷却系放水后，要按表 3-6 进行预加。

4．如果在工作滤芯更换之间的"B"级检查中加添了 3300858（DCA-4L）直接化合物添加剂到冷却系中，工作滤芯可在"C"级检查中更换。一瓶直接添加剂可满足 10 加仑的冷却系溶量。如果冷却系统中使用 Methoxy Propanol 防冻液，则一瓶直接添加剂可满足 15 加仑冷却系容量。

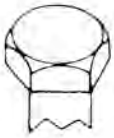
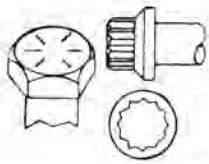
5．在每更换第三次（或三次以上）滤芯时，要检查冷却液是否还有足够的防腐能力，见第 2 部分的"检查发动机冷却液"。

表 3-7：旋装式 DCA 水滤芯器

冷却系统	乙二醇基防冻剂			Methoxy Propanol		
容量 (美制加仑)	DCA-4L 预加 (件号3300858)	工作滤芯 (新件号)	DCA 单位	DCA-4L 预加 (件号3300858)	工作滤芯 (新件号)	DCA 单位
0~8	1	WF-2010[2051] (件号 299080)	4	1	WF-2011[2050] (件号 3300721)	2
9~15	2	WF-2010[2051]	4	2	WF-2011[2050]	2
16~30	5	WF-2010[2051]	4	4	WF-2011[2050]	2
31~60	10	WF-2010[2051]	4	8	WF-2011[2050]	2
35~90(V-1710)	12	WF-2016[2053] (件号 299086)	8	8	WF-2017[2052] (件号 3300724)	6
70~90(KT-2300)	16	WF-2010[2051]	4	16	WF-2011[2051]	2
80~100(KTA-3069)	16	(4)WF-2010[2051]	4			

IDCA 单位=1. 5 干盎司（42. 5 克）或 4 液体盎司（0.12 升）

螺钉标记和上紧扭矩

现在用途	用得较多	用得较多	有时用	有时用
最小抗拉强度磅/平方英寸[兆帕]	到 1/2~69,000[476] 到 3/4~64,000[441] 到 1~55,000[379]	到 3/4~120,00[827] 到 1~115,000[793]	到 5/8~140,000[965] 到 3/4~133,000[917]	150,000[1034]
材料品质	中等	商业上用得最少	商业上一般使用	商业上用得最多
SAE 等级号	1 或 2	5	6 或 7	8
螺灯头标记 制造厂的标记是不同的 这些都是 SAE **5 级（3 条线）**				

螺钉尺寸 (英寸)-(螺扣)		扭矩 英尺-磅(牛·米)	扭矩 英尺-磅(牛·米)	扭矩 英尺-磅(牛·米)	扭矩 英尺-磅(牛·米)
1/4	-20	5[7]	8[11]	10[14]	12[16]
	-28	6[8]	10[14]		14[19]
5/6	-18	11[15]	17[23]	19[26]	24[33]
	-24	13[18]	19[26]		27[37]
3/8	-16	18[24]	31[42]	34[46]	44[60]
	-24	20[27]	35[47]		49[66]
7/16	-14	28[38]	49[66]	55[75]	70[95]
	-20	30[41]	55[75]		78[106]
1/2	-13	39[53]	75[102]	85[115]	105[142]
	-20	41[56]	85[115]		120[163]
9/16	-12	51[69]	110[149]	120[163]	155[210]
	-18	55[75]	120[163]		170[231]
5/8	-11	83[113]	150[203]	167[226]	210[285]
	-18	95[129]	170[231]		240[325]
3/4	-10	105[142]	270[366]	280[380]	375[508]
	-16	115[153]	295[400]		420[569]
7/8	-9	160[217]	395[563]	440[597]	605[820]
	-14	175[237]	435[590]		675[915]
1	-8	235[319]	590[800]	660[895]	910[1234]
	-14	250[339]	660[895]		990[1342]

注：1．如果没有特别规定扭矩的，就一律使用表列的拧紧扭矩。

2．在本手册中提到过有特定扭矩的地方，不能使用本表数值。在使用 SAE6、7 和 8 级螺钉时要特别注意。

3．表中所列数值是按清洁、干燥螺纹而定的。

4．当使用机油来润滑螺纹时，上紧扭矩要较表列数值减小 10%。

5．使用新的电镀的螺钉时要减小 20%扭矩。

6．螺钉拧入铝件时扭矩应按 SAE5 级螺钉减小 30%或更多，螺纹啮合长度应是螺纹直径的 2 倍。

注意：如果换上的螺打级别高于原有螺打，按照要装上的螺打等级定扭矩。

故 障 排 除

在这章中所指的术语-故障，它包括了在发动机使用中为排除故障所要求的调查、研究、分析和采取的措施。但它并不是指一般的常规修复，也不是指全部故障的分析内容。

康 明 斯 柴 油 机

这张故障排除一览表并没有对所有提出的问题提供解决办法，但能够提供思考的途径和提出如何去找到故障的根源。使用故障排除一览表时，在表的上方找出故障，顺着纵列往下找到一个黑点，在黑点的左面可以找到可能的故障原因。

行动之前思考

仔细地研究故障，问自己如下问题：

1. 在故障发生之前出现过那些警告征兆？
2. 在这之前进行过什么修理和保养工作？
3. 以前出现过类似的故障吗？
4. 如果发动机仍在运转，让它继续运转下去，以便做更多检查是否安全？

通常可以通过一下几个方面找到答案：

1. 询问操作者。
2. 阅读操作者工作日志。
3. 查阅保养检查单。
4. 全面思考所有问题。
5. 寻找另外的征兆。
6. 查阅故障排除图表。
7. 首先检查最简单事项。
8. 用校准仪器检查。
9. 发动机或总成拆卸前重复检查所有结论。

大多数故障是简单的和容易排除的，例如“功率不足”是由于油门机构松动和燃油滤清器脏，“润滑油消耗量过大”是由于密封垫或接头联接处泄漏，等等。

首先总要检查最容易的和明显的事，下列这一简单规则就能节约时间和减少麻烦。

拆卸前应再次重复检查项目

大多发动机故障不只是起源于某一部件而可以追溯到各部件之间的关系。例如，燃油消耗量过大不只是由于燃油泵未调整好，而堵塞的空气滤清器或排气道受阻造成背压过高也是可能的原因。常常会出现这种情况：整台发动机被拆散以求寻找某一故障的原因，以致于在拆散过程中破坏了寻找故障的所有线索。所以应当再一次检查思考是否忽略了一个容易的解决办法。

找出并消除故障的基本原因

在机械故障被校正后，还要将故障的基本原因找到并加以消除。免得以后出现同样的故障。“喷油嘴柱塞粘结”可以用换掉失效的柱塞偶件来解决，但总是有个因素导致柱塞粘结的，这可能是喷油嘴调整不当，或者常常是由于燃油中有水等等。

故障排除一览表 重庆康明斯发动机		起动困难或不能起动	起动后容易熄火	怠速时冒黑烟多	负荷下冒黑烟多	怠速时冒白烟多	功率小或无功率	不能达到限制的转速	进气不足空气输出少	加速反应不灵敏	燃油消耗过多	减速性能不好	怠速漂移	发动机突然熄火	在限制转速上时高时	加速时冒黑烟多	机油消耗过多	曲轴箱内生成油泥	机油稀释	机油压力低	AFC通气螺钉漏燃油		冷却液温度过低	冷却液温度过高	机油温度过高		活塞、汽缸套和活塞环磨损	主轴承和连杆轴承磨损	气门和气门导管磨损		燃料敲击声	机械敲击声	齿轮噪声	发动机过度振动	箱轴和压力过高
进排气系统	进气道受阻	●			●		●		●		●					●																		
	排气背压高				●		●			●					●									●										
	在高温或高海拔下空气稀薄				●		●		●						●																			
	空气滤清器到发动机之间漏气						●		●						●											●	●	●						
	涡轮增压器的压缩机脏				●		●		●		●				●																		
	不正确使用启动加热器	●			●																									●				
燃油系统	缺燃油或燃油截流阀关闭	●																																
	燃油质量不好	●	●		●	●	●				●																						●	
	进油管漏气	●	●	●				●			●		●	●	●	●																	●	
	进油管受阻、回油阀粘住	●	●	●	●		●	●		●	●	●				●																		
	外部或内部燃油泄漏						●				●			●					●	●														
	喷油嘴喷油孔堵塞	●	●	●	●		●			●	●					●																		
	燃油泵驱动轴断	●												●																				
	齿轮泵刮伤或齿轮磨损	●					●																											
	喷油嘴进油或回油接头松动	●																●																
	喷油嘴杯装错			●	●	●	●			●	●					●		●																
	喷油嘴本体或杯有裂纹	●	●	●	●	●	●			●	●					●		●																
	喷油嘴杯“O”形圈损坏										●							●																
	油门机构调整不当						●	●				●	●	●	●																			
	怠速弹簧装配不当											●	●	●																				
	调速器飞锤总成装配不当												●	●																				
	高速调速器调整速度过低						●	●																										
	燃油中有水或蜡质	●	●					●						●																				
	AFC 膜盒漏气				●		●			●																								
	AFC 调整不当			●			●			●						●																		
	AFC 柱塞密封磨损或损坏									●										●														
	燃油泵失调						●			●						●																		
	喷油嘴油流不正常						●			●						●																		
润滑系统	外部或内部漏机油																●		●															
	机油滤清器脏																		●		●					●	●							
	汽缸上油			●													●		●						●									
	油道堵塞																									●	●	●						
	机油吸油管受阻																		●							●	●	●						
	机油压力调节器失效																		●															
	曲轴箱缺油或油面过低																		●					●	●	●	●	●						
	机油等级和气候不符																●		●															
	机油液面太高																●							●										
冷却系统	冷却液不足						●												●					●	●									
	水泵磨损						●												●					●	●									
	节温器失效						●										●		●				●	●	●									
	水管破裂																		●					●	●									
	皮带松																		●					●	●									
	水道堵塞																		●					●	●									
	内部漏水																	●																
	机油冷却器堵塞																		●						●									
	冷却系统中有空气																		●					●	●									
	外部漏水																		●					●	●									
	冷却液容量不足和热交换器芯脏						●												●					●	●									
	冷却液温度低																●	●																
使用保养	滤清器和滤网脏						●										●									●	●	●						
	长时怠速运转	●	●	●	●	●	●										●	●																
	发动机过载				●				●										●					●	●		●	●		●	●			
	机油需要更换																●									●	●	●						
	发动机外部灰尘结块																		●					●	●									
机械调整和修理	汽缸盖衬垫漏气或冲坏			●	●	●	●		●							●		●																
	扭转减震器失效																																	
	飞轮不平衡或松动																														●		●	
	气门漏气或调整不良	●	●				●								●																●		●	
	活塞环磨损或断裂	●	●	●	●	●	●																					●						
	轴承间隙不当						●				●						●									●					●			●
	曲轴端隙不当																		●												●	●		
	主轴承孔未对准																														●		●	
	发动机需要大修	●		●	●		●				●					●	●		●	●					●	●	●			●	●	●	
	主轴承或连杆轴承损坏																		●									●			●			
	齿轮传动中有断齿																														●	●		
	齿隙太大																														●	●		
	发动机与船用齿轮箱未对准										●																	●			●	●		
	安装螺栓松动	●		●	●	●	●									●															●		●	
	喷油嘴和气门不正时			●	●		●									●												●		●				
	汽缸套或活塞磨损或刮伤		●	●	●	●	●			●	●					●	●								●					●			●	
	喷油嘴需要调整															●														●				
	凸轮轴的凸角损坏															●																		
	推杆或凸轮从动件罩破裂或弯曲															●																		

工 作 原 理

只有在完全了解发动机工作原理的情况下，操作重庆康明斯柴油机，才能得到可靠的检修。发动机的各零件都会影响其他工作零件，和整台发动机的工作。本手册中所叙述的重庆康明斯柴油机是四冲程工作循环、高速柴油机。

重 庆 康 明 斯 柴 油 机

重庆康明斯柴油机工作循环

重庆康明斯柴油机在许多方面与火花点燃式发动机不同。它的压缩比较高，在进气冲程中进人燃烧室的仅仅是空气而不是燃油混合气。康明斯喷油嘴接受来自燃油泵的低压燃油，并定时定量将燃油以雾状喷人各个燃烧室进行燃烧。燃油着火是由燃烧室内被压缩的空气的热量引起的。在活塞的四冲程循环的各冲程期，若知道在燃烧室内发生了什么，则较容易了解发动机各零件的功能。四冲程及其顺序是：进气冲程、压缩冲程，作功冲程及排气冲程。

为了使四个冲程正常工作，气门和喷油嘴的动作必须与活塞的四个冲程中的每一冲程发生直接的关系。进气门、排气门和喷油嘴通过凸轮随动臂或挺杆、推杆、摇臂和气门十字头由凸轮轴推动。凸轮轴由曲轴齿轮进行推动，这样，曲轴的转动控制了凸轮轴的动作，而凸轮轴又控制了气门的开关次序和喷油时间（燃料供给）。

进气冲程

在进气冲程中，活塞下行；进气门开启，排气门关闭。活塞下行使得空气中的空气进人气缸。在涡轮增压的发动机上，增压器迫使更多的空气通过进气歧管进入气缸而使进气歧管处于受压状态。进气充量只有空气而不是燃油混合气。

压缩冲程

在进气冲程的终了，进气门关闭，活塞开始上行而进入压缩冲程。此时排气门仍保持关闭。在压缩冲程的终了，燃烧室内的空气由压缩冲程开始时所占的容积，被活塞压缩到一个很小的容积（根据发动机型号不同，其压缩容积约为原来容积的 1/14~1/16）。因此，压缩比即为燃烧室内空气量压缩前和压缩后体积之比。

空气被压缩到一个很小的空间后，使得空气的温度提高到足以使燃油着火。

在压缩冲程末期，以及做功冲程的开始阶段，一小部分定量的燃油被喷人燃烧室。

燃油喷入燃烧室后，几乎立即被其中的热压缩空气所点燃。

做功冲程

在做功冲程开始时，燃烧并膨胀着的气体推动活塞向下运转；进、排气门全部关闭。由于更多的燃油喷人气缸并燃烧，气体温度更高而更加膨胀，进一步推动活塞向下运动，这样便增加曲轴旋转的驱动力。

排气冲程

在排气冲程中，进气门关闭，排气门打开，活塞向上运动。

上行的活塞迫使燃烧室中燃烧过的废气通过打开的排气门口排到排气歧管中。

发动机的正常运转取决于两点一首先是压缩以供点火；其次是将适量的燃油在适当的时间喷人气缸。

燃 油 系 统

PT 燃油系统专门使用在康明斯柴油机上。字母“PT”为“压力-时间”的缩写。

康明斯 PT 燃油系统是基于这样的原理来工作的：液流的体积是与流体压力、流过的时间以及液体流过的通道的截面尺寸成比例的。为将这一简单原理应用到康明斯燃油系统上，PT 燃油系统需要具备下列装置：

1. 燃油泵。
2. 控制装置-控制燃油泵输送到喷油嘴的燃油压力，这样，各缸将获得的发动机功率所需要的正确的燃油量。
3. 适当尺寸和形式的燃油通道-使得燃油在任一速度和负荷条件下以各白的压力分配到所有喷油嘴和气缸中去。
4. 喷油嘴-从燃油泵得到低压燃油，并在准确的时间以相等的量和适当的状态，将燃油送入各个燃烧室中进行燃烧。

PT 燃油系统由燃油泵、进油管路、回油管路，燃油通道和喷油嘴组成。燃油流向见图 5-1 和图 5-2 PT（G）型，VS（可变速度亦称全程式）型燃油泵见图 5-3。

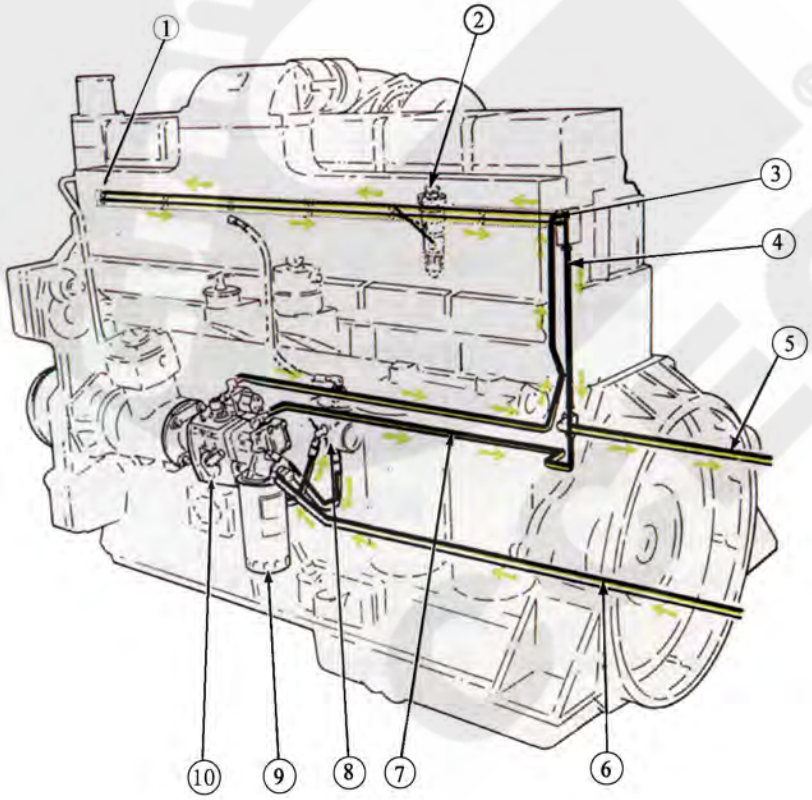


图 5-1　燃油流向图-KT/KTA19 发动机

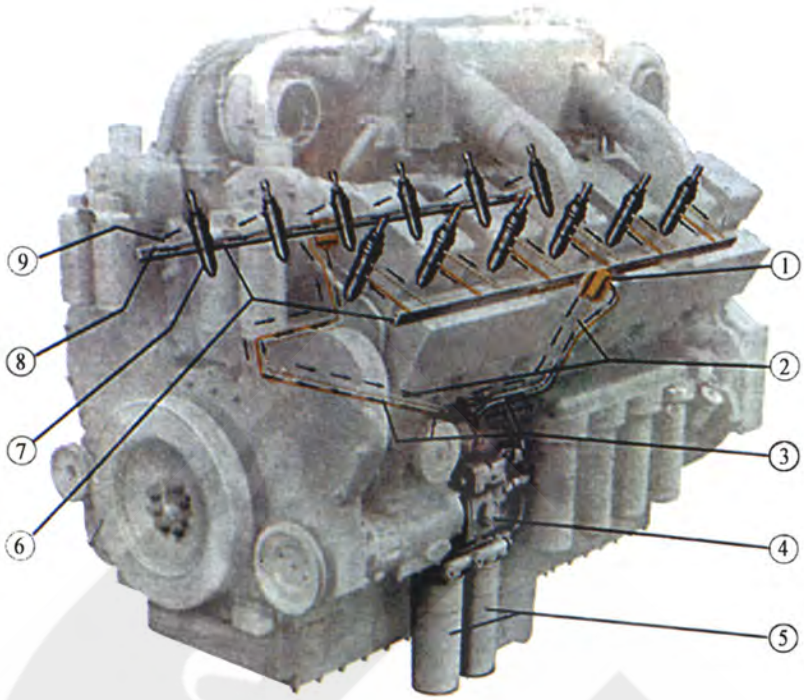


图 5-2 燃油流向图-KT/KTA38 发动机

1. 转速表传动
2. 怠速齿轮和轴
3 .AFC（空气燃油比控制）活塞
4 .VS 调速器飞锤
5 .去喷油咀的燃油
6 .截油阀
7 .AFC 控制柱塞
8. AFC 燃油套筒
9.VS 调速器柱塞
10. VS 怠速弹簧
11. VS 高速弹簧
12. VS 油门轴
13.齿轮泵
14.脉冲消减器
15. AFC 针阀
16.压力调节器阀
17.来自滤清器燃油
18.油门轴
19.怠速调节螺钉
20.弹簧垫
21.高速弹簧和燃油流向
22.怠速弹簧
23.怠速弹簧柱塞
24.燃油调节螺钉
25.滤清器网
26.调速器柱塞
27.扭矩弹簧
28.调速器飞锤
29.调速器辅助柱塞
30.主动轴

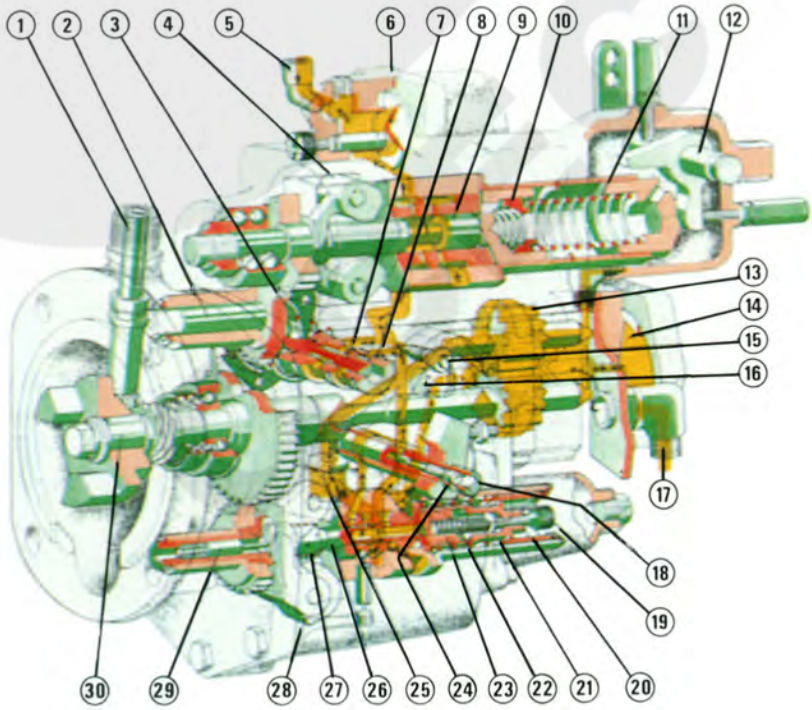


图 5-3 PT(G 型)VS(全程式)AFC 燃油泵

燃油泵

燃油泵连接在由发动机齿轮系驱动的燃油泵传动轴上。燃油泵主轴依次驱动齿轮泵，调速器和转速表轴总成。

齿轮泵和脉冲式减振器

齿轮泵由燃油泵主轴驱动，由一对齿轮组成，向整个燃油系统输送燃油。进油口位于齿轮泵后部。装在齿轮泵上的脉冲消减器有一片钢质膜片，它能吸收脉冲并使燃油系统的燃油流动平顺。燃油从齿轮泵流出，经滤清器网到调整器总成，如图 5-4 所示。

油门

油门供司机在怠速以上，按不同速度和负荷条件的需要，用手控制发动机转速。

在燃油泵内，燃油流过调速器到油门轴。在怠速时，燃油流过调整器套筒上的怠速孔而通过油门轴。为了在怠速以上的速度运转，燃油流经主调速器套筒的油孔到轴上的节流孔中。

PT（G 型）VS 燃油泵

PT（G 型）VS 燃油泵（图 5-3）由四个主要部件组成：齿轮泵、标准调速器、油门和一个 VS（变速，即全程式）调速器。

调速器

“标准”调速器由一个弹簧和飞锤系统所控制，它有两个功能：

1．当油门控制机构在怠速位置时，调速器保持足够的燃油供给量以维持怠速运转。

2．当速度高于最高额定转速时，它切断喷油嘴的燃油供给。

当在怠速和最高转速之间进行工作时，燃油流经调速器而到喷油嘴。燃油被油门所控制，并受到怠速弹簧柱塞沉孔尺寸的限制。当发动机达到所调节的速度时，调整器飞锤移动调速器柱塞，通往喷油嘴的燃油通道便被截断。与此同时，另一个燃油通道打开，使燃油回到主泵体中。这样，不管油门的位置如何，发动机速度就受到了调速器的控制和限制。

VS 调速器位于燃油泵壳体的上部，它与标准调速器串联工作，使它有可能在标准调整器所校准的速度范围内的任何所要求的速度（接近恒速）下工作。速度可以通过位于燃油泵顶部的 VS 速度控制杆加以改变。这种燃油泵由于其速度降小于标准调速器的燃油泵，所以能在发动机整个转速范围内提供平顺的速度调节和适应动力输出机构等不同速度的要求。

当操作 PT（G 型）VS 燃油泵在任何要求的恒速度下工作时，VS 调速器杆应放在工作位置，油门应锁在全开位置上，以便全部燃油能通过标准调整器。

PT（D 型）喷油嘴

喷油嘴是将燃油引人各个燃烧中去的装置。它具有计量、定时和喷射作用。使用在直列式发动机和 V 型发机上的喷油嘴的工作原理是相同的，只有喷油嘴尺寸和内部结构略有不同，见图 5-4 和 5-5。

进油和回油通过气缸盖内部的油道流动，每个喷油嘴周围有一个径向槽与气缸盖上的油道相配合，让燃油通过喷油嘴体上的一个可调孔塞（在试验台上打磨到规定尺寸以进行调整）。每个进油口有一个细滤网对燃油进行最后的滤清。

喷油嘴周围的燃油槽被“O”形圈隔开，“O”形圈抵住气缸盖上的喷油嘴孔而起密封作用。这就在喷油嘴和气缸盖喷油嘴孔表面之间形成了密封油道。

1. 喷油嘴杯
2. 喷油嘴杯导座
3. 筒柱
4. 体吸塞像
5. 止回阀球
6. 密封衬垫
7. 卡环
8. 滤网
9. 燃料进口
10. 油孔
11. 油孔密封衬垫
12. 连接器
13. 接头
14. 弹簧
15. 连接杆
16. 燃油出口
17. “O”形圈
18. 螺母
19. 摇臂
20. 调整螺钉
21. 推杆
22. 挺杆
23. 凸轮轴凸轮

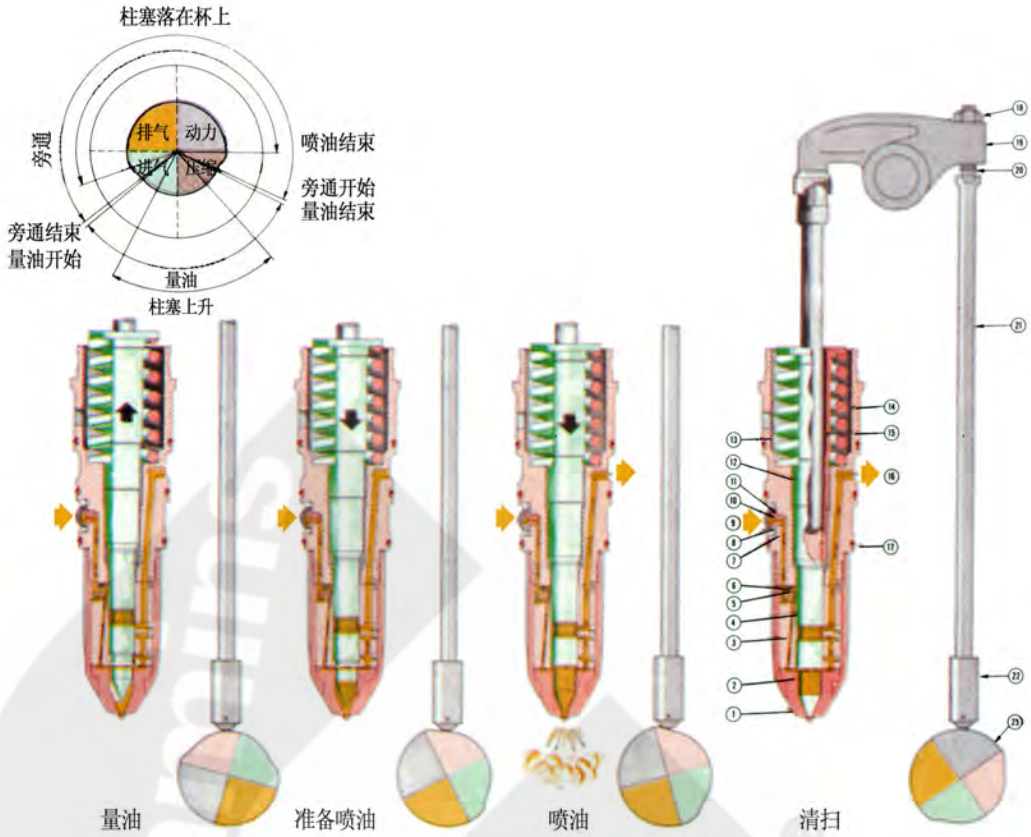


图 5-4（FWC-28）PT（D）型 Ø3/8”柱塞喷油嘴的喷油循环

1. 喷油嘴杯
2. 喷油嘴杯导座
3. 筒体
4. 柱塞
5. 止回阀球
6. 密封衬垫
7. 卡环
8. 滤网
9. 燃料进口
10. 油孔
11. 油孔密封衬垫
12. 连接器
13. 接头
14. 弹簧
15. 连接杆
16. 燃油出口
17. “O”形圈
18. 螺母
19. 摇臂
20. 调整螺钉
21. 推杆
22. 挺杆
23. 凸轮轴凸轮

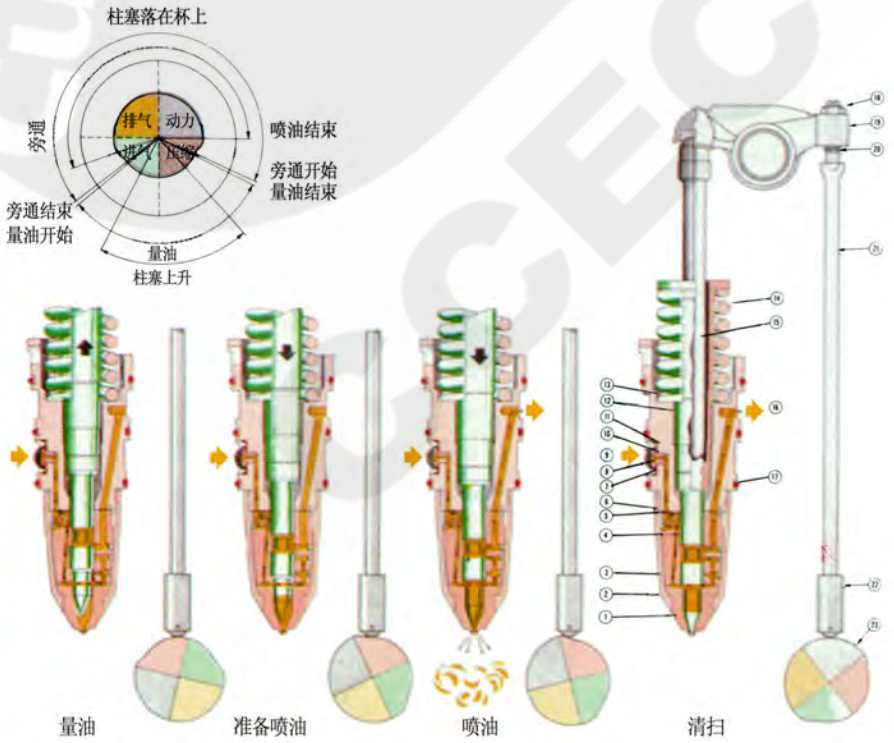


图 5-5 (FWC-29) PT（D）型 Ø5/16”柱塞喷油嘴的喷油循环

从燃油泵截流阀顶上一个接头来的燃油，通过一根输油管到气缸盖的下部钻孔油道中。气缸盖上的第二个油道与喷油嘴上部的径向槽相对准，以排出多余的燃油。多余的燃油通过回油管回到油箱中。

喷油嘴带有一个球形止回阀。当喷油嘴柱塞向下运转盖住进油口时，一个冲击压力波使球阀关闭，与此同时，在喷油嘴杯中截留了一定量用于喷射的燃油。当柱塞继续向下运动，燃油就被喷人燃烧室中，同时打开了回油孔，球阀从座上抬起。这样，燃油便自由地流过喷油嘴，流出回油管以进行冷却喷油嘴，同时排除了喷油嘴环中的气体。

燃油管、接头和截流阀

输油和回油管

燃油通过油管进人气缸盖中。有一根共用的回油管，使没有喷射的燃油流回到油箱中。

接头

燃油管接头使用在直列式发动机气缸盖之间，用以搭接每个气缸的进、回油管。

截流阀

在康明斯燃油泵上使用一种手动截流阀或电动截流阀（图 5-6）。

对于手动阀，应将控制旋钮按顺时针旋到头，顶开阀片让燃油通过截流阀。

对于电动阀，当钥匙开关转到接通位置时，必须将手动控制旋钮按逆时针方向旋到头，以便电磁阀能打开截流阀。在紧急情况下，如电气系统出现故障时，可顺时针转动手动控制旋钮，以供燃油通过截流阀。

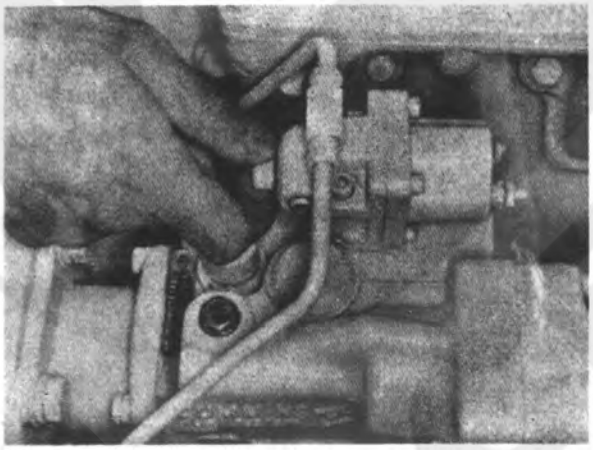


图 5-6（V21970）燃油泵手动控制旋扭

润 滑 系 统

重庆康明斯发动机采用压力润滑，压力由一只齿轮式润滑油泵提供，润滑油泵位于机油盘中或在发动机的一侧。

润滑油泵上装有一只压力调节器，以控制机油压力。

润滑系统中带有滤清器和滤网，以清除循环机油中的外来杂质，防止轴承或零件配合表面的损坏。在全流式机油滤清器的座上带有一只旁通阀，当油流被脏物阻断或滤芯堵塞时可起使保险作用。

同时使用旁通式和全流式机油滤清器，可使润滑油达到最高的净化和滤清效果。全流式机油滤清器是所有发动机的标准装备；旁通式机油滤清器被使用在全部增压型发动和上，而在所有其他类型的发动机上则为选用装备。

一些专门用途的发动机，装有特殊的机油盘和滤清器，有些发动机装有辅助机油冷却器，使油温保持比较接近规定。

增压器是从发动机润滑系统得到润滑的。还利用润滑系统中的润滑油进行冷却。燃油泵和喷油嘴利用燃油进行润滑。

KT/KTA19 型发动机

KT / KTA19 型发动机通过一齿轮式机油泵进行压力润滑，机油泵位于发动机排气歧管一侧的齿轮室盖内，正好在水泵的下方。

润滑油被机油泵从机油盘通过一根吸油管吸来（见图 5-7），然后，被机油泵齿轮从吸油腔输送到压力腔。压力调节器阀把多余的机油直接排放至机油泵进油口，而不是送回机油盘。

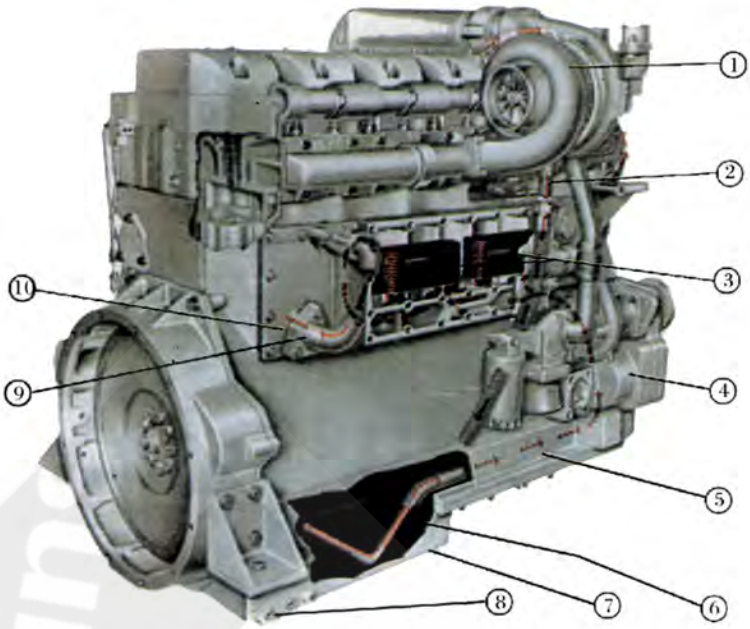
自机油泵来的机油流进机油冷却器，通过冷却器后再穿过气缸体。在气缸体的进气管一侧，机油流人滤清器头部，在吸油腔内装有一个旁通阀，当滤清器芯子堵塞时，确保机油油流不致中断。机油从滤清器头部进人滤清器壳中，穿过滤芯后向卜分成两路。一路进人发动机主油道，另一路进人活塞冷却油道。在滤清器头的底部有一个副压力控制阀，它根据机油泵的供油压力限制去喷咀的润滑油流量。

主轴承通过分支油道直接由主油道供油润滑：从主油道来的机油流人凸轮轴衬套；从这里分出一股定流量的机油流向凸轮随动臂轴，并向上穿过气缸盖。凸轮随动臂从其轴卜得到润滑；随动臂再以单独的油孔向滚子和推杆座供应机油。摇臂衬套也是从其轴上得到润滑的。调整螺钉则通过摇臂和衬套上的油道得到润滑，见图 5-8。

连杆轴承从曲轴上的油道得到润滑；然后机油再流经连杆上的斜油道去润滑活塞销和衬套。主油道里的机油还通过正时齿轮室壳和盖上的油道去润滑凸轮轴和水泵传动齿轮。它还穿过齿轮室盖通过油道被送到其余的齿轮和衬套上。

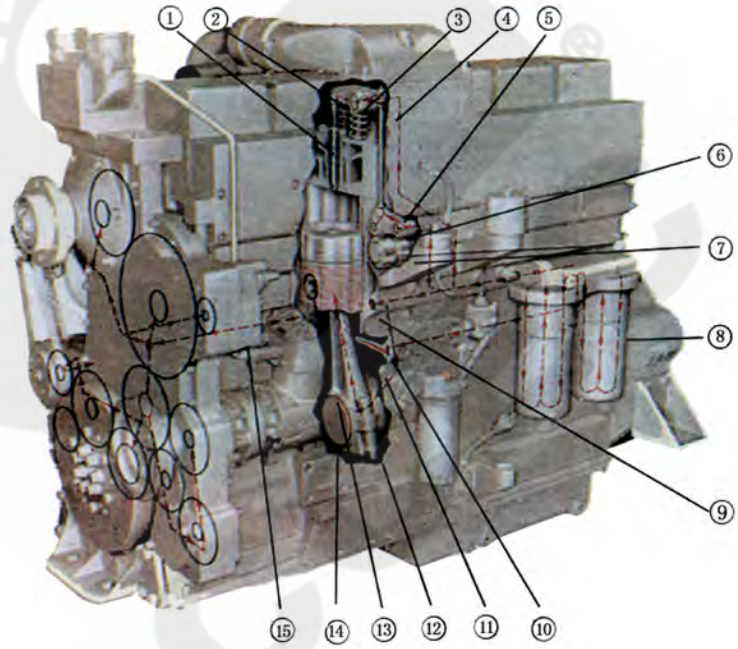
经滤清和冷却过的润滑油通过齿轮室壳上的一个外油道被送到增压器中，增压器的回流机油直接排人曲轴箱中。

1. 涡轮增压器进油
2. 涡轮增压器回油
3. 机油冷却器芯子
4. 机油泵
5. 机油盘接头
6. 吸油管
7. 机油盘
8. 机油盘放油螺塞
9. 输油管
10 去润滑油滤清器



5-7 KT/KTA19 型发动机润滑油流向图（排气管侧）

1. 喷油嘴
2. 摇臂
3. 摇臂轴
4. 推杆
5. 凸轮随动臂
6. 凸轮随动臂轴
7. 凸轮轴
8. 润滑油滤清器
9. 主油道
10 活塞冷却油道
11 活塞冷却喷嘴
12 连杆
13 活塞锁
14 曲轴
15 去传动齿轮组的机油



5-8 KT/KTA19 型发动机润滑油流向图（进气管侧）

KT/KTA38 和 KTA50 型发动机

KT/KTA38 和 KTA50 型发动机都是用一个齿轮式机油泵进行压力润滑的，机油泵位于发动机后部的机油盘内，直接安装在曲轴下方的气缸体上，并由后曲轴齿轮驱动。

机油泵通过一根吸油管将机油从机油盘中吸人，然后油泵齿轮将机油由吸油腔输送到压力腔。压力调节器阀将多余的机油排回机油盘。

从机油泵出来的机油通过气缸体仁的油道进入 V 形缸体中间的机油冷却器中，然后通过冷却器流人滤清器内，滤清器可以安装在气缸体任意一侧，如图 5-9，图 5-10，图 5-11 和图 5-12 所示。在滤清器头部的进油腔中装有一个旁通阀，当滤清器芯子堵塞时，它可以确保机油不致被隔断。

机油从滤清器头部进人滤清器壳中并穿过滤芯，然后流人机油主油道，主油道位于V形缸体的中间。主油道向缸体上的两个凸轮轴和两个活塞冷却油道供油。压力控制阀根据机油泵的压力，限制去活塞冷却喷嘴的机油流量。

主轴承通过分支油道直接由主油道供油阀滑。从凸轮油道来的机油进人凸轮轴衬套；从这里分出一股定流量的机油流往凸轮随动臂轴，并向上穿过气缸盖。凸轮随动臂从其轴上得到润滑；随动臂单独钻有油孔，向滚子和推杆座供应机油。摇臂衬套也是从其轴上得到润滑的。调整螺钉和气门导管通过摇臂和衬套上的油道得到润滑。

连杆轴承从曲轴上的油道得到润滑；然后机油再流经连杆上的斜油道去润滑活塞销和衬套。从主油道来的机油，通过齿轮室壳和齿轮室盖上的油道去润滑发动机前部传动齿轮组、衬套和传动轮轴。后部传运齿轮组通过一分支油道从右排凸轮轴轴道中得到润滑。

经滤清和冷却过的润滑油由凸轮轴油道通过接在气缸体油道上的外接油管送往每个增压器。增压器的回流机油通过气缸体上的油道流回机油盘。

1. 喷油嘴摇臂
2. 喷油嘴推杆
3. 机油冷却器芯子
4. 活塞销
5. 凸轮随从臂
6. 主油道
7. 连杆
8. 活塞冷却油道
9. 全流式机油滤清器
10 机油吸油管
11 机油盘
12 机油泵
13 曲轴
14 气缸套
15 凸轮轴
16 气门推杆
17 气门导管
18 气门摇臂
19 气门十字头
20 涡轮增压器回油管
21 涡轮增压器进油软管

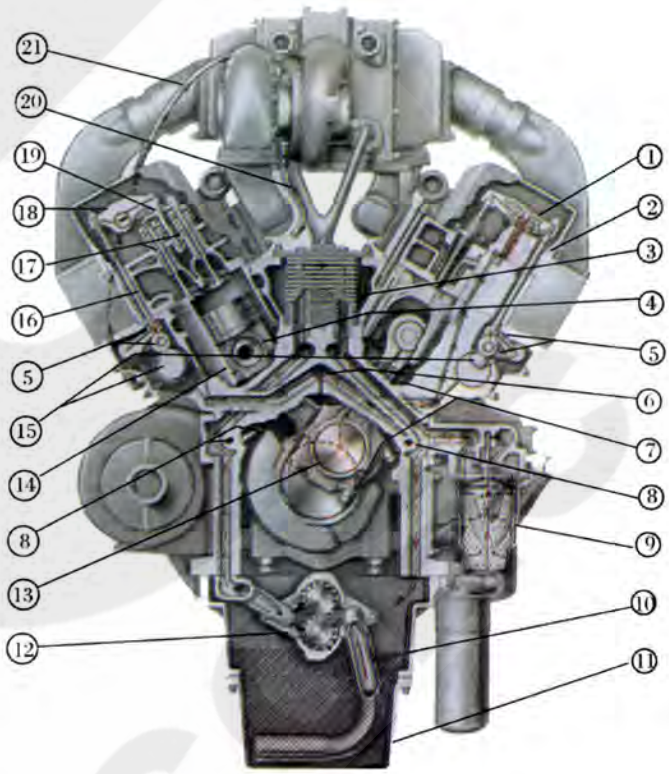


图 5-9　KT/KTA38 型发动机润滑油流向图（前剖视）

1. 涡轮增压器
2. 机油冷却器芯子
3. 去机油冷却器机油
4. 机油滤清器至发动机的机油
5. 压力调节器
6. 全流式机油滤清器
7. 润滑油泵
8. 活塞冷却喷嘴
9. 机油吸油管
10 在凸轮轴衬套机油流向
11 辅件驱动
12 主轴承
13 水泵驱动
14 凸轮轴
15 凸轮随从臂
16 活塞销
17 活塞
18 推杆
19 气门导管
20 喷油嘴摇臂

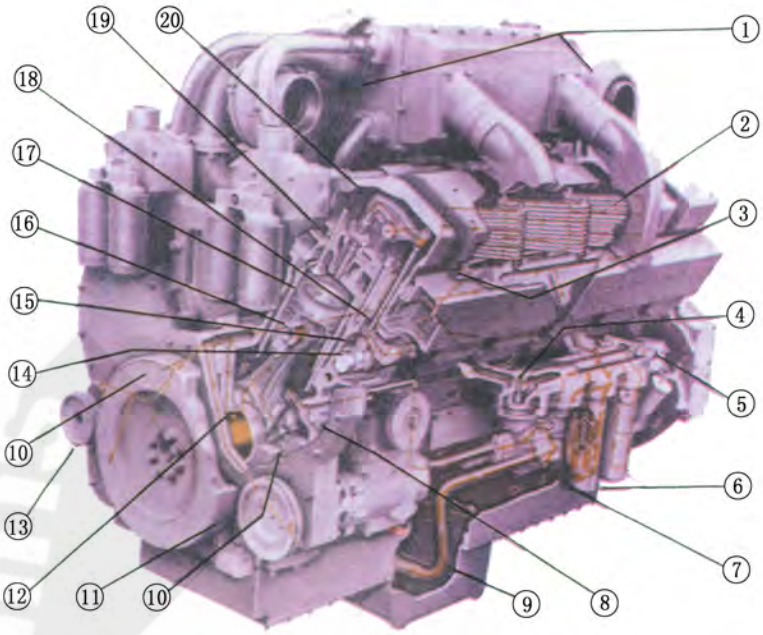


图 5-10　KT/KTA38 型发动机润滑油流向图（3/4 前剖视）

1. 主油道
2. 机油冷却器
3. 滤清器头
4. 机油泵
5. 吸油管
6. 排油管
7. 活塞冷却油道
8. 凸轮轴油道
9. 凸轮轴驱动齿轮
10 附件传动齿轮
11 传转动齿轮
12 液压泵驱动齿轮
13 水泵驱动齿轮
14 排气门
15 摇臂
16 机油控制口
17 凸轮轴
18 凸轮随动臂
19 活塞冷却喷嘴
20 曲轴
21 连杆
22 活塞

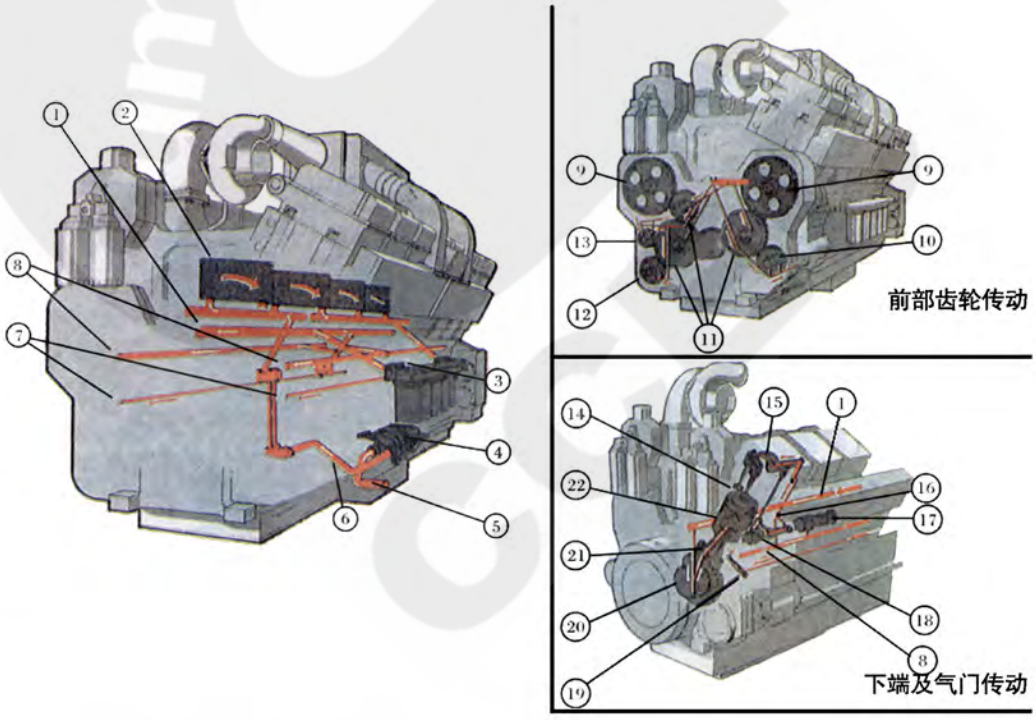
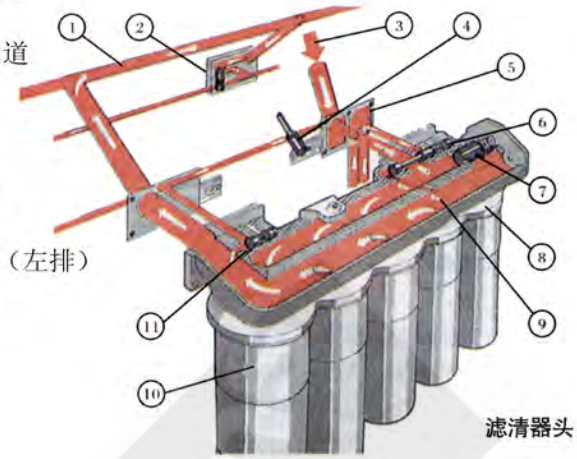
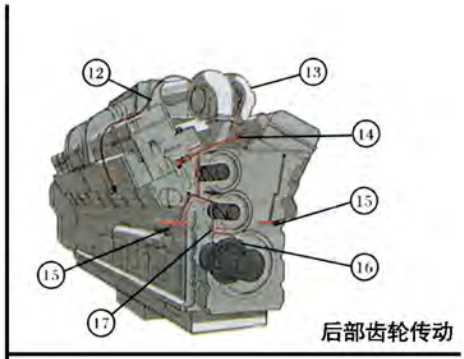


图 5-11　KTA50 型发动机润滑油流向图

1. 主油道
2. 活塞冷却调节器（右排）
3. 从机油冷却器流来
4. 活塞冷却喷嘴
5. 去机油盘旁通油道
6. 压力调节器
7. 旁通阀
8. 滤清器头
9. 调节器控制油道
10 滤清器
11 活塞冷却调节器（左排）
12 增压器进油管
13 增压器
14 增玉器回油管
15 凸轮轴油道
16 推力抽承
17 从主油道来
18 机油冷却器
19 排油管
20 机油泵
21 吸油管





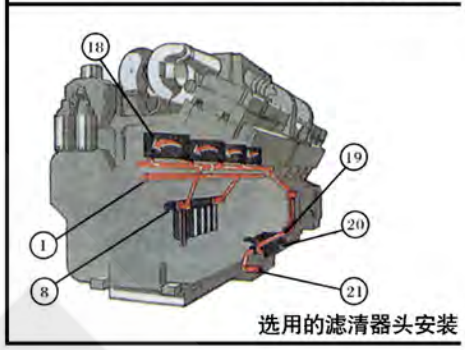


图 5-12　KTA50 型发动机选用润滑油流向图

冷 却 系 统

冷却液用一离心式水泵进行循环，水泵安装在发动机的前面或前部，由附件传动装置或曲轴用皮带驱动。

冷却液沿湿式气缸套周围，通过气缸盖并围绕喷油嘴套进行循环，喷油嘴套中安装着喷油嘴，此处设计使热量尽快散失。发动机有一个或几个节温器以控制发动机的工作温度。

发动机冷却液通过一只热交换器或舷外冷却器进行冷却。由装在发动机前端的海水泵将海水通过热交换器循环或海水冲刷舷外冷却器冷却冷却液。

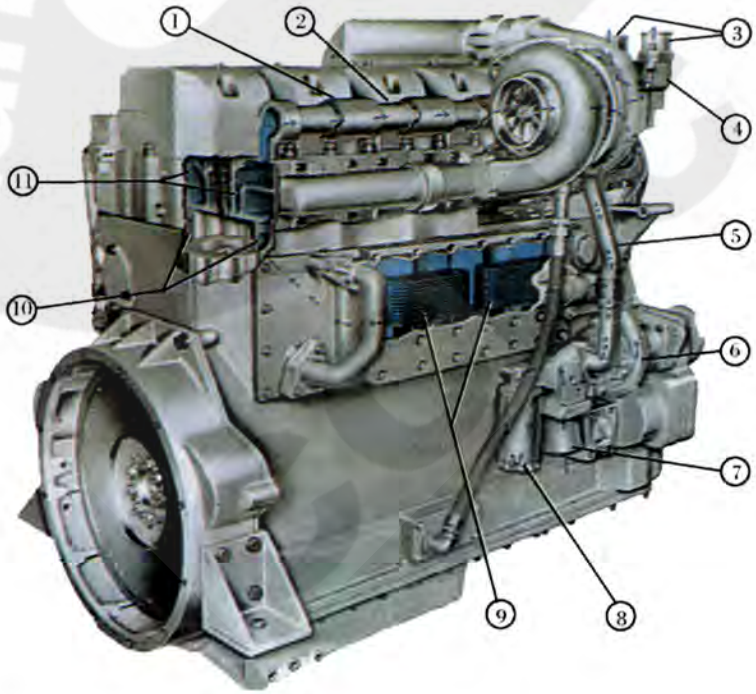
弗列加（Fleetguard ）冷却液滤清器是重庆康明斯发动机上的标准装备。从发动机冷却系统中旁流出一小部分冷却液使之通过滤清器，滤清器芯子必须定期更换。有关冷却液滤清器的容量及补充水的处理方法，参见"冷却液规格"。

KT/KTA19 型发动机

冷却液由一个安装在气缸体排气管一侧的离心式水泵进行循环，如图 5-13 所示。水泵通过一个传动齿轮由曲驱动。

从水泵来的冷却液进人机油冷却器壳中，通过冷却器壳（作用相当于分水管）进到气缸体中，并保持到各气缸套的冷却液流量相等。自气缸套表面来的冷却液通过气门之间和喷油器套壁周围的水道进人各个气缸盖中。气缸盖中的冷却液流向冷却液出水管，然后进人节温器壳中，进人节温器壳中的冷却液经由一个旁通管又回到水泵中直到发动机冷却液温度将双节温器开启时为止。以后，冷却液将直接流经热交换器或舷外冷却器。

1. 冷却液歧管
2. 输水管
3. 冷却液出口
4. 节温器壳
5. 旁通管
6. 水泵
7. 冷却液进口
8. 冷却液滤清器
9. 机油冷却器
10 气缸体水套
11 气缸盖水套



5-13　KT/KTA19 型发动机冷却液流向图

KT/KTA38 和 KT A 50 型发动机

冷却液由一个安装在右排缸体上的离心式水泵进行循环。水泵通过一个转动齿轮由曲轴驱动，见图 5-14 和图 5-15。

自水泵来的冷却液进入 V 型缸体中间，围绕机油冷却器芯子流动。V 形缸体中间水道如同一个分水管供应冷却液，通过中间冷却器芯子并围绕气缸套流动。

冷却过气缸套的冷却液，通过气门之间和喷油嘴套壁周围的水道进到各气缸盖中。气缸盖内的冷却液流向冷却液出水歧管。然后再流往节温器壳。节温器壳中的冷却液经一个旁通管重又回水泵中，直到发动机冷却液温度使节温器开启时为止。以后，冷却液便直接流经热交换器或舷外冷却器。通过中间冷却器的循环冷却液也流回节温器壳中。

1. 中间冷却器芯子
2. 进入中间冷却器的冷却液
3. 气缸盖水套
4. 气缸套周围水道
5. 冷却液进口
6. 水泵
7. 在 V 形缸体中的冷却液
8. 冷却液输送管（气缸盖之间）
9. 由中间冷却器至节温器壳

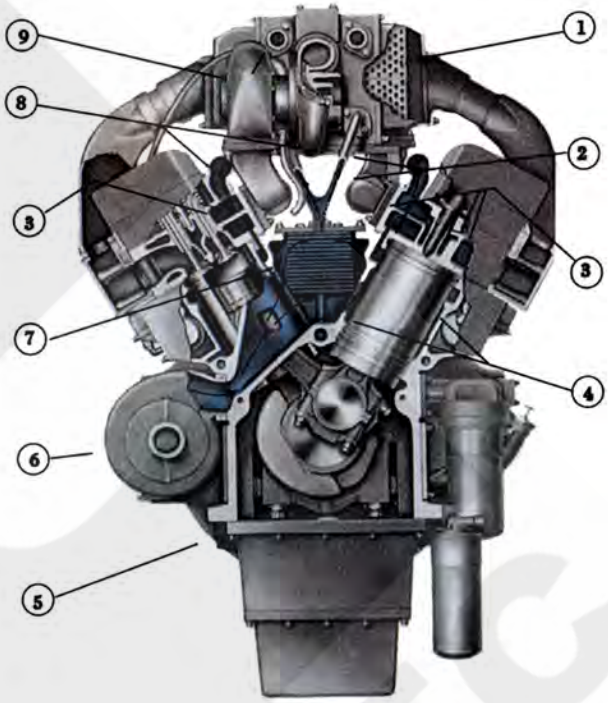


图 5-14 KT/KTA38 型发动机冷却液流向图

1. 中间冷却器壳
2. 中间冷却器芯
3. 进入中间冷却器的冷却液
4. 流出中间冷却器的冷却液
5. 冷却液回到散热器
6. 冷却液输送管（气缸盖之间）
7. 节温器
8. 冷却液滤清器
9. 机油冷却器
10 水泵
11 从散热器来的冷却液
12 旁通管
13 在 V 形缸体中的冷却液
14 气缸套
15 气缸盖

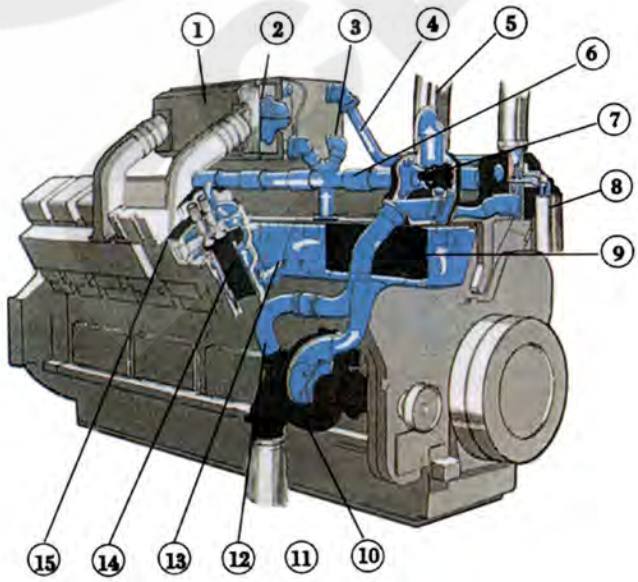


图 5-15 KTA50 型发动机冷却液流向图

空 气 系 统

柴油机发动机每燃烧一加仑的燃油，需要几百加仑的空气。为使发动机有效地工作，必须保证发动机吸气畅通、进、排气系统不得有阻滞。

吸入的空气必须通过空气滤清器。根据发动机的用途，空气滤清器可以安装在发动机上或工作机械上，可以是油浴式，纸滤芯式或综合式滤清器。自空气滤清器来的空气直接进入进气歧管或涡轮增压器中。

KT A19 中冷器

中冷器（有时亦称中间冷却器），是一个装在发动机进气系统中的装置，用于降低进气温度和（或）预热进入的空气。

中冷器由一个壳和一个内芯组成，中冷器壳作为发动机进气歧管的一部分。内芯用管子制成，发动机冷却液在其中循环。空气在进入发动机燃烧室以前，流过芯子而受到冷却或加热，如图 5-16 所示。这样，由于应用了中冷器，更好地控制了进气温度（冷却或加温），从而改善了发动机的燃烧状况。

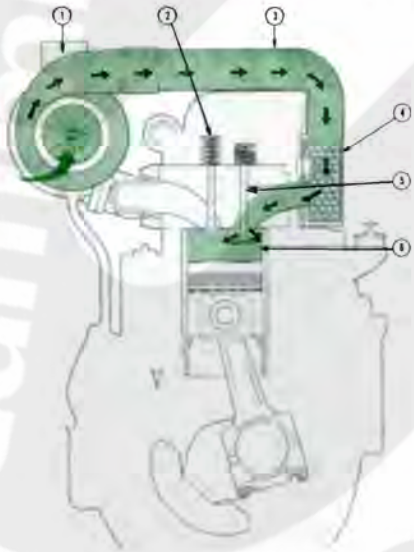


图 5-16　KTA19 型发动机进气流向图

KT/KTA38 和 KTA50 中冷器

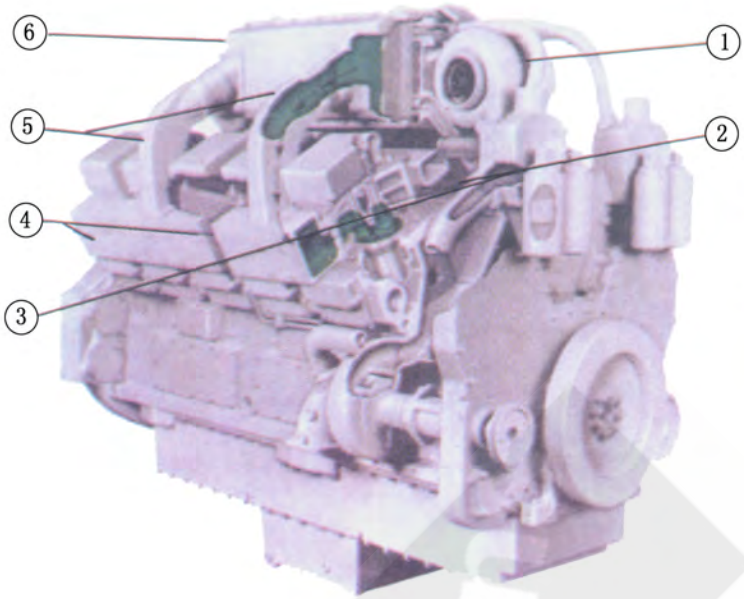
中冷器由一个外壳和两个内芯组成，中冷器外壳安装在气缸体的上部。发动机冷却液在中间冷却器芯内循环，使得在进入发动机燃烧室之前通过内芯的空气得到冷却或加热。这样，便改善了燃烧状况。

涡轮增压器

涡轮增压器迫使更多的空气进入燃烧室，所以，它比自然进气式发动机燃烧更多的燃油，发出更大的功率。在某些情况下，增压器用于保持发动机在较高海拔高度使用时的效率（平衡燃油对空气之比）。

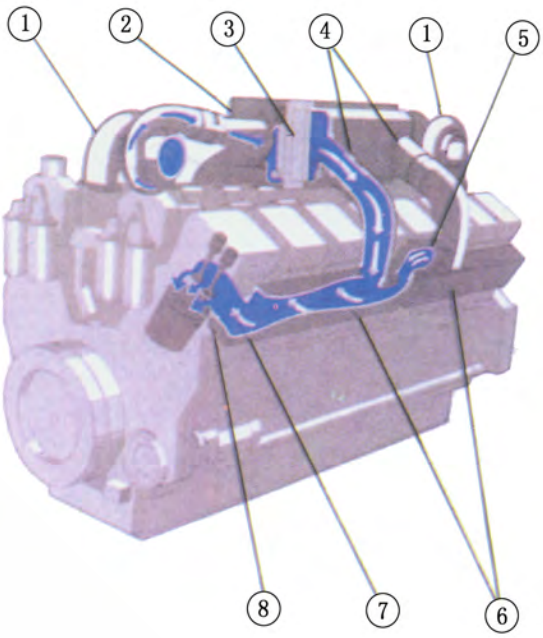
增压器包括一个涡轮和一个离心式鼓风机或空气压缩机叶轮，它们分开装在外壳中，但安装在一个共用轴上，并随共用轴转动。

推动涡轮转动的动力——涡轮再推动压缩机——是从发动机的排气能量中得到的。涡轮转速随排气能量的改变而改变。因此，可根据负荷的需要向发动机供给足够的空气用于燃烧，见图 5-20 和图 5-21，增压器用发动机润滑油进行润滑和冷却。



1 增压器　　4 进气岐门
2 进气门　　5 进气管
3 进气口　　6 中间冷却器

图 5-20　KT/KTA38 型发动机进气流向图



1 增压器　　5 进气平衡器
2 中间冷却器壳　　6 进气岐管
3 中间冷却器芯　　7 进气口
4 进气管　　8 进气门

图 5-21　KTA50 型发动机进气流向图

滤 清 器

重庆康明斯柴油机上装配的滤清器有空气滤清器、机油滤清器、柴（燃）油滤清器和水滤器等，这些滤清器的使用和维护分别如下：

1. 空气滤清器

1.1 由于空气中的尘土等是柴油机汽缸盖、活塞、活塞环、气门和气门导管以及其它运动零件磨损的主要根源，柴油机进气中的含尘量越大，柴油机零部件磨损就越快。发动机的磨损试验表明，小于 1um（0.001mm）的尘粒对发动机的影响比较小，99.5 %的这种尘粒会通过发动机排气排出，而 1~10um 尘粒则对发动机寿命具有可以测量的影响。发动机进气中的尘粒尺寸如果大于承载油膜的厚度，就会严重影响发动机轴瓦（或轴承）、活塞环等的寿命。因此，仔细选用柴油机空气滤清器对柴油机的使用寿命是十分重要的。

重庆康明斯柴油机所使用的空气滤清器为干式空气滤清器，其滤芯是经过严格的树脂处理的优质滤纸制成的，并可更换。在给定尺寸内，滤芯做成波褶状以提供最大的过滤面积。

1.2 根据用途不同，重庆康明斯柴油机所用的空气滤清器有轻型空气滤清器和重型空气滤清器两种。轻型空气滤清器的滤清效率、纳污能力分别在 99.5%和 6.4g/1.s 以上，适用于在环境空气含尘量较低的工况下工作的所有重庆康明斯柴油机发电机组和船舶推进（主、辅）用柴油机（机组），主要由空气滤清器帽、壳体和一个滤清器芯等组成；重型空气滤清器的滤清效率和纳污能力分别在 99.9%和 53g /1.s 以上，适用于在环境空气中高含尘量的特殊工况工作的建筑工程机械（如推土机、挖掘机、装载机等）、矿用汽车和非公路用特种牵引车辆（如矿用自卸汽车、石油勘探与钻采机械等）、农林及水利工程机械（如伐木牵引车、水泵动力机组等）、铁道建筑机械（如铁路起重塔吊）等，重型空气滤清器主要由滤清器壳体、两级（或内、外）空气滤清器芯和旋流管组等构成，空气从旋流管组（或预滤器）壳体周围的小孔沿着切线方向进入各旋流管（或旋风管），旋流管通过管内的导流叶片而使气流产生强烈的旋流，在旋流和反向过程中，由于离心力的作用，空气中夹杂着的水和灰尘等粒度较大的杂质颗粒便被甩向旋流管的管壁及其下面，再落入空气滤清器的积尘盘内，再从集尘盘内间隙地或经常性的排出尘土。气流再由旋流管下方反向，流过其通气管，之后再进入空气滤清器壳体，通过微孔外滤芯（或主滤芯）将残存的轻质粉尘过滤后进入内滤芯（或次滤芯、安全滤芯），最后从安全滤芯出来的清洁的空气经增压器增压和（或）中冷器冷却后就进入柴油机燃烧室参加燃烧。

对于重型空气滤清器，使用过程中，应经常打开积尘盘出尘口（必要时，还可拆下积尘盘），放掉积聚的尘土等，不允许积尘盘中积聚较多的尘土。间隔期长短需视使用环境的大气中尘土含量多少而定。

空气滤清器使用一定时间后，滤清器芯就会变脏，滤清器的进气阻力也会随之增大，当空气滤清器的进气阻力增大到 625 kPa 以上时，柴油机将因得不到足够的空气供应而将产生排气冒黑烟、动力不足等问题。图 6-1 给出了空气滤清器的进气阻力与柴油机功率之间的关系。

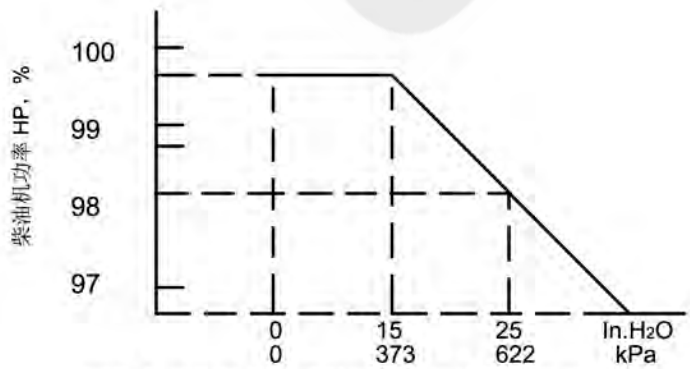


图 6-1 空气滤清器进气阻力与柴油功率的关系

用户可以通过观察装在空气滤清器后的进气管上的空气阻力指示器来判断空气滤清器的堵塞情况，即如当空气阻力指示器的指示窗口由正常情况下的绿色变成红色，则表明滤清器进气阻力超过限定值，需要对其进行清理或更换。

当出现空气滤清器堵塞，就应该立即停机清理或更换空气滤清器芯，而后应按空气阻力指示器端头的橡皮塞复位。按下列程序来清理滤清器芯。

1. 轻敲空气滤清器芯端盖，将滤清器芯上积聚的尘土振落；
2. 打开积尘盘出尘口，放掉积聚的尘土；
3. 打开滤清器端盖，将滤清器芯拉出来；
4. 用干净的布或橡皮塞堵住滤芯两端，然后再用压力不大于 0.2~0.3MPa 的干燥压缩空气沿滤清器芯斜角方向或者从滤芯内向外吹净滤清器芯表面。

注意：

① 不允许用油或水清洗空气滤清器芯，否则滤芯孔隙被堵塞，增加空气阻力；同时柴油易被吸入气缸，造成装后起动飞车；

② 旋流管与其壳体固定在一起，是不可拆的，清洗时可用热碱水清洗干净，并用清水冲洗后再用压缩空气将其吹净；

③ 重型空气滤清器的内滤清器芯（即为安全滤清器芯）是不能清理的。

当出现下列问题时，就必须更换空气滤清器（外）滤芯：

① 空气滤清器（外）滤芯已破损；

② 装上清理后的滤清器芯时，进气阻力指示器又指示为红色；

③ 滤清器芯的清理次数已达到五次。

注意：对于重型空气滤清器，当其外滤清器芯破损或清理次数达到五次时，就必须更换其滤清器芯。

2 旋装式滤清器的使用和维护

2.1 机油滤清器的使用与维护

机油在柴油机中，因不断被柴油机零部件的磨损微粒和外界落入的杂质所污染，同时，因受柴油机发热零部件的热辐射而氧化产生了可溶于机油中的酸性物质和不可深的胶状沉淀物（凝胶或乳胶）而变质。这些杂质和污染物对柴油机是有害的，不滤除机油中这些杂质和污染物，机油中的硬质粒子就会增加柴油机零部件的磨损，堵塞润滑油道；酸性物质对合金轴瓦产生腐蚀性磨损；胶质会使活塞与活塞环、气门与气门导管等零件之间发生胶结，甚至柴油机不能正常运转，使机油的使用期缩短。经验证明，柴油机机油盘中机油的固态杂质总量低于 0.15 % 时，对柴油机的危害尚不大，但达到或超过 0.5 % 时，则将大大加速柴油机零部件的磨损。

为了及时清除机油中的机械杂质和胶状沉淀物，延长机油的有效使用期，在柴油机的润滑系统中设置机油滤清器。

柴油机的最长寿命除取决于正确选择和使用润滑机油等外，还取决于选择和使用合适的机油滤清器、燃油滤清器及选择合适的更换周期。所有的重庆康明斯柴油机均装配有全流式机油滤清器、旁流式机油滤清器和燃油滤清器。它们均是纸质滤清器芯的、旋转拆装式的滤清器总成，总成一次性使用和更换。其结构简单，滤清效率高，更换方便，无需对滤清器芯进行清理和维修，从而使柴油机的保养大大简化。

2.1.1 全流式机油滤清器

全流式机油滤清器又被称作机油粗滤器，串联于重庆康明斯柴油机的机油泵与润滑主油道之间，其目的是滤除悬浮于循环通过柴油机的润滑机油中粒度在 40um 以上的颗粒污染物，柴油机全部循环的润滑机油均要通过它进行过滤（一般情况下，一分钟时间内，全流式机油滤清器可以过滤整个润滑机油三次），这样能更好地保护柴油机零、部件磨擦表面免遭磨料磨损之害。

全流式机油滤清器的纸滤芯是用要求很高的合成纤维滤纸制造的，其在高温、高压（1MPa）和污染堵塞的情况下不会破裂，而且纸滤芯是经过打褶的，过滤表面积大，滤清器过滤能力强。

为了防止因种种原因导致滤清器阻力达到或超过某一压力值而堵塞时，柴油机不缺润滑机油，在重庆康明斯柴油机的机油滤清器座中安装有滤清器堵塞旁通阀，当滤清器中机油流动阻力达到某一压差值（大凸轮Ⅰ、Ⅲ型NT/NTA855 分别规定为 320、340KPa，KT/KTA/KTTA19 规定为 207~270kPa；KT/KTA38 和 KTA/KTTA50 规定为 351.6kPa），这个旁通阀就开启，让部分机油不经滤清器过滤而直接进入柴油机主油道，以保证在机油滤清器堵塞时，柴油机各润滑点仍有足够的润滑油压力。

在某些改进型的重庆康明斯柴油机（如 NTA855-G2、NTA855-C360-HY5380TJCD）的机油滤清器座上装有滤清器堵塞报警装置，在旁通阀开启的同时，还输送给汽车驾驶室的报警信号指示灯一个电信号，通知驾驶人员应立即更换机油滤清器。

滤清器堵塞的情况有以下几种：

① 污染过度堵塞。柴油机机油中的燃烧积炭、氧化产物和燃烧产物等超过机油的容纳极限时，便出现这种堵塞，其表现形式是在滤清器纸滤芯上覆盖有一层稠密的松散的油泥，引起堵塞的原因可能是柴油机机油更换周期过长、维护保养差或曲轴箱中的燃烧废气量过高等等；

② 机油分散力水削弱堵塞。当柴油机冷却液泄入曲轴箱中时，就会产生潮气，这种冷凝的潮气削弱了机油中的分散剂的作用，从而使油烟和炭灰粘在一起并形成沉淀。其表现形式是沿滤清器纸滤芯波褶方向附有较坚固的、光泽的油泥，引起的原因是冷却液泄入柴油机曲轴箱和柴油机在寒冷气候条件怠速成时间过长等。

③ 添加剂析出堵塞。机油中有柴油机冷却液或潮气，因而引起机油中添加剂析出或从溶液中分离而引起堵塞。其表现形式是滤清器滤纸呈灰色或扭曲变形、纸褶断裂等，主要由泄入曲轴箱中的柴油机冷却液或曲轴箱中的潮气引起的。

④ 凝胶或乳胶堵塞。其表现形式是在滤清器纸褶有上奶油状的、类似凝胶的物质，主要由泄入柴油机中的冷却液污染了机油而引起的。

⑤ 氧化特堵塞。因柴油机机油稀释、受柴油机高温辐射或使用了不能抵御一般柴油机条件的机油而形成不能被机油溶解的氧化物引起的。其表现形式是堵塞时的滤清器芯呈红色（烟灰等沉积物）。

⑥ 磨料（磨削）堵塞。因机油中存有大量磨损物质而引起的，主要与柴油机磨损、损坏、润滑系统中进入大量的灰尘和脏物等引起的。

2.1.2 旁流式机油滤清器

旁流式机油滤清器（又称分流式机油滤清器或细滤清器）并联在柴油机润滑油路中，并在滤清器座上设计、加工某一尺寸的节流孔来限制通过滤清器的机油流量，让一部分机油通过旁流式机油滤清器过滤后流回机油盘。其目的是滤除全流式滤清器没有过滤掉的、影响柴油机磨损的尺寸较小的颗粒，以便控制柴油机的机油污染水平，进而阻止柴油机的磨损。这种滤清器在 10 分钟内才对所有的柴油机机油过滤一次。

由于通过这种滤清器的机油流量比较小，允许有较大的流量阻力，因而这种滤清器的过滤精度较高，一般可达 5~10um。

重庆康明斯柴油机所装用的这种滤清器的纸滤芯为层叠盘片式滤芯，它所使用的滤纸是长纤维纸浆制成的，纸质较细，流量较小，过滤细度较小。因而其过滤精度较高。

注意：不允许用旁流式机油滤清器代替全流式机油滤清器使用。

有些用户对旁流式机油滤清器的作用不甚了解，认为既然柴油机上已经装有全流式机油滤清器，用不用旁流式机油滤清器对柴油机影响不大，同时又认为每 250 小时更换滤清器，增大了柴油机的使用成本，因此常常不注意定期更换滤清器。

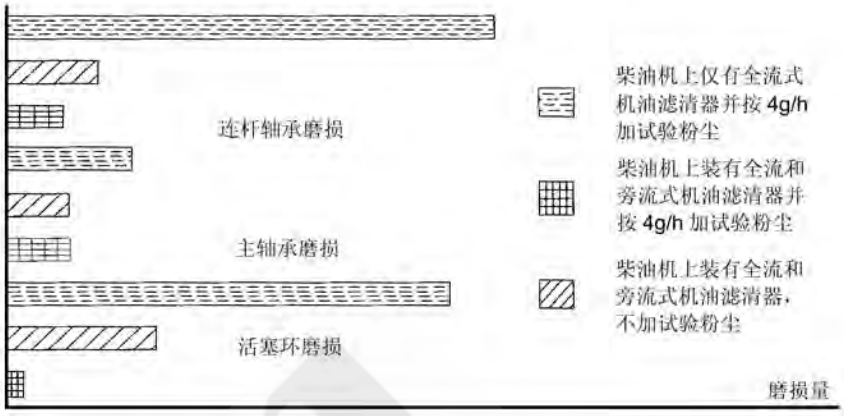


图 6-2 旁流式机油滤清器与柴油机零部件磨损情况

从图 6-2 可以看到，当使用旁流式机油滤清器时，柴油机各零部件的磨损量明显减少。事实上，当使用旁流式机油滤清器时，柴油机的磨损与柴油机中无脏物时的磨损水平几乎相当。

复合工机油滤清器兼具有全流式和旁流式机油滤清器的功能。

2.1.3 燃油（或柴油）滤清器

柴油机燃油中如果有铁锈、泥沙、灰尘、蜡晶体、水等，将引起燃油泵中的齿轮泵、喷油器的精密偶件等的磨损。为了使柴油机燃油泵和喷油器（嘴）受到的污染物减低到最小的限度，每一台柴油机均安装了优质的燃油滤清器。在正常的使用周期内，这种滤清器在品质和性能上能防止灰尘、柴油中的固体石腊等杂质和柴油中含有的水分、腐蚀性液体等进入柴油机燃油泵和喷油器（柴油机燃油系统中的水是引起柴油机燃油系统维修问题的主要原因之一）。

重庆康明斯柴油机燃油滤清器有两种，即轻型滤清器（燃油/水分离滤清器）和重型滤清器，轻型燃油滤清器外形尺寸小，容量小，流量也较小，适用于功率在 700HP 以下的重庆康明斯柴油机；重型燃油滤清器外形尺寸大，容量大，流量较大，适用于功率在 700HP 以上的重庆康明斯柴油机。

由于滤清器使用一定时间之后就会变脏乃至堵塞，因此应定期更换重庆康明斯柴油机所使用的机油和燃油滤清器。机油和燃油滤清器的更换周期除了根据重庆康明斯柴油机维修保养手册中根据机油和燃油的消耗曲线来确定之外，也推荐汽车等每运行 16000 公里（汽车或公路用车）、250 小时（非公路用车）或六个月时（无论哪个先到就执行）进行更换。

更换机油和燃油滤清器的方法和程序如下：

① 从柴油机上拆下已经堵塞的滤清器，然后将其扔掉。拆卸时可以使用旋装式滤清器扳手；

② 向将要装柴油机的机油滤清器（燃油滤清器）加注规定的润滑机油（燃油或柴油）；

③ 将已加油的滤清器静置半分钟后，再向滤清器中加油；

④ 重复步骤③ 多次，直至确信滤清器中的空气全部排出、滤清器已充满机油或燃油为止；

⑤在滤清器密封圈上端面涂上一层薄薄的柴油机润滑机油油膜，之后，将滤清器安装到滤清器座上去，旋转滤清器直到其密封圈与滤清器座面接触；

⑥ 再将全流式机油滤清器、旁流式机油滤清器和燃油滤清器分别旋转 3/4~1 和 1/2~3/4 圈（带矩形和锥形密封圈的机油滤清器的安装扭矩分别为 45~50ft-1bs 和 15ft~1bs[61~68 和 20.5N.m]，注意不要拧得过紧。

注意：绝对不允许将未加油的滤清器直接装到滤清器座上，否则将引起柴油机烧瓦、曲轴抱死、零件干磨擦而磨损、损坏等一系列严重问题。

燃油滤清器中，因油的比重较水轻，因而水沉积在滤清器下部，油在水之上。放水时，先旋松滤清器底部的塑料旋塞，滤清器随即先卸压，然后首先流出来的是水，后流出来的是油，待估计滤清器中的水已基本放完时，立即装上螺塞或旋紧塑料旋塞。

3 水滤器的使用和维护

3．1 水滤器的作用

① 减少穴蚀和抑制腐蚀

向柴油机冷却系统补充最有效的化学添加剂，维护冷却液具有合适的添加剂浓度，减少柴油机缸套、水泵叶轮等零件穴蚀和抑制水泵叶轮及其壳体，冷却系统弯接头和管子以及热交换器、散热器、机油冷却器、中冷器管子及期端盖等零部件的腐蚀。

② 保持冷却液具有合适的酸碱性或 PH 值；

③ 防止堵塞和积垢。

用化学物质软化冷却液，防止在传热零部件水侧表面形成积垢而引起缸盖炸裂，活塞环磨损严重等，防止沉淀物堵塞热交换器和散热器管子及缸体和缸盖中的冷却液通道。

④ 减少磨损

滤除冷却液中的泥芯砂、淤泥、机油、矿物性水垢、铁锈、变质的添加剂沉淀物和密封件碎块等杂质，减少水泵轴与水泵壳体之间、缸套缝隙密封圈、水泵水封（端面密封）、调（节）温器与调温器壳体以及调温器密封圈等零件的磨损。

⑤ 可以用来诊断发动机故障并确定故障发源处。

⑥ 抑制变脏

通过对发动机冷却液中的泥芯砂、淤泥、机油、矿物质水垢、变质的添加剂沉淀物等的过滤呵以抑制调温器、水温传感器和水加热器等零件表面变脏。

⑦ 水滤器的存在，本身可以提醒用户保护好冷却系统，并向冷却液中补充化学添加剂，对冷却系统进行良好的维护保养；

3.2 旋装式水滤器的使用和更换

对冷却系统进行正确维护、保养的关键之一就是使用水滤器，许多发动机操作者认为向冷却系统加入了清洁水和化学添加剂后，就没有必要再使用水滤器了。这种观点是不正确的，因为污物是发动机所固有的，它与使用优质的冷却水无关。

不正确使用优质水滤器将引起下列问题：

① 在水泵密封表面及缸套表面形成沉淀或使这些零件鳞片化（即腐蚀）；

② 冷却系统零部件腐蚀、磨损、堵死调温器等；

③ 堵塞机油冷却器、散热器和中冷器管子、冷却系统软管和水道；

④ 在传热表面形成油性沉淀物。

注意，在发动机工作过程中，随着其工作时间的延长，发动机冷却液中的化学添加剂在不断地被消（损）耗和稀释，亦即在不断地减少。因此，用户要定期检测发动机冷却液在的 DCA 的浓渡。

在重庆康明斯柴油机的第一次“B 级”保养（或更换机油）时，必须将水滤器预加芯子更换成水滤器工作（或维修）芯子。在以后的每次“B 级”保养检查时都要换装水滤器工作（或维修）芯子，但下列两种情况例外。

① 如在水滤器芯子更换期间向冷却系统加入了配制的冷却液，则应用水滤器预加芯子进行更换；

② 每一次排净冷却液后，应安装水滤器预加芯子。

更换冷却液后的新发动机或大修后的发动机，其初次使用的水滤器，使用时间（或寿命）一般推荐为 100 小时或 5000 公里，正常的水滤器使用时间则按每种型号的发动机的“B 级”保养要求进行，亦即每使用 250 小时（可六个月）或 16000 公里后予以更换。

更换水滤器的方法程序如下：

① 关闭水滤器进、出水管上的两个放水开关或闸阀；

② 从柴油机上拆下添加剂已经耗尽的水滤器，然后将其扔掉。拆卸时可以使用旋装式滤清器扳手；

③ 在滤清器密封圈上端面涂上一层薄薄的柴油机润滑机油油膜，之后，将滤清器安装到滤清器座上去，旋转滤清器直到其密封圈与滤清器座面接触；

④ 再将滤清器旋转 3/4~1 圈即可，拧紧力矩为 40N.m（30ft-1b）。

当水滤器安装好后，如暂不使用水滤器或更换水滤器时，则应将水滤器进、出水管路上的闸阀（或开关）关闭，使用时才打开这两个闸阀（或开关），并将其旋至最大的开度。

3.3 水滤器成本费用的补偿

柴油机上使用水滤器，可以延长柴油机的寿命，保持水泵、散热器、机油冷却器和调温器的工作状况良好。实践表明，冷却系统大多数故障出自调温器、缸套、散热器和水泵。不使用水滤器，虽然不增加柴油机使用成本，但冷却液中的碎屑物可能堵塞调温器而妨碍其正常的开、闭，因而增加了柴油机的修理费。实际上增加的费用还可能更高，因为如果柴油机在冷却液过冷的情况下运行，则要消耗更多的燃料，一个星期内柴油机燃料消耗增加的费用可能等于一年内维护和保养柴油机所使用的水滤器费用。

水泵密封件一般在 64000~80000 公里发生故障，其主要原因是冷却液中的铜、铁、铝、铅等腐蚀产物、剥蚀的软管碎片、缓蚀剂、硬处理水引起的硅酸盐和磷酸盐、MBT 分解产物等在水泵密封件上沉积而引起的。如果使用水滤器，则这种故障率至少可以减少三分之一。又如果冷却液中的污泥和沉淀堵塞了散热器和机油冷却器，则为了清理这种故堵塞，也需要支出很高的费用。再如冷却液中含有过量的泥芯砂而引导起缸套缝隙密封圈快速磨损性损坏，则把柴油机总成拆卸下来修理，就会大大地增加柴油机维修费用，从而增加了柴油机使用成本。

因此，使用水滤器可减少柴油机冷却系统的修理次数和停车时间，延长柴油机使用寿命，从而可以弥补因使用水滤器增加的成本。

Cummins
CCEC

Operation and Maintenance Manual

Chongqing-Cummins Diesel Marine Engines- K Series

Cummins
CCEC

FORWORD

The information contained in this publication pertains to Chongqing-Cummins inline and V diesel engines currently being produced by Chongqing Cummins Engine Company Ltd. for Marine applications. Operation and maintenance procedures are detailed so the information can be used to obtain the best service from the engine.
For model identification of an engine, check the Date and Serial No. On the Data plate. The following example shows how an engine is identified:

KTA19-M4

K=Model Identification
T=Turbocharged
A=After-cooled
19=Displacement
M=Marine Application
4=Rate level

This is an operation and maintenance manual; repair operations should be performed by specially trained personnel. Trained personnel are available at Chongqing Cummins Engine Company Ltd. Distributor and Dealer locations to perform full repair.

Marine Rating Guidelines

Rating Definitions

Ratings are based on ISO8665 conditions of 100 kPa (29.612 in Hg) and 25℃ (77℉) and 30% relative humidity. Propeller shaft power represents the net power available after typical gear losses and is 97% of rated power. Power rated in accordance with IMCI procedures.

Fuel consumption has a tolerance of +5% and is based on fuel of 35°API gravity at 16℃(60℉) having an LHV of 42,780 KJ/KG (18,390 BTU/lb) when used at 29℃(85℉) and weighing 838.9 g/liter (7.001 lb/US gal) with after-cooling when available.

Continuous Duty:

This power rating is intended for continuous use in applications requiring uninterrupted service at full power. This rating is an ISO 3046 standard power rating.

Typical vessel applications include: ocean-going displacement hulls such as fishing trawler, freighter, tugboats, bottom drag trawlers, and deep river towboats.

Heavy Duty:

This power rating is intended for continuous use in variable load applications where full power is limited to eight (8) hours out of every ten (10) hours of operation. Also, reduced power operations must be at or below 200 rpm of the maximum rated rpm. This is an ISO 3046 Fuel Stop Power Rating and is for applications that operate 5,000 hours per year or less.

Typical vessel applications include: displacement hull vessels such as mid-water trawlers, purse seines, and towboats where frequent slowing is common and engine speed and load is stable. Also used in passenger vessels such as ferries and crew boats.

Medium Continuous Duty:

This power rating is intended for continuous use in variable load applications where full power is limited to six (6) hours out of every twelve (12) hours of operation. Also, reduced power operations must be at or below 200 rpm of the maximum rated rpm. This is an ISO 3046 Fuel Stop Power Rating and is for applications that operate 3,000 hours per year or less.

Typical vessel applications include: planning hull ferries, fishing boats designed for high speeds to and from fishing grounds, off-shore service boats, and also (non-cargo) displacement hull yachts and short trip coastal freighters where engine load and speed are cyclical.

Intermittent Duty:

This power rating is intended for continuous use in variable load applications where full power is limited to two (2) hours out of every eight (8) hours of operation. Also, reduced power operations must be at or below 200 rpm of the maximum rated rpm. This is an ISO 3046 Fuel Stop Power Rating and is for applications that operate 1,500 hours per year or less.

Typical vessel applications include: planning hulls such as customs, military and police vessels, charter and some fishing vessel applications.

High Output:

This power rating is intended for continuous use in variable load applications where full power is limited to one (1) hour out of every eight (8) hours of operation. Also, reduced power operations must be at or below 200 rpm of

the maximum rated rpm. This is an ISO 3046 Fuel Stop Power Rating and is for applications that operate 300 hours per year or less.
Typical vessel applications include pleasure craft such as sport-fishers, motor-yachts, and cruisers.

BHP:
ISO 8665 fuel stops power rating. Fuel 40℃ (104℉).

Metric Horsepower:
ISO 3046 fuel stops power rating. Fuel 25℃ (77℉).

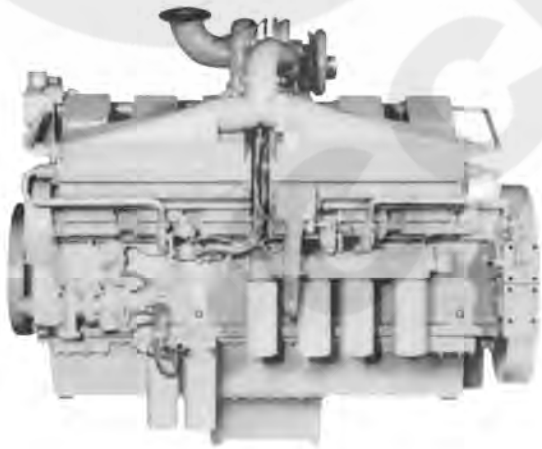
Marine Generator Drive Ratings

Prime Power

Prime power rating is applicable for supplying electric power for marine ship service or emergency use. Intermittent overloads up to 110% of rating are allowable. Rating conforms to ISO 3046 overload power (Prime rating) and fuel stop power (110%). Rated power is available for air temperature up to 38℃ (100℉).

A 10 percent overload capability is available for a period of one hour within a twelve hour period of operation. This power rating conforms to ISO 8528 guidelines.

KTA19-D(M)



KTA38-D(M)

Table of Contents

Cummins
CCEC

Operating Instructions

The operator of the engine assumes the responsebility of unit care during operation. There are comparatively few rules which the operator must observe to get the best service from a Cummins Diesel.

Marine Engines

New and Rebuilt Engine Break-In

The way a new engine is operated during the first 100 hours' service will have an important effect on the life of the engine and its parts. Even though all Cummins engines are run on a dynamometer for several hours before they leave the factory, an additional period of careful operation is required.
During the first 100 hours' service:

1. Avoid operation for long periods at engine idle speeds, or at maximum horsepower levels in excess of five minutes.
2. Develop the habit of watching engine instruments closely during operation and re-duce speed if oil temperature reaches 250℉[121℃] or coolant temperature exceeds 190℉[88℃].
3. Check oil level each 10 hours during break-in period.

Pre-Starting Instructions-First Time or Seasonal

Priming the Fuel System

1. Fill fuel filter with clean No. 2 diesel fuel oil meeting the specifications outlined in Section 3. Remove suction line from fuel pump and prelubricate gear pump with 2 to 3 oz. [50 to 60 cc] of clean lubricating oil.
2. Check fuel tanks. There must be an adequate supply of a clean No. 2 diesel fuel in the tanks. See "Fuel Oil Specifications" section 3.
3. If injector and valve or other adjustments have been disturbed by any maintenance work, check to be sure they have been properly adjusted before starting the engine.

Priming The Lubricating System

Note: On turbocharged engines, remove oil inlet line from the turbocharger and prelubricate bearing with 2 to 3 oz. [50 to 60 cc] of clean lubricating oil. Reconnect oil supply line.

1. Fill crankcase until oil appears on dipstick. See "Fuel Oil Specifications" section 3.
2. Remove plug from boss on rear gear housing on front of oil cooler housing on KTA19 Engines (Fig.1-1). On KTA38 Engines remove plug from lubricating oil filter head (Fig 1-2).

Caution: Do not prime engine lubricating system from by-pass filter.

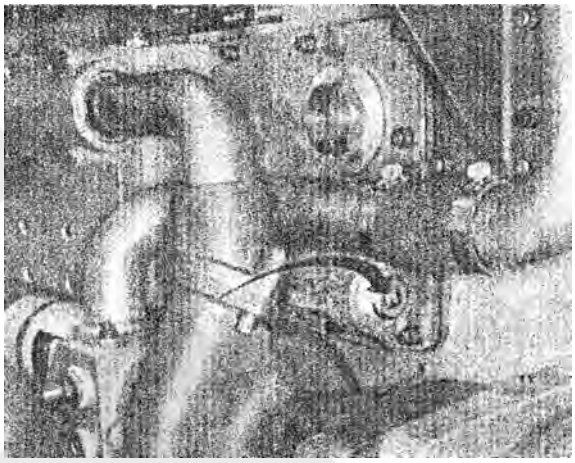


Fig.1-1 Lubricating system priming point on KT/KTA-19.

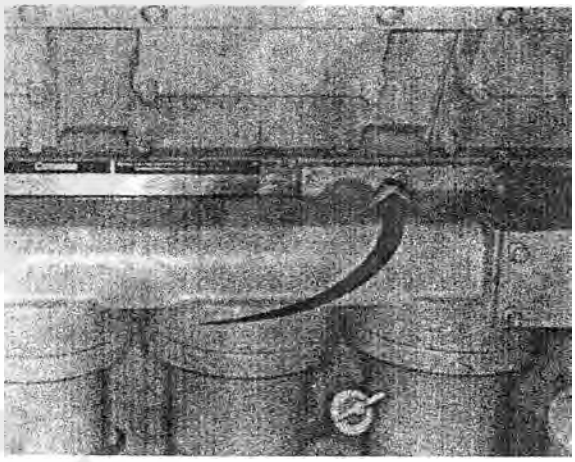


Fig. 1-2 Lubricating system priming point on KT/KTA-38 and KTA-50.

3. Connect a hand or motor-driven priming pump hose from source of clean lubricating oil (see Section 3) to priming point.
4. Prime until a 30 psi [207 kPa] pressure is obtained.
5. Crank engine at least 15 seconds (with fuel shut-off valve closed or disconnected to prevent starting), while maintaining external oil pressure at a minimum of 15 psi [103 kPa].
6. Remove priming hose and replace plug, removed in Step 2.

Lubricating Oil Dipstick Gauge Marking
All marine engines are shipped with unmarked lubricating oil dipstick gauges. The reason for this is the engine mounting angle is determined at installation; and even though a given amount of oil is required, the dipstick must be marked so the oil level is correct at the engine mounting angle.
Where the preceding conditions exist, the dipstick is lost or not originally furnished or the engine mounting angle is changed, use the following procedures in marking the dipstick oil gauge.

1. With engine in installed position and the boat in the water, remove the oil pan drain plug or use suction pump to be sure all oil drained. Replace plug.

Caution: Any oil left in oil pan will cause error in marking; the oil sometimes accumulates as the oil drains from upper portions and oil passages within the engine.

2. A tag is attached to new engines indicating high and low capacities of the oil pan. If there is doubt about proper capacities, consult Oil Pan Capacities, Table 1-1.
3.

Table 1-1: Oil Pan Capacities

Engine	Oil Pan Capacity	
	High gal.[l]	low gal.[l]
KT/KTA 38	30[114]	23[87]
KTA 50	40[152]	32[122]
KT/KTA 19	10[38]	8.5[32]
KTA19-M3/M4	18[72]	16.6[64]

Capacities listed are for oil pan only. Total system capacities vary with filter sizes and length of oil lines.

4. Fill engine with amount of oil listed as low-level oil pan capacity.
5. Allow five (5) minuets or more for oil to drain to the oil pan. If engine and/or oil temperature is below 40℉[4℃], a longer period may be required for full drain.
6. Insert dipstick into gauge tube until fully seated; hold for five (5) to ten (10) seconds, then with-draw slowly.
7. Mark oil level indicated on dipstick with an electric etches. Depth of mark must not exceed 0.010 inch [0.24mm]. Etch “L” above mark.
8. Add enough additional oil to fill engine to listed high-level capacity.
9. Repeat Steps 4,5 and 6. Etch letter “H” directly above the second or “high” level mark.
10. Start engine and operate at idle for 3 minutes. Stop engine and fill to high mark. Additional oil may be required to fill oil filters and lines.

The above procedure determines dipstick gauge marking for oil pan capacity only. Do not confuse with complete oil system capacity which also includes drilled passages, lines and filters.

Fill Marine Gear (CCEC not supplied)
The marine gear is a separate unit and carries its own lubrication. Fill housing according to manufacturer’s recommendations.
Start engine and briefly operate the gear in both forward and reverse.

Caution: If engine oils are used in transmissions or gear boxes the respective manufacturers should be contacted regarding the required oil viscosity for these components. Most gear manufacturers recommend single viscosity lubricating oil.

Prime Raw Water Pump
The Gilmec type pumps require initial priming. The pump will continue to self prime at al subsequent starts unless the pump body has been emptied deliberately. Fill pump body prior to connecting inlet connection.

Check Air Connections
Check air connections for loose clamps or connections, cracks, punctures, or tears in hose or tubing, collapsing hose, or other damage. Tighten clamps or replace pars as necessary to insure an airtight air intake system. Make sure that all air goes through air silencer or air cleaner.

Check Engine Coolant

1. Remove expansion tank cap and check engine coolant supply. Add coolant and check water filter. See Section 3 for coolant specifications.
2. Check for evidence of coolant leakage around tubing, hose connections, etc.; correct as necessary. Inspect water pump bleed hole for leakage. Leakage indicates worn or damaged seal.

Check Fuel Supply and Connections
Visually check for evidence of external fuel leakage at fuel connections and tighten as necessary.

Warning: Fuel lubricating oil spills or leaks create a fire hazard.

Starting the Engine
Starting requires only that clean air and fuel be supplied to the combustion chamber in proper quantities at the correct time.

Caution: Protect the engine and engine components during start-up by idling until normal idle oil pressure is obtained.

Normal Starting Procedure

1. Open sea cocks to permit raw water flow through heat exchanger and marine gear oil cooler.
2. Set throttle for idle speed.
3. Place marine gear in neutral.

Note: A manual over-ride knob provided on the for-ward end of the electric shut-down valve allows the valve to be opened in case of electric power failure. To use, open by turning full clockwise.

4. Press starter button or turn switch-key to "start" position.

Note: To prevent permanent cranking motor damage, do not crank engine for more than 30 seconds continuously. If engine does not start within 30 seconds, wait one to two minutes before recranking.

5. After engine has run for a few minutes, shut down and wait 5 minutes for oil to drain back into pan. Check engine oil level again; add oil as necessary to bring oil level to "H" mark on dipstick. The drop in oil level is due to absorption by the oil filter and filling of the oil cooler.

Caution: Never operate the engine with oil level below the low level mark (L), or above the high level mark (H).

External Leaks
Check for evidence of external oil leakage. Tighten capscrews, fittings, connections, or replace gaskets and o-rings as necessary to correct. Check oil dipstick and filler tube caps; see that they are tightened securely.

Engine Warm-up
When the engine is started, it takes a while to get the lubricating oil film re-established between shafts and bearings and between pistons and liners. The most favorable clearances between moving parts are obtained only after all engine parts reach normal operating temperature.
Allow the engine to run at 800 to 1000 rpm for 4 to 5 minutes before engaging the load. During the next 10 to 15 minutes, or until water temperature reaches 160 to 165℉ [71 to 74℃], operate at approximately 75 percent of governed rpm.

Engine Speeds

Idle speeds
In most applications engine idle speeds are 550 to 650 rpm; however, the parasitic load may require a slightly higher speed setting to smooth out operation.

Governed Speeds

All Cummins engines are equipped with governors to prevent excessive engine speeds.
The governor has two functions: First, it provides the exact amount of fuel needed for idling when the throttle is in idling position. Second, it overrides the throttle and shuts off fuel if engine rpm exceeds the maximum rated speed.

Continuous Duty
For continuous duty operation, engine governors are normally set for reduced rpm and fuel rate. Therefore a reduced cruise speed is not necessary.

Instrument Panels

Operate By the Instruments
The operator should observe the instrument panel at all times to find the operating characteristics of the engine.

Use The Tachometer
The tachometer indicates engine rpm and is a good indicator of engine loading and performance. Governed engine speed is the maximum rpm which a properly adjusted governor will allow the engine to turn under full load. At high idle (no-load) conditions, engine rpm will exceed governed speed by a small percentage.

Engine Oil Temperature Gauge
The oil temperature gauge normally should read between 212℉ [100℃] and 240℉ [116℃] at full load.

Caution: Any sudden increase in oil temperature which is not caused by load increase is a

warning of possible mechanical failure and should be investigated at once.

During warm-up increase speed gradually until oil temperature reaches 140℉ [60℃] increases likelihood of sludging, dilution, and acids in the lubricating oil which accelerates engine wear.

Oil Pressure Gauge

The oil pressure gauge indicates lubricating oil pressure or mechanical malfunction in the lubricating oil system. The operator should note loss of oil pressure and immediately shut down the engine.

Normal operating pressures are shown in Table 1-2.

Table 1-2: Engine Oil Pressure

Engine	Idle RPM	Minimum PSI [kPa]	Rated RPM	Rated PSI [kPa]
KT(A)19	625	15[103]	1800/1950	45~70 [310~482]
KT(A)38	625	15[103]	1800/1950	45~70 [310~482]
KT(A)50	625	15[103]	1800/1950	40~70 [276~482]

Note: Individual engines may vary from listed pressures. Observe and record pressures when engine is new to serve as a guide for indication of progressive engine wear. (High oil pressure during start-up is not cause for alarm.)

Water Temperature

A water temperature of 165 to 195 ℉ [74 to 91℃] is the best assurance that cylinder liners are heated to the proper temperature to support good combustion and that working parts of the engine have expanded evenly to the most favorable oil clearances. See “Engine Warm-up”.

Overheating problems require mechanical correction. They may be caused by loose or worn water pump belts, a clogged cooling system or heat exchanger, or clogged sea water pump inlet.

Maximum engine coolant temperature of 200℉ [93 ℃] should not be exceeded.

Engine Shut-Down

Idle Engine A Few Minutes Before Shut-Down,It is important to idle an engine 3 to 5 minutes before shutting it down to allow lubricating oil and water to carry heat away from the combustion chamber, bearings, shafts, etc. This is especially important with turbocharged engines.

The turbocharger contains bearings and sealing rings that are subject to the high heat of combustion exhaust gases. While the engine is running, this heat is carried away be oil circulation, but if the engine is stopped suddenly; the turbocharger temperature may rise as much as 100℉ [56℃]. The results of extreme heat may be seized bearings or loose oil seals.

Do Not Idle Engine For Excessively Long Periods

Long periods of idling are not good for an engine as temperatures drop and the fuel may not burn completely. This will cause carbon to form around the injector spray holes and piston rings.

If engine temperature becomes too low, raw fuel will wash lubricating oil off cylinder walls and dilute crankcase oil so all moving parts of the engine will suffer from poor lubrication.

Engine Shut Down

The engine can be shut down by turning off the switch key which controls the electric shutdown valves always stops the engine unless override button on shut-down valve has been locked in open position. If manual override on electric shut-down valve is being used, turn button full counterclockwise to stop engine. Valve cannot be reopened bus witch key until after engine comes to complete stop.

Caution: Never leave switch key or override button in valve open or run position when engine is not running. With overhead tanks this would allow fuel to drain into cylinders, causing hydraulic lock.

Stop Engine Immediately If any Parts Fail

Many engines are saved because alert operators heed warning signs (sudden drop in oil pressure, unusual noises, etc.) and immediately shut down the engine. Any delay may result in further engine damage.

Cold-Weather Protection

1. For cold-weather operation, use of permanent type antifreeze with rust inhibitor additives is recommended. See Section 3.
2. To completely drain cylinder block and heads, open petcock or remove drain plugs on engine block, lubricating oil cooler, heat exchanger, water pump inlet connections, sea water pump, marine gear oil cooler and exhaust manifolds. Failure to drain may cause serious damage in freezing weather.

Ship’s Log or Engineer’s Report

The engine must be maintained in top mechanical condition if the operator is to get the most satisfactory service. Engine adjustments, etc. are the work of a Chongqing-Cummins Distributor. However, the Cummins Distributor needs running reports from the operator in order to make provisions for more extensive maintenance work.

Intelligent interpretation of the daily or trip report will make it possible to eliminate most failures and emergency repairs.

Always write in the report any of the following conditions:

1. Low lubricating oil pressure.
2. Low fuel pressure.
3. Abnormal water temperature.
4. Unusual engine noise.
5. Excessive smoke.
6. Difficulty in starting.
7. Excessive fuel consumption.
8. Excessive lubricating oil consumption.
9. Overheating of marine gear.
10. Unusual vibration.

Maintenance Operations

Maintenance is the key to lower operating costs. A diesel engine requires regularly scheduled maintenance to keep it running efficiently.
Preventive maintenance is the easiest and least expensive type of maintenance. It permits maintenance to be done at a convenient time.

Maintenance Schedule

Using the Suggested Schedule Check Sheet

The check sheet shown on Page 2-2 can be reproduced by any printer. The person making each check can then indicate directly on the sheet the operation that has been performed. When a completed column (under A, B, C, etc.) of checks is indicated the engine will be ready for additional service until the next check is due.
A detailed list of component checks is provided through several check periods; also a suggested schedule basis is given for hours of operation, or calendar of time.
The maintenance schedule check sheet is designed as a guide until adequate experience is obtained to establish a schedule to meet a specific operation.

Changing the Maintenance Schedule

Actual operating environment of the engine governs the maintenance schedule. Any change in the established maintenance schedule should be preceded by a complete re-analysis of operation. A lubricating oil analysis should be the major factor used in establishing the original maintenance schedule; it should be studied before making any change in or extending the schedule periods.

Storage for Engines Out Of Service

If an engine remains out of service for three or four weeks (maximum six months) and its use is not immediately forthcoming, special precautions should be taken to prevent rust. Contact the nearest Chongqing-Cummins Distributor for information concerning engine storage procedures.

Maintenance Schedule

SHIP/BOAT	ENGINE S/N
MECHANIC	HOURS,GALLONS
TIME SPENT	CHECK PERFORMED
PARTS ORDER NO.	DATE

Chongqing-Cummins Marine Engines — Check each operation as performed

A-Check	B-Check	C-Check	D-Check	Seasonal	Other
Daily and at each refueling ☐Check ship's log • Oil level • Coolant level • Air intake system ☐Check oil level • Marine gear • Raw water pump ☐Visually inspect engine for signs of leakage, damage, loose or frayed belts, hoses, engine noise and correct. ☐Drain sediment from fuel filter/water separator. ☐Record all operating temperature and pressures in ship's log.	Repeat "A" Check ☐Change oil • Engine ☐Change filters • Engine oil full flow • Engine oil by-pass • Engine fuel filter ☐Check coolant • Check engine coolant D.C.A. concentration level. Add make-up D.C.A. and change element if required[2]. ☐Clean/air silencer ☐Check heat exchanger zinc plugs.	Repeat "A" & "B" ☐ Adjust valves and injectors	Repeat "A" & "B" ☐ Clean and calibrate injectors, fuel pump ☐ Rebuild and/or replace the following assembly • Water pump ☐ Check and/or rebuild the following assemblies: • Turbocharger • Vibration damper	Fall ☐ Replace hose as required Clean engine/marine gear ☐ Tighten mounting bolts ☐ Check crankshaft end clearance ☐ Check safety controls ☐ Prepare engine for winter storage if required	+ Marine gear + Raw water pump Electrical Components + alternator + batteries + gauges + generator + starter + switches + tachometers + voltage regulator + Fuel tanks + Turbocharger + Throttle and gear cables
Interval[1]					
Hours Calendar	Chart Method or 250 6 Mo.	1500 1 Year	4500 2 Year		+ On these components follow the manufacturer's recommended maintenance procedure

Notes: 1. Perform checks on operating basis of interval that occurs first. Normally calendar period is used only when hours is less than 1/3 that suggested during the six (6) month period.

2.Any time cooling system is completely drained and/or flushed, use DCA Service Element and DCA-4L Precharge as listed in Table 3-6.

"A" Maintenance Checks

Perform the following checks at intervals suggested on maintenance schedule.

Check Ship's Log Daily
Comparison and intelligent interpretation of the daily report along with a practical follow-up action will eliminate practically all failures and emergency repairs.

Check Engine

Oil Level

1. Check oil level with dipstick oil gauge located on the engine. For accurate readings, oil level should not be checked until oil has settled into pan after engine shut-down.
   Keep dipstick with the engine and oil pan with which it was originally furnished. Keep oil level as near "H" (high) mark as possible.

Caution: Never operate the engine with oil level below "L" (low) mark or above the "H" (high) mark.

2. Add oil as necessary of the same quality and brand as already in the engine. See Section 3.

Cooling System
Keep cooling system filled to operating level. Check coolant level daily or at each fuel fill point. Investigate for causes of coolant loss. Check coolant level only when system is cool.

Check Air Connections
Check air connections for loose clamps or connections, cracks, punctures, or tears in hose or tubing, collapsing hose, or other damage. Tighten clamps or replace parts as necessary to insure an airtight air intake system. Make sure that all air goes through air silencer.

Visually Inspect

Check for evidence of external air, coolant or oil leakage. Tighten capscrews, fittings, connections or replace gaskets as necessary. Check oil dipstick and filler tube caps. See that they are tightened securely.

Damage Check
Check fuel system, etc., including the fuel pump for misadjustment or tampering, check all connections for leaks or damage.

Drive Belts
Visually check belts for looseness. If there is evidence of belt slippage adjust as follows.

Belt Tension

1. Tighten belts up to ½ inch [12.7 mm] wide, with ST-968 Belt or ST-1274 Tension Gauge. For belts over ½ inch [12.7 mm] wide, use ST-1138 Belt Gauge. See Table 2-1.
2. On K series engines, use ST-1274 or ST-1293 Belt Tension Gauge. Adjust to tension listed in Table 2-1.

Table 2-1: Belt Tension (Pounds)

Belt Width Inches	Belt Gauge	*New Belt Tension + or - 10	**Belt Tension After Run-In + or - 10
Standard "V" Belt			
½	ST968	140	100
	ST1274	140	100
11/16	ST1138	140	100
¾	ST1138	140	100
Ploy-V			
6 Rib	ST-1293	150	130

*New belts must be retensioned to values listed under "Belt tension after run-in".
**Use belts should be retensioned to values listed under "Belt tension after run-in".

Readjusting New Belts
All new belts will loosen after running for an hour or more and must be readjusted. Readjust as descrybeed under "Belt Tension".

Belt Installation
If belts show wear or fraying replace as follows:

1. Always shorten distance between pulley centers so belt can be installed without force. Never roll a belt over the pulley and never pry it on with a tool such as a screwdriver. Either of these methods will damage belts and cause early failure.
2. Always replace belts in complete sets. Belt riding depth should not vary over 1/16 inch [1.6mm] on matched belt sets.
3. Pulley misalignment must not exceed 1/16 inch [1.6mm] for each foot [0.3m] of distance between pulley centers.
4. Belts should not bottom on pulley grooves nor should they protrude over 3/32 inch [2.4 mm] above top edge of groove.
5. Do not allow belts to rub any adjacent parts.
6. Adjust belts to proper tension.

Exhaust System

Check Exhaust System For Leaks And Deterioration

1. Check exhaust manifold connections for exhaust leaks.
2. Check all exhaust piping connections to be certain they are air tight.
3. If water is used in exhaust piping, Check all connections and tubing for leaks and corrosion.

Drain Sediment From Fuel Filter

Remove the drain plug in bottom of fuel filter to drain water and sediment. If plug is omitted, remove filter element to check for water and sediment. Fill new element with clean fuel and replace.

Fuel/Water Filter Separator

If moisture is present when checking fuel filters it may be advisable to install a water separator.

Contact the nearest Chongqing-Cummins Dealer for a Fleetguard water separator that meets requirements.

Drain plugs are located in bottom of some fuel filter cans and in sump of fuel supply tanks. More condensation of water vapor occurs in partially filled fuel tank than in a full one. Therefore, fuel supply tanks should be kept as nearly full as possible. Warm returning fuel from injectors heats fuel in the supply tank. If fuel level is low in cold weather, the fact that the upper portion of the tank is not being heated by returning fuel tends to increase condensation. In warm weather both supply tank and fuel are warm. In the night, however, cool air lowers temperature of the tank much more rapidly than the temperature of the fuel. Again this tends to increase condensation.

Ship's Log or Engineer's Report

The engine must be maintained in top mechanical condition if the operator is to get the most satisfactory service. Engine adjustments, etc., are the work of a Chongqing-Cummins Distributor. However, the Cummins Distributor needs running reports from the operator in order to make provisions for more extensive maintenance work.

Comparison and intelligent interpretation of the daily entry in ship's log will make it possible to eliminate most failures and emergency repairs.

Always write in the report temperatures, pressures and any other data pertinent to engine operations.

Caution: Discharge of oil prohibited. Such as, the Federal Water Pollution Control Act prohibits the discharge of oil or oily waste into or upon the navigable waters and contiguous zone of the United States if such discharge causes a film or sheen upon, or discoloration of, the surface of the water, or causes a sludge or emulsion beneath the surface of the water. Violators are subject to a penalty of $5,000.

"B" Maintenance Checks

B-Check
At each "B" Maintenance Check, perform all "A" Checks in addition to the following.
Maintaining a proper "B" Maintenance check interval is a very important factor in preserving the integrity of an engine. Lubricating oil contamination is the direct result of engine operation, the load factor involveed and the amount of fuel the engine consumes.

Note: If the lubricating oil is drained from the oil pan to make an engine repair, new oil must be used. Do not use oil after it has been drained from the oil pan.

Lubricating Oil Change Intervals

1. The recommended oil change interval is determined by the "Chart Method" based on fuel oil consumed and lubricating oil added. See "Chart Method" following.
2. An alternate to the "Chart Method" is 250 hours or 6 months.
3. A second alternate method of determining oil change interval may be established through the use of oil analysis. Refer to "Lubricating Oil Analysis".

Chart Method
Advancement in lubrication technology has made it possible for users of Chongqing-Cummins engines to successfully extend oil change intervals, thus reducing maintenance costs.

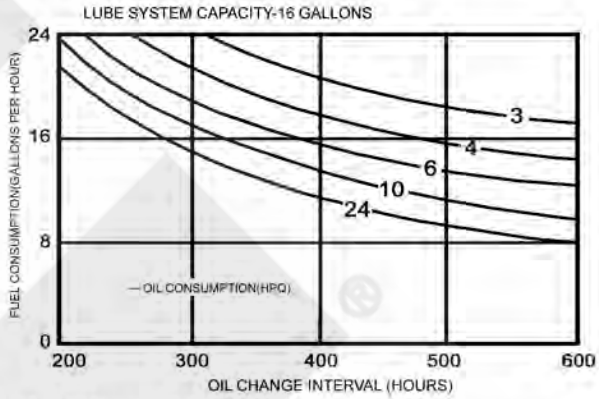
Note: At oil change, change full-flow filter, by-pass filter (if used) and fuel oil filter.
Lubricating oil change intervals depend on the following variables:

1. Fuel consumption per hour.
2. Oil consumption per hour.
3. Filtration systems.
4. Lubricating system capacity.

The following graphs are to be used to determine the proper oil change interval for engines.
Total lubricating system capacity (in gallons) can be determined by adding the oil pan (high level), full-flow filter(s) and by-pass filter(s) capacities. Total lubricating capacities must be rounded to the nearest gallon. See example following.

KT/KTA19 Marine Engine	
Oil pan capacity	10.00 gal.
Full-flow filter(3)	
By-pass filter(2)	
Total system capacity	
Example:KTA19-M with 750 By-pass Filter	
Lubricating System Capacity	
Fuel Consumption	
Oil Consumption	
Recommended Oil Change Interval	

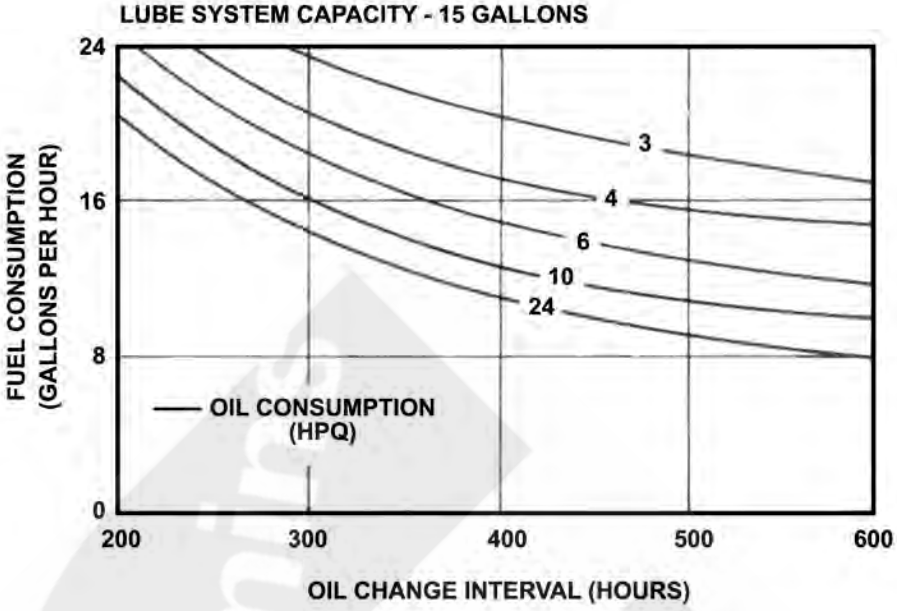
Note: Cummins Engine Company, Inc. **does not** recommend exceeding 600 hour oil change intervals. Therefore, curves are limited to 600 hours and should not be extended.

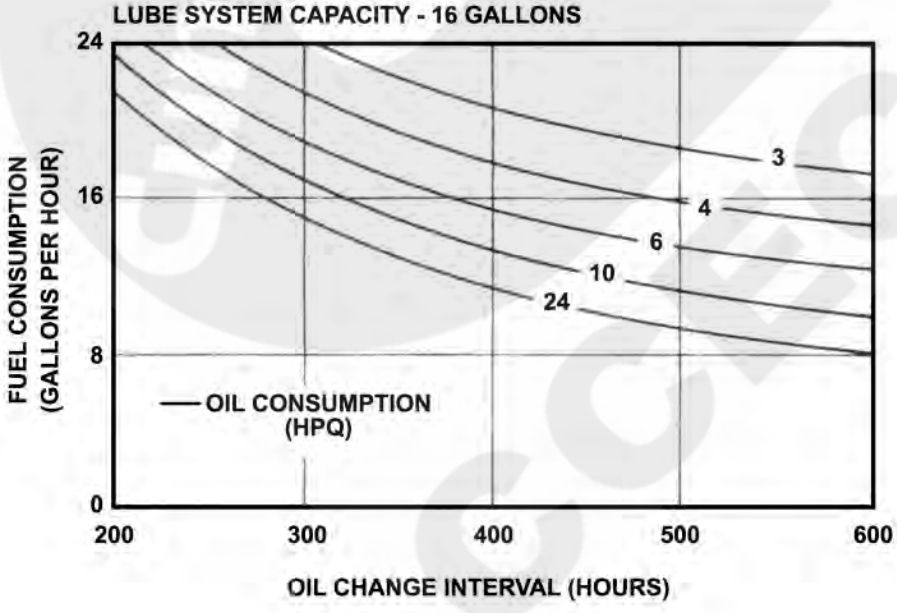


Lubricating Oil Analysis
An alternate method for determining when to change lubricating oil is analysis, using laboratory tests. A new series of test should be run if filters, oil brands or grades are changed.
In the beginning, tests should be made each 100 gallons of fuel consumed (after the first 400 gallons), or 20 hours (after the first 100 hours) until the analysis indicates the first oil change is necessary.

Analysis Test for Lubricating Oil
Check oil properties in the following list during analysis. These methods are fully described in the American Society for Testing Materials Handbook.

Oil Property	Test Number
Viscosity at 100℉ and 210℉ [38℃ to 99℃]	ASTM-D445
Sediment	ASTM-D897
Water	ASTM-D95
Acid and Base Number	ASTM-D664


LUBE SYSTEM CAPACITY - 15 GALLONS
FUEL CONSUMPTION (GALLONS PER HOUR)
24
16
8
0
3
4
6
10
24
OIL CONSUMPTION (HPQ)
200
300
400
500
600
OIL CHANGE INTERVAL (HOURS)


LUBE SYSTEM CAPACITY - 16 GALLONS
FUEL CONSUMPTION (GALLONS PER HOUR)
24
16
8
0
3
4
6
10
24
OIL CONSUMPTION (HPQ)
200
300
400
500
600
OIL CHANGE INTERVAL (HOURS)

General Limits for Oil Change

1. Minimum Viscosity (dilution limit): Minus one SAE grade from oil being tested or point equal to a minimum containing five percent by volume of fuel oil.
2. Maximum Viscosity: Plus one SAE grade from oil being tested, or ten percent increase at 210℉ [99℃] or 25 percent increase at 100℉ [38℃].
3. Sediment Content: Normal pentane insoluble 1.0 to 1.5 percent. Benzene insoluble 0.75 to 1.0 percent.
4. Acid Number: Total number 3.5 maximum.
5. Water Content: 0.2% maximum.
6. Additive Reduction: 25% maximum.

Caution: If the above tests indicate presence of any metal particles, or if found in filters, the source should be determined and corrective action taken before a failure results.

Change Engine Oil

Oil change at "B", as shown in maintenance chart on Page 2-2, is for average conditions.

1. Bring engine to operating temperature, shut down engine, remove drain plug from bottom of oil pan, and drain oil, or pump oil from pan (Fig. 2-1).
2. If removed, reinstall drain plug in oil pan. On KT(A)19, KT(A)38, and KTA50 Engine Torque to 60 to 70 ft-lb [81 to 95 N.m].

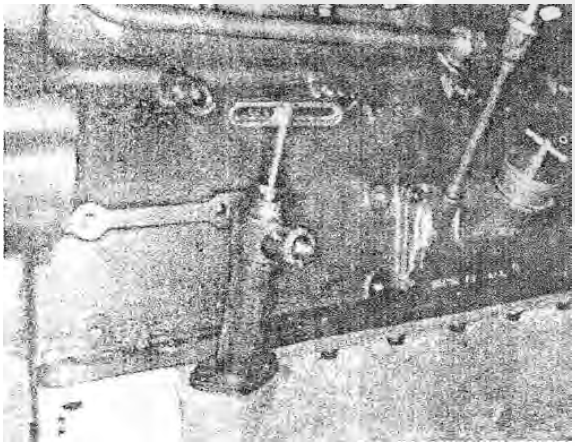


Fig 2-1 Hand sump pump

3. Fill crankcase to "H" (high level) mark on dipstick.
4. Start engine and visually check for oil leaks.
5. Shut down engine; allow 15 minutes for oil to drain back into pan; recheck oil level with dipstick. Add oil, as required.

Note: Use lubricating oil meeting specifications listed in Section 3, and genuine Chongqing-Cummins or Cummins filters on equipment.

Change Spin-On Lubricating Oil Filter Elements（Include Full-Flow Filter Element and By-pass Filter Element）

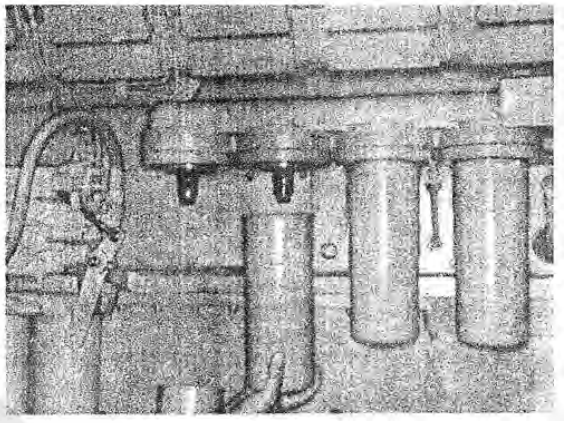


Fig. 2-2 Removing spin-on lubricating oil filter

Spring on Filters

Oil Filter

Engine oil will be polluted by the parts wearing particle and outer impurity which enters into the engineees, also , for being subjected to heat radiation of the hot parts, it will be oxidized , and produces acidic material which can dissolve in oil and colloidal deposit which is not soluble. These impurity and contamination are very harmful to the engines, if they are not be filtered, the hard particle in the oil will accelerate parts to abase, and jam the oil passage; the acidic material will bring the corrosive abrasion of the alloy bearings. The colloidal deposit will lead the pistons and piston rings and valves and valve stem guide to cement, even the engine can not run, and shorten the oil drain interval. It is said that if the total value of the solid contamination in the oil is less than 0.15%, the harm to the engine is limited, if this value is more than 0.5%, the harm to the engine is very serious. Therefore, the oil filters should be assembled in the lubrication system of the engine. All Chongqing-Cummins engines use the following filters: oil filter, bypass oil filter, fuel filter and corrosion resistor.

Full flow oil filter

The grain contamination with a diameter more than 0.04mm in the oil can be filtrated by this filter.

The element of this filter is made from synthetic fiber filter paper; it can not be collapsed on high temperature and high pressure and filter jamming.

There is bypass valve in the filter head, when the restriction arrives at or exceeds a pressure which is pre-confirmed, the oil will not pass the filter and flow the filter head to the main rifle directly, so that there are sufficient oil to lubricate the engine's parts.

There is a alarming equipment in the filter head in some engines, when the restriction arrives at or

exceed a pressure which is pre-confirmed, it can give a alarming signal to the alarming lamp which can remind the drive to replace the oil filter A.S.A.P.

There are some jamming types about the oil filter:

a. The filter is polluted unduly. When the carbon deposit an oxid and buring byproduct in the engine oil exceed the limit that the oil can absorb, this will appear. It may be the primary reason for that the oil drain interval is very long and the maintenance or service is very bad, or the blowby is very high.
b. The ability that the oil disperse the deposit is weakened. When the coolant leaks into the oil pan, the humidity will be formed, the humidity will weaken the dispersing ability of the oil, this will cause the lampblack and chary dust to agglutinate and deposit. It is the primary reason for the coolant leaks into the oil pan and the engine idles for long time at cold status.
c. The additives separate form the oil. The additives will separate from the oil for coolant or humidity in the oil, this will cause jam.
d. Gel and latex. When the oil have been polluted by the coolant, this things will form in the oil.
e. Oxide. When the oil is diluted and the oil is eradiated by the high temperature, the oxide will form in the oil.
f. Abrasion material. This things are caused by the triturate and the dust in the lubrication system.

Full flow oil filters must always be used with bypass filters, but a bypass filter can not be used to instead of a full flow oil filter.

Bypass oil filter

This filter will filtrate out those granules which can not be percolated by the full flow oil filter. Because the oil flow which passes the filter is very small, it is allowable that the restriction of this filter maybe greater than the full flow oil filter. Granule dimension after filtrating by the bypass oil filter is between 0.005mm and 0.010mm.

Some customers think that the full flow oil filter has been assembled on the engine, it is not necessary to use the bypass oil filter again. At the same times, they consider the using cost will increase if the oil filter is replaced by a new one after the engine runs for 250 hours or 6 months or 16000kilometres, therefore, they don’t replace the filter. It is proven that when the engine only use for full flow oil filter, the abrasion of the engine’s parts are very serious. When the engine use full flow an bypass oil filters, the abrasion of the engine’s parts will be decreased observably.

The combo filter has the function of full flow oil filter and bypass oil filter.

Check Throttle Linkage

Check throttle Linkage and make sure it is in good operating condition. Check throttle travel to make sure linkage operates throttle from stop to full throttle.

Change Fuel Filter Element

Check Fuel Filter Restriction and Air Entrainment

To check restriction, connect ST-434 Vacuum Gauge to the fuel pump as shown in using the special adapter furnished. If restriction reads 8 inches vacuum while the engine is running at full speed and load, change element or check other sources of restriction and correct.

Check sight gauge ST-998 (Fig. 2-3) fir air bubbles which indicate air entrainment and possible gasket or other leaks on suction side of pump.

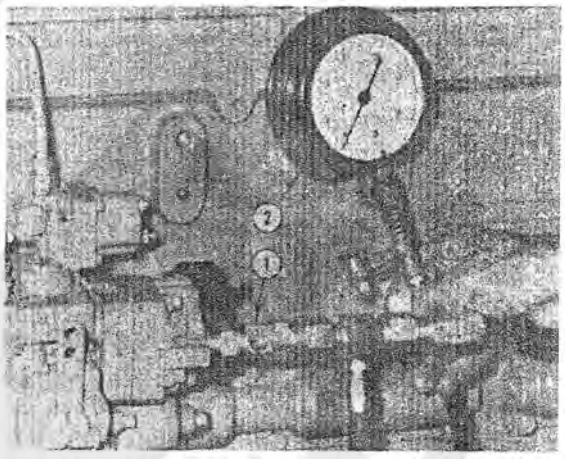


Fig. 2-3 Checking fuel filter restriction

There are two types fuel filters assembled on Chongqing-Cummins engines, normal and heavy duty fuel filter. The first one is applied to those engines whose power is below 700BHP. The second one is applied to those engines whose power is above 700BHP.

After the filter has been used for a period of time, the filter will be contaminated and jammed, it must be replaced trebly. The interval of the oil and fuel filters can be determined by the consumption curve of the oil and fuel, also, it is recommended that the oil and fuel filter is replaced every 250hours, 16000kilometers or 6 months.

The methods for replacing the filters can be seen on the filters.

For fuel/water separator, the user can drain the water from the separator by burning on the drain valve. When you estimate that the water have been drained drastically, you can turn off the drain valve.

Caution: Mechanical tightening will distort or crack filter head.

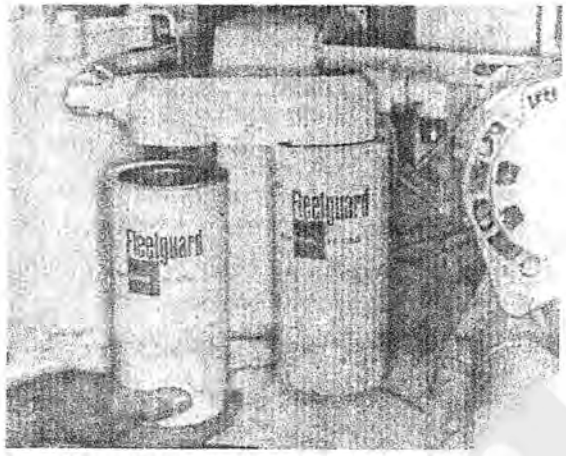


Fig. 2-4 Changing fuel filter

Check Engine Coolant

Periodic tests of engine coolant should be made to insure that the frequency of water filter servicing or concentration of DCA inhibitor is adequate to control corrosion for any specific condition of operation. In case where “make-up” water must be added frequently, we suggest that a supply of water be treated and added as necessary.

The concentration of effective inhibitor dissolved in coolant can be measured by Fleetguard DCA Coolant Checking Kit Part. No. 3300846-S or Cummins 3375208 which is available from Chongqing-Cummins or Cummins Distributors for this Check (Fig. 2-5).

The test kit indicates DCA concentration by measureing the total nitrite of a coolant sample, which provides cylinder liner cavitation protection.

When antifreeze is present, it may contribute to the total nitrite, but most of the nitrite protection is obtained from the DCA inhibitor. In general, a good nitrite reading indicates that the combined inhibitor packages contained in the antifreeze (if used) and in DCA are sufficient to insure complete cooling system protection.

Concentration Test Procedure

1. Dilute one part of engine coolant with nine parts tap water. Mix well.
2. Fill vial to scribe mark (Fig. 2-6) with the diluted coolant solution. Add two or three drops of nitrite indicator solution and swirl to attain a uniform red color.
3. Add one drop of nitrite test solution “A” to the solution in vial. Swirl to mix.

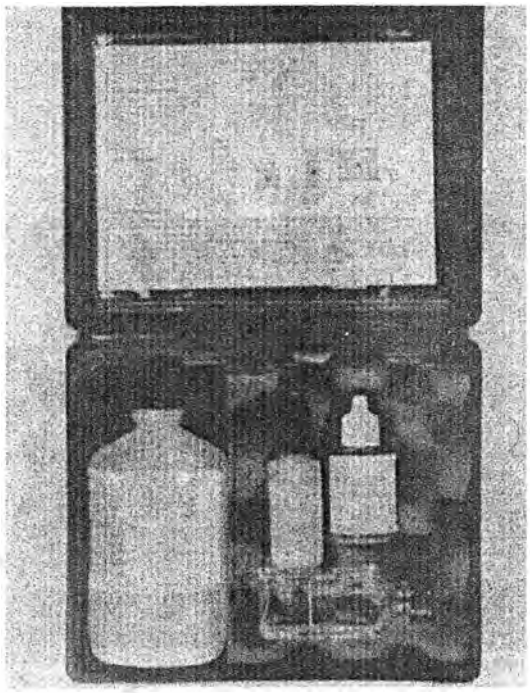


Fig. 2-5 DCA coolant test kit

Fig. 2-6 Mixing bottle

4. Continue to add nitrite solution “A” one drop at a time, mixing between each drop, until a color change from red to pale blue, gray or green is observed. Make sure that the dropper is held in a vertical position.
5. Record the number of drops required for color change, and consult Table 2-2 for coolant condition and maintenance.

Table 2-2: Number of Drops of Test Solution "A"			
Coolant With Antifreeze	Coolant Without Antifreeze	Coolant Condition	Maintenance Required
0-12	0-6	Dangerous (0 to 0.6 oz, per gallon DCA)	Pre-charge system or add make-up DCA to top tank.
13-17	7-12	Borderline (0.7 to 1.2oz, per gallon DCA)	Replace service filter and/or add make-up DCA to top tank.
18-25	13-20	Acceptable (1.3 to 2.0 oz, per gallon DCA)	None.
26-30	21-30	Tolerable (2.1 to 3.0 oz, per gallon DCA)	None.
Over 30	Over 30	Overrated (over 3.0 oz, per gallon DCA)	Drain part of coolant and make-up with plain antifreeze and water.
Note: Ethylene glycol/water solutions should not contain more than 3.0 oz. per gallon DCA and Dowtherm 209/water solutions should not contain more than 2.0 oz. per gallon DCA. Concentrations in excess of the above can cause sludge to form in the water filter.			

Adding Make-up Coolant and DCA to Cooling System

1. Test coolant for DCA according to nitrite test procedure "With or Without Antifreeze" depending on the presence or absence of antifreeze in cooling system.
2. Estimate make-up DCA. For example, if a fifteen gallon cooling system contains only 0.5 oz/gal. [4 ml per l] DCA, and 1.5 oz/gal. [12 ml per l],is required, 15 ounces [426 g] of DCA should be added to the make-up coolant.

Note: A one pint bottle of DCA-4L liquid (P/N 3300858) contains six dry ounces of DCA chemical in solution. In Step 2, concentrations are in dry ounces of chemical per gallon of coolant.

3. Estimate the total amount of make-up coolant required (gallons), and calculate the proportions of water and antifreeze, if used, required. For example, one gallon of 50-50 antifreeze/water solution will require two quarts of antifreeze and two quarts of water.
4. Add the required amount of water to a mixing container and dissolve the number of ounces of DCA obtained in Step 2 in the water. If negative or zero results were obtained in Step 2, do not add DCA (For DCA to dissolve; water should be above 50 ℉ [10 ℃].
5. Add the required amount of antifreeze, if used to the water solution and mix thoroughly.
6. Add make-up coolant to cooling system.

Note: If the DCA concentration is low, and coolant level high, DCA may be added directly to the heat exchanger in the amount indicated in Step 2. The engine should be running and warm enough to permit coolant circulation throughout the entire system.

Bulk Storage of Make-up Coolant

If make-up coolant is stored in bulk, the following recommendations are provided for mixing and storing the coolant.

1. Drain and clean bulk storage tank to remove any possible contaminant.
2. Knowing the total capacity of the holding tank, calculate the proportions of water and antifreeze, if used, required. For example, a 500 gallon [1892 l] tank will hold 250 gallons [946 l] of water and 250 gallons [946 l] of antifreeze for a 50-50 mixture.
3. Multiply the desired DCA concentration by the total capacity of the holding tank in gallons. In the example above, 15 oz DCA per gallon [12 ml per l] of coolant can be used in the 50-50 mixture. Multiplying 1.5 oz DCA per gallon [12 ml per l] times 500 [1892 l] gallons yields a total DCA requirement of 750 oz [46 lb, 14 oz] [21.3 kg].
4. Add the water to the holding tank. Agitating continuously, add the DCA to the water in small amounts until the entire chemical has dissolved. The water should be above 50 ℉ [10 ℃].
5. Add the antifreeze last, if used, maintaining agitation to bring and keep the finished coolant in solution. Both antifreeze and DCA will settle to the bottom of the tank unless constant mixing or recirculation is provided. An example of recirculation is the use of a small pump operating continuously to draw DCA and antifreeze off the bottom of the tank and discharging the solution at the top. Samples of coolant can be drawn off the top, middle and bottom of the storage tank and tested for antifreeze and/or DCA concentration if inadequate mixing is suspected.

Change DCA Water Filter

Change filter as indicated by coolant test; selection of element to be used should be based upon size of system listed in Table 3-5. See "Coolant Speci-

fications", Section 3 for DCA compatibility with different brands of antifreeze.

Spin-On Water Filter

1. Close shut-off valves on inlet and drain lines.
2. Unscrew filter and discard.
3. Install new filter, tighten until seal touches filter head. Tighten an additional one-half to three-fourths turn (Fig. 2-7). Open shut-off valves.

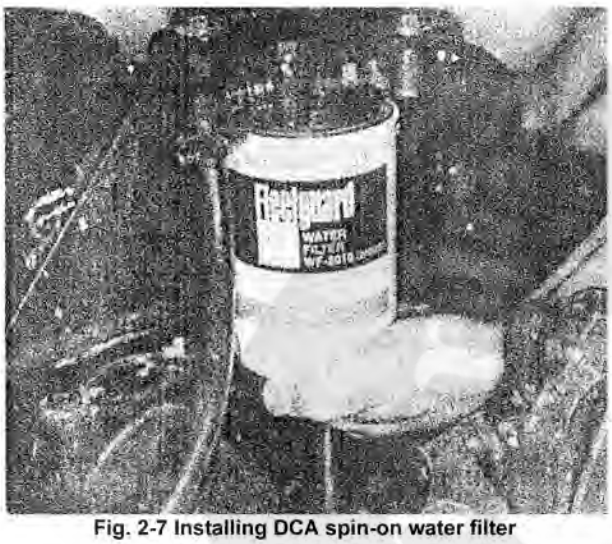


Fig. 2-7 Installing DCA spin-on water filter

Clean/Change Crankcase Breather and Air Cleaner

Mesh Element Breather

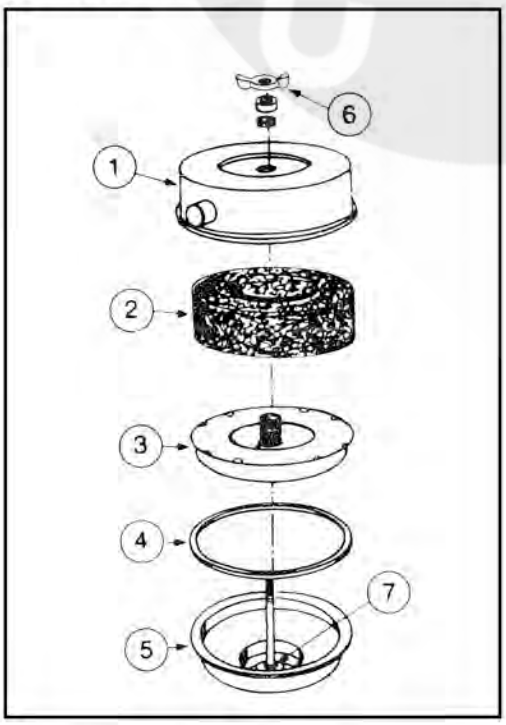


Fig. 2-8 Crankcase breather --- element with vapor barrier

1. Remove wing nut (Fig. 2-8), flat washer and rubber washer securing cover (1), to breather body (5).
2. Lift off cover and lift out breather element (2), vapor element (3) and gasket (4).
3. Clean all metal and rubber parts in approved cleaning solvent. Dry thoroughly with compressed air.
4. Inspect rubber gasket; replace if necessary. Inspect body and cover for cracks, dents or breaks; discard all unserviceable parts.
5. Install cleaned or new breather element and cleaned vapor element to breather body.
6. Install rubber gasket in cover; position cover assembly to body.
7. Install rubber washer, flat washer and wing nut; tighten securely.

Clean Pre-Cleaner and Dust Pan

Under extremely dirty conditions and air precleaner may be used. Clean pre-cleaner jar and drytype air cleaner dust pans daily or more often, as necessary, depending on operating conditions.

Clean or Replace Air Cleaner Elements

The paper element in a dry-type air cleaner, (Fig. 2-9 Fig. 2-10 Fig. 2-11 and Fig. 2-12) may be cleaned several times by using air to blow off dirt or by washing with non-sudsing household detergent and water at 120 to 140 ℉ [49 to 60 ℃], then drying with compressed air, approximately 30 psi [206 kPa]. Do not hold air jet too close to paper element. Elements that have been cleaned several times will finally clog and air flow to engine will be restricted. After cleaning, check restriction as previously described and replace element if necessary.

Caution: Holes, loose end seals, dented sealing surfaces and other forms of damage render cleaner inoperative and require immediate element replacement.

The dust in the air is the primary reason on abrasion for cylinder liner, piston, piston ring , valves, valve stem guide and other athletic parts, the more the dust in the intake of the engine is, the more the abrasion of the engine’ s parts is . It is founded by wearing test of engine that the dust less than a diameter 0.001mm has an very small effect on engines, the dust with a diameter between 0.001mm and 0.01mm has an measured effect on the engine. If the diameter of the dust in the intake is larger than the thickness of the bearing oil film, it will affect the life of the main and connecting bearing and the piston ring. Therefore, it is very important that air cleaner should be chose careful.

The air cleaners used on Chongqing-Cummins engines are dry type, it can be divided into normal

duty and heavy duty air cleaners according to their applications. The minimum efficiency for normal duty cleaner at any flow between 15% and 100% of the rated air flow is 99.5%, and its minimum dust holding capability is 3.0 grime/CFM (or 6.4 grime/L.S) at rated air flow, it will be applied primarily to those generator drive engines and marine engines.

The Minimum efficiency for heavy duty cleaner at any flow between 15% and 100% of the rated air flow is 99.9%, and it’ s minimum dust holding capability is 25.0 grime/CFM (or 53 grime/L.S) at rated air flow, it will be applied primarily to the mining product, construction product, automotive product, off-high heavy duty, etc. those engines (and generator drive engines) and marine engines (and generator drive engines).

After the air cleaners have been used for period of time, it’ s element(s) will be dirtied, and the restriction of the air intake will increase. When the restriction increases to above 6.25 kPa, the engine can not get sufficient ari, therefore, the engine will discharge the black smoke and the engine’ s power will be down.

The customer can estimate the air-logged conditions of the air cleaner by the air induction indicator or annunciate, if the indicating window of the indicator changes from green to red, or the annunciate gives an alarm, the air intake restriction had exceeded the limit value, the element will need to be cleaned up or replaced.

The following methods can be used to clean up the element(s) of the air cleaner:

a. Lightly knock the end plate of the element(s) to shake off the dust accumulating on the element(s);
b. Open the dust discharging jaws on the air cleaner to remove the dust in the air cleaner shell.
c. Open the end cover of the cleaner, and pull out the element(s).
d. Clean up the element(s) with the dry compressed air.

Note:

I. It is not permitted to clean up the element(s) with oil or water;
II. For the heavy duty air cleaner, there are many convolute pipes, these pipes can not be taken down, and it can be washed up with not alkaline water, flush it with cleanly water, then blow it with compressed air.
III. The secondary (or safty) element of the heavy duty air cleaner can not be cleaned up.

When the following problems are founded, the primary element must be replaced with a new element.

I. The primary element is in disrepair;
II. After assembly the element(s), the indicator indicates red or the annunciate gives an alarm again.
III. The primary element have been cleaned up for five times.

Note: For heavy duty air cleaner, when it`s primary element is disrepair or cleaned up for five time, it`s secondary must be replaced.

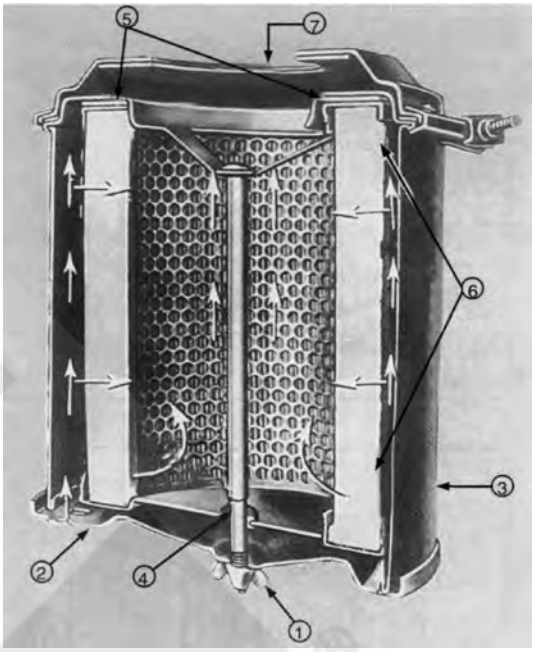


Fig. 2-9 Air cleaner --- dry type

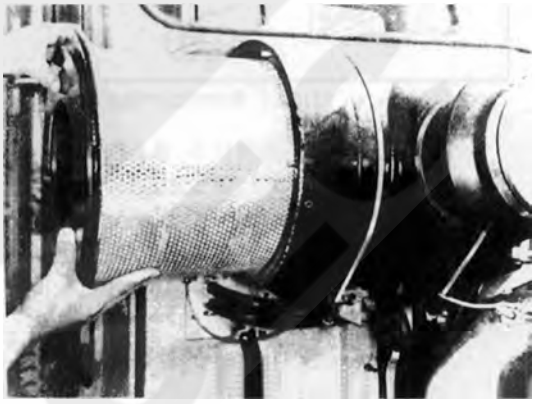


Fig. 2-10 Replace Air Cleaner Elements

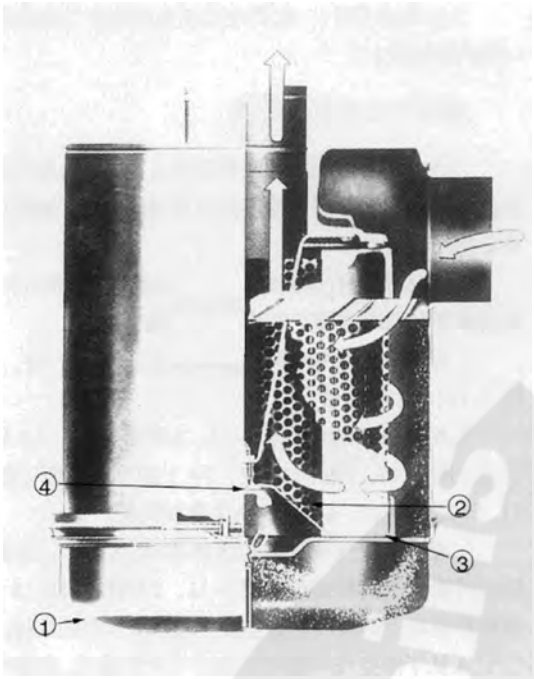


Fig. 2-11 Air cleaner --- heavy duty

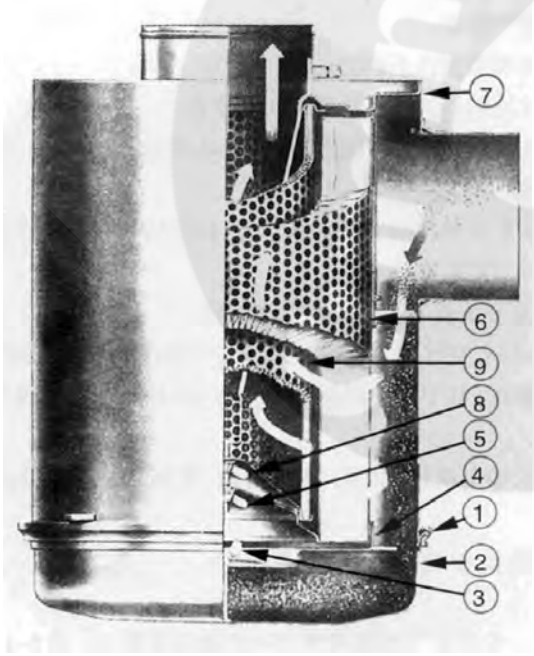


Fig. 2-12 Air cleaner --- heavy duty & double element

Clean Air Silencer

1. Remove air silencers.
2. Steam clean air silencer. Direct the steam jet from air outlet side of silencers to wash dirt out in opposite direction of air flow.
3. Position air silencers with new gaskets to intake manifolds; secure with flat washers, lock washers and capscrews.

Check Zinc Plugs

Remove and check zinc plug in heat exchanger or marine gear cooler. If zinc anode has deteriorated to less than ½ original size, replace with new.

"C" Maintenance Checks

At each "C" maintenance check, first perform all "A" and "B" checks in addition to those following.

Clean Engine
Steam or high pressure hot water are satisfactory methods of cleaning a dirty engine or piece of equipment.
All electrical components and wiring should be protected from the full force of the cleaner spray nozzle.

Adjust Injectors And Valves
It is essential injectors and valves be in correct adjusttment at all times for engine to operate properly. One controls engine breathing; the other controls fuel delivery to the cylinders.
Final operating adjustments must be made using correct values as stated.

Temperature Settings
The following temperature conditions provide the necessary stabilization of engine components to assure accurate settings.

Definition of "Cold Set"
The engine must have reached a stabilized temperature (4 hours minimum) without operation in ambient temperature where the adjustments are to be made.

Definition of "Hot Set"
1. The oil sump temperature must be a minimum of 190 ℉ [88 ℃] and water temperature a minimum of 185 ℉ [85 ℃] for adjustments to be made using the Hot Set values.
2. If oil temperature gauge is unavailable, set injectors an valves immediately after engine has operated at rated speed and load or at high idle for a period of 20 minutes.

KT/KTA-19 Series Engines Injector and Valve Adjustment

Barring the Engine
1. Remove the shaft retainer key (Fig. 2-13) from the shaft. Press inward on the shaft until the barring gear engages the drive gear.

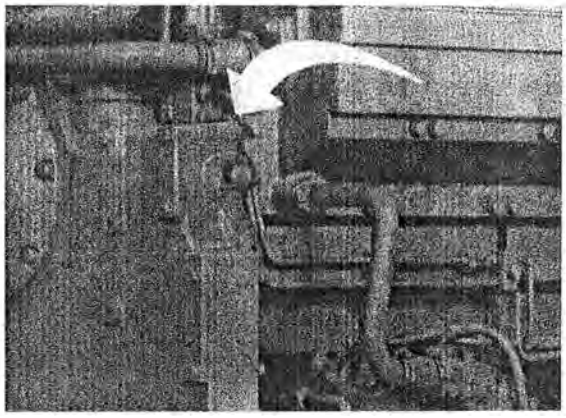


Fig. 2-13 Barring location on KTA-19

2. Turn crankshaft in the direction of rotation until the valve set mark aligns with its pointer.
3. Make all valve and injector adjustments; when the adjustments are complete, disengage the barring mechanism and install the retainer key into the safety lock groove.

Caution: The barring gear must be completely engaged with the drive gear when rotating the crankshaft or damage to the teeth of the gear may result. Do not use the fan to rotate the crankshaft.

Valve Set Mark Locations
The valve set marks are located on the accessory drive pulley (Fig. 2-14). These marks are aligned with a boss on the front cover. On some engines the valve set marks can be seen through an opening in the power take-off housing (Fig.2-15).

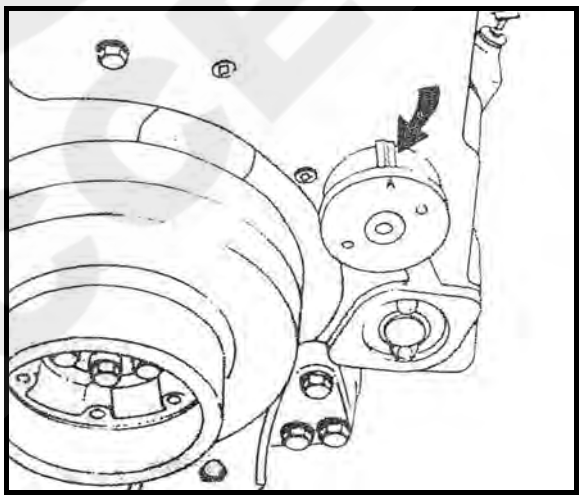


Fig. 2-14 "VS" marks on KTA-19 accessory drive

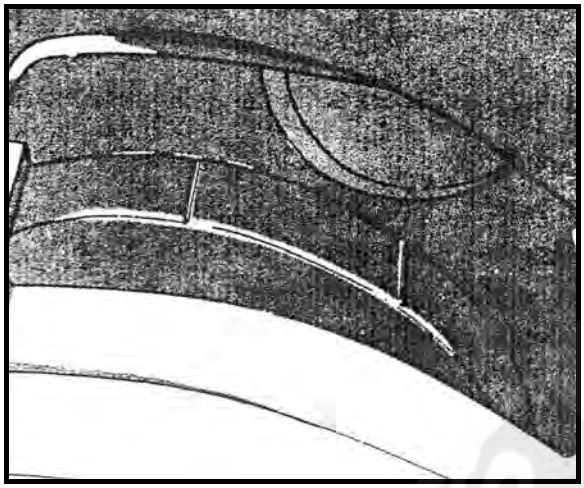


Fig. 2-15 "VS" marks on the fly wheel --- KTA19-M

Injector Adjustment (Dial Indicator Method)

1. Turn the Crankshaft in the direction of rotation until "A" valve set mark on the accessory drive pulley is aligned with the pointer on the gear housing cover (Fig.2-14, 2-15 and 2-16). In this position check the valve rocker levers on cylinder number 5 and 2. The cylinder with the loose rocker levers will be ready for valve adjustment and the corresponding cylinder number 3 or 4 will be ready for injector adjustment, see Table2-3.

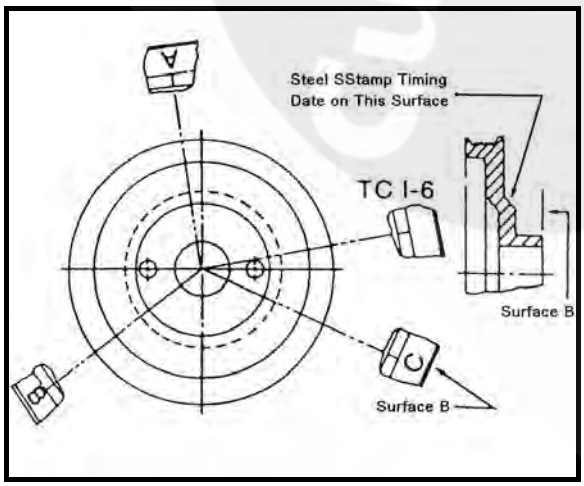


Fig. 2-16 Accessory drive pulley markings

Table 2-3: Injector and Valve Set Position

Bar in Direction	Pulley Position	Set Cylinder Injector	Valve
Start	A	3	5
Adv. To	B	6	3
Adv. To	C	2	6
Adv. To	A	4	2
Adv. To	B	1	4
Adv. To	C	5	1
Firing Order 1-5-3-6-2-4			

Note: The injector and valve on any cylinder cannot be set at the same time.

2. Set up 3375007 Dial Indicator and support so that the extension sets on top of the injector plunger. Make sure the indicator extension is installed in the indicator stem properly and is not touching the rocker lever.

Note: Actuate the rocker lever with 3375010 Rocker Lever Actuator (Fig. 2-17), note the indicator travel; if the injector plunger travel is not within the limits shown in Table 2-4, and proceed to Step 3.

3. Loosen the locknut on the injector adjusting screw.

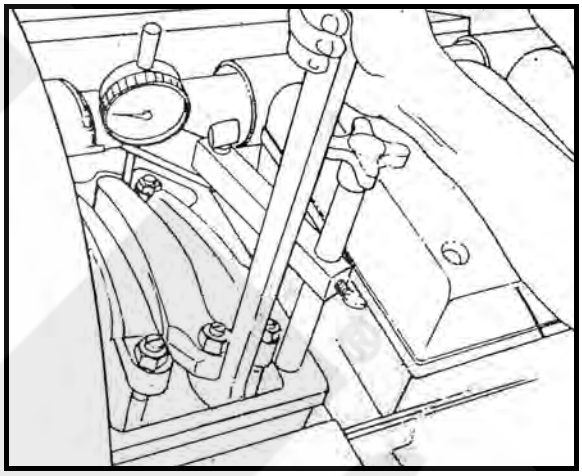


Fig. 17 Actuate rocker lever with 3375010

Table 2-4: Uniform Plunger Travel Adjustment Limits

Injector Plunger Travel Inch [mm]	Valve Clearance Inch [mm]	
Adj. Valve	Intake	Exhaust
0.304±0.001 [7.72]	0.014 [0.36]	0.027 [0.69]

4. Turn the adjusting screw down until the injector plunger touches the injector cup. Turn the adjusting screw and additional 15 degrees to squeeze all the oil from the cup.
5. Loosen the adjusting screw at least ½ turn and bottom the adjusting screw again. Set the dial indicator to zero.

Caution: Do not over tighten the adjusting screw or damage to the injector may result.

6. Turn the adjusting screw back out until the indicator shows the proper injector plunger travel values given in Table 2-4 (Fig.2-18).
7. Hold the adjusting screw in this position and tighten the adjusting screw locknut to 40 to 45 ft-lb [54 to 60 N.m] torque.

Note: When ST-669 is used, tighten the lock nut to 30 to 35 ft-lb [41 to 47 N.m] torque (Fig.2-19).

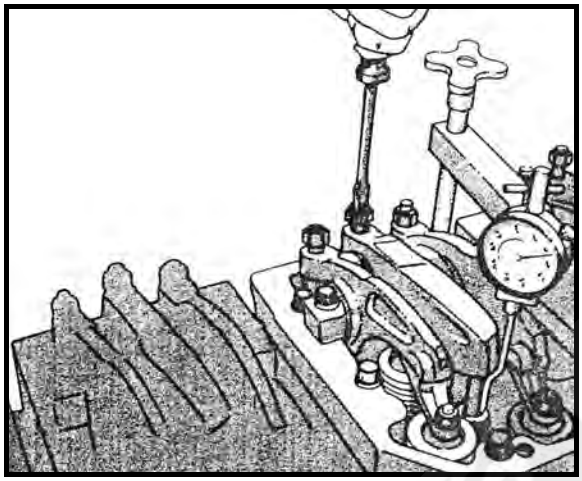


Fig. 2-18 Adjust injector plunger travel

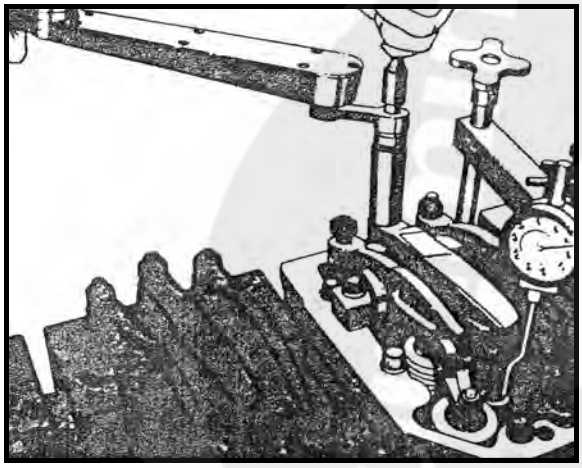


Fig. 2-19 Tighten locknut using ST-669

Crosshead Adjustment

Note: The engines built after 2004 used new crosshead which does not need adjust any more.

1. Loosen the locknut on the crosshead adjusting screw. Turn the adjusting screw out at least one turn.
2. Hold the crosshead down against its mating valve stem. Turn the adjusting screw back in until it touches the valve stem.
   Hold the adjusting screw in this position and tighten the lock nut to 25 to 30 lf-lb [34 to 41 N.m] torque.

Note: When ST-669 Torque Wrench Adapter is used, tighten the locknut to 22to 26f-lb [30to 35.m] torque.

3. Check the clearance between the crosshead and the valve spring retainer (1-2, Fig.2-20), with a wire gauge. There should be a minimum of 0.025 inch [0.64 mm] clearance.

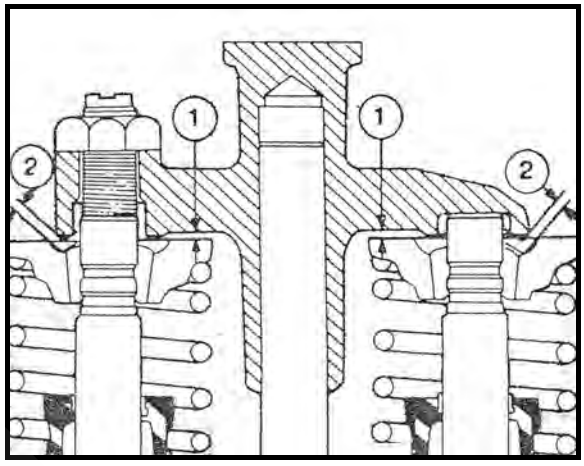


Fig. 2-20 Valve Spring retainer to crosshead clearance

Valve Adjustment

Note: The same “VS” mark, crankshaft position, used when setting the injectors is used when the intake an exhaust valves are adjusted. The valves are adjusted on the cylinder with the loose valve rocker levers.

1. Loosen both locknuts on the intake and exhaust valve adjusting screws.
2. Insert the proper feeler gauge between the rocker lever and crosshead contact surfaces (Fig. 2-21). See Table 2-4 for valve clearance values.

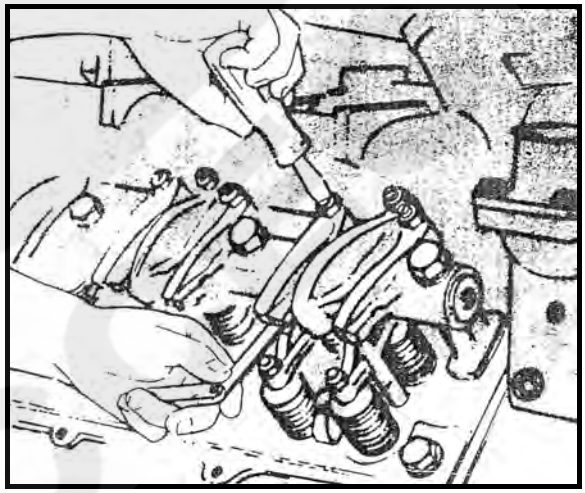


Fig. 2-21 Adjust valve clearance

3. Turn the adjusting screw down until the rocker lever just touches the feeler gauge.
4. Hold the adjusting screw in this position and tighten the locknut to 40 to 45 lf-lb [54to 6 N.m] torque.

Note: When ST-669 Torque Wrench Adapter is used, tighten the locknut to 35 to 40 lf-lb [47 to 54 N.m] torque.

5. Hold the crosshead adjusting screw in the adjusted position and tighten the locknut to

47 to 49 lf-lb [64 to 66 N.m] torque with the torque wrench adapter, 3375008.

Note: Turn the crankshaft in the direction of rotation. Make the correct valve and injector adjustments in firing order, Table 2-3.

KT/KTA-38 and KTA-50 Series Engines Injector and Valve Adjustment

Barring Arrangement

The barring mechanism may be locked on either the left bank side or the right bank side at the flywheel housing (Fig.2-22). The cover plate on opening "A" or "C", directly above the barring device, must be removed to see the "VS" valve set marks on the flywheel.

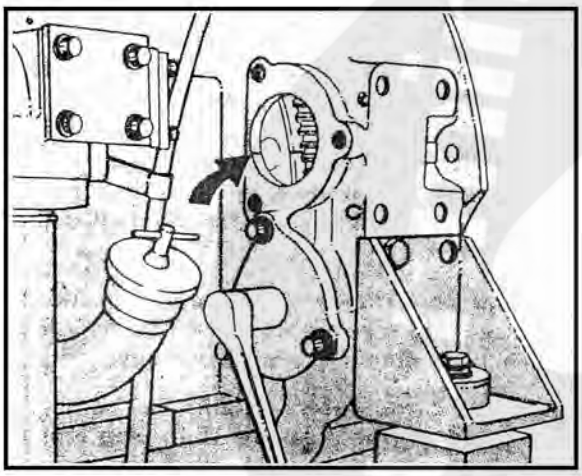


Fig. 2-22 Barring mechanism location "C"

1. Remove the shaft retainer key from the shaft. Press inward on the shaft until the barring gear engages the drive gear.
2. Turn crankshaft in the direction of rotation until the valve set mark aligns with its pointer.
3. Make all valve and injector adjustments; when the adjustments are complete, disengage the barring mechanism and install the retainer key into the safety lock groove.

Caution: The barring gear must be completely engaged with the drive gear when rotating the crankshaft or damage to the teeth of the gear may result. Do not use the fan to rotate the crankshaft.

Valve Set Mark Locations

There are three locations where the "VS" valve set marks may be seen. The injector and valves should all be set on the same cylinder at the same time.

Note: The crankshaft must be turned through two complete revolutions to properly set all valves and injectors.

1. When barring an engine from the left bank side at the flywheel housing, the "VS" marks on the flywheel (Fig. 2-22), must be aligned with the scribe mark on the flywheel housing at the opening marked "C".
2. When viewing the "VS" marks at the vibration damper (Fig. 2-23), align the marks on the damper with the pointer on the gear cover.
3. When barring an engine from the right bank side at the flywheel housing, the "VS" marks on the flywheel (Fig. 2-24) must be aligned with the scribe mark on the fly wheel housing.

Note: Be sure to match "A" valve set marks to the "A" scribe mark and "C" valve set marks to the "C" scribe mark. Refer to Figs. 2-25 and 2-26 for specific cylinder arrangement and firing order.

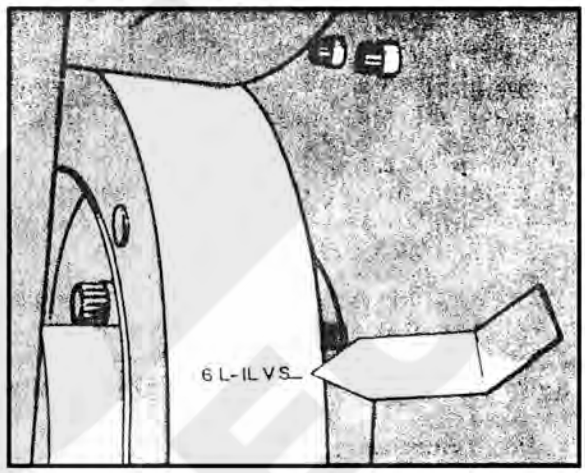


Fig. 2-23 "VS" marks on vibration damper

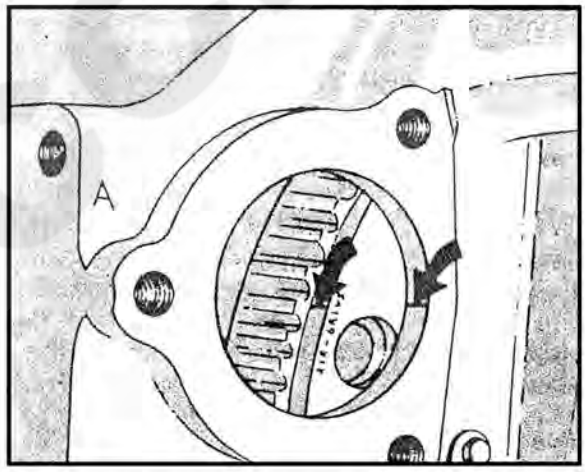


Fig. 2-24 "VS" marks location "A"

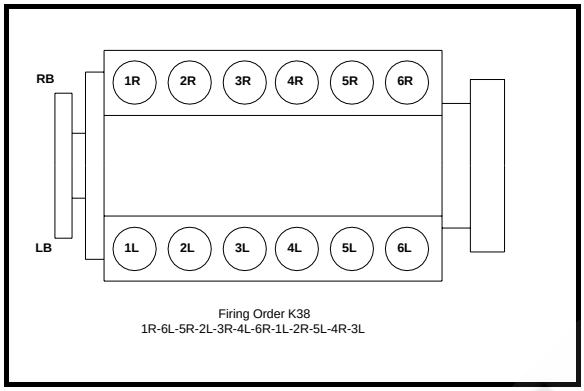


Fig. 2-25 Cylinder numbering arrangement K38

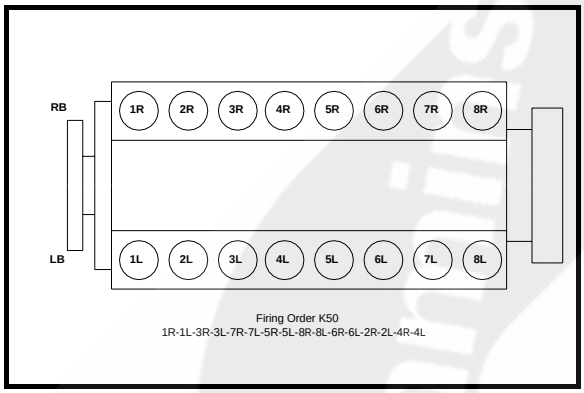


Fig. 2-26 Cylinder numbering arrangement K50

Injector Adjustment (Dial Indicator Method)

1. Bar the engine in the direction of rotation until the appropriate valve set mark is aligned with the scribe mark on the flywheel housing or until a valve set mark on the vibration damper is aligned with the pointer on the gear case cover.

Note: Any valve set position may be used as a starting point when setting the injectors and valves. Determine which of the two cylinders indicated have both valves closed (rocker levers free). This cylinder is in position for the injector plunger travel and valve adjustment.

2. Set up 3375004 Dial Indicator and support so that the extension sets on top of the injector plunger (Fig. 2-27), Make sure the indicator extension is installed in the indicator stem properly and is not touching the rocker lever.
3. Use a rocker lever actuator 3375010 (Fig. 2-28) to depress the lever toward the injector until the plunger is bottomed in the cup. Allow the injector plunger to rise, then bottom it again, holds it in the bottom position set the indicator at zero. Check the extension contact with the plunger top.

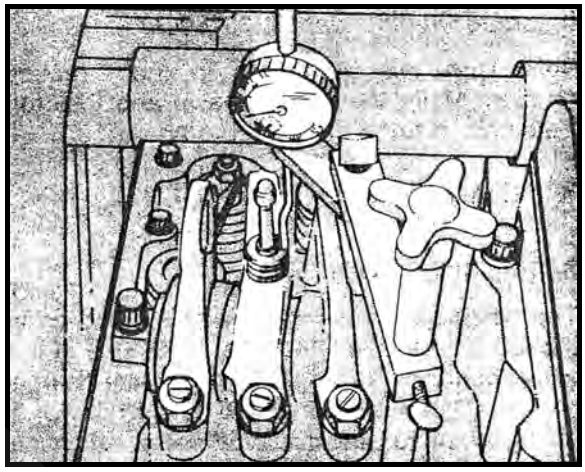


Fig. 2-27 Dial indicator extensions in contact with plunger

4. Remove the rocker lever actuator and turn the adjusting screw until the Adjustment Value, Table 2-5, is obtained on the dial indicator.

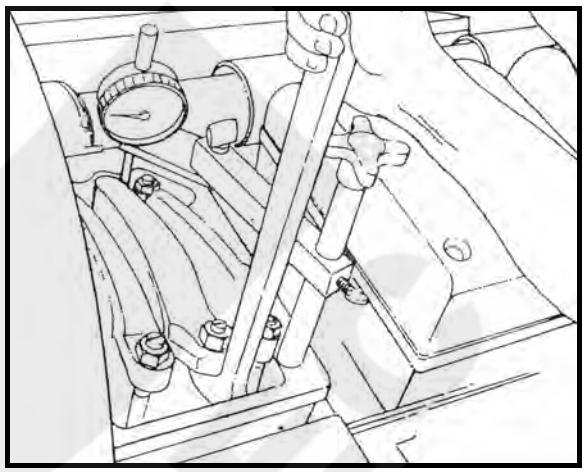


Fig. 2-28 Actuate rocker lever with 3375010

5. Use the rocker lever actuator to bottom the plunger again, releases the lever; the indicator must show the injector plunger travel to be within the Recheck Limit travel range as shown in Table 2-5.
6. Do not remove the dial indicator until the “Plunger Free Travel” check is com-pleted.

Table 2-5: Uniform Plunger Travel Adjustment Limits

Injector Plunger Travel Inch [mm]	Valve Clearance Inch [mm]	
Adj. Valve	**Intake**	**Exhaust**
0.308±0.001 [7.82]	0.014 [0.36]	0.027 [0.69]

Check Injector Plunger Free Travel

In order to prevent an excessive loading of the injector actuating train and possible early failure, check the plunger free travel as follows:

1. Use he rocker lever actuator to bottom the injector plunger, check the dial indicator setting; it must be on “O”. Release the lever.
2. Back the injector lever adjusting screw out 1-1/2 turns from the adjusted position; tighten the locknut.
3. Check the dial indicator extension contact on the plunger top, bar the engine and record the total amount of plunger free travel. The plunger free travel must fall within the range of 0.330 to .0338 inch [8.38 to 8.59].

Note: Upon completion of the injector and Valve Adjustment, the cylinders with recorded free travel outside the range stated in Step 3 must have the rocker lever assemblies and/or cam follower assemblies changed until the proper range is obtained. If changing the components does not affect the proper free travel, new parts must be installed.

4. Loosen the adjusting screw and readjust the plunger travel as stated in the injector plunger travel adjustment, Step 3, 4 and 5.
5. Use a ST-69 Torque Wrench Adapter to hold the adjusting screw in position, tighten the locknut to 30 to 35 ft-lb [41 to 47 N.m] torque, If a torque wrench adapter is not used, hold the adjusting screw with a screwdriver; tighten the locknuts to 40 to 45 ft-lb [54 to 61 N.m] torque.
6. After tightening the locknut, actuate the injector plunger several times as a check of adjustment; readjust if necessary.
7. Remove the indicator support.

Crosshead Adjustment

Crossheads are adjusted in the same manner as the KT19 C.I.D. series engines. See Page 30 for crosshead adjustment.

Valve Adjustment

1. Insert the correct thickness feeler gauge between the rocker lever and crosshead for the valves being adjusted. See Table 2-5 for valve clearances.

Note: The exhaust valves are toward the front of the engine in each cylinder head on the LB side and are toward the rear of the engine in each cylinder head on the RB side.

2. Turn the adjusting screw sown until the rocker lever just touches the feeler gauge (Fig. 2-29); lock the adjusting screw in this position with the locknut.
3. Use a ST-669 Torque Wrench Adapter to hold the adjusting screw in position, tighten the locknut to 30 to 35 ft-lb [41 to 47 N.m] torque (Fig. 2-30). If the torque wrench adapter is not used, hold the adjusting screw with a screwdriver; tighten the locknuts to 40 to 45 ft-lb [54 to 61 N.m] torque.

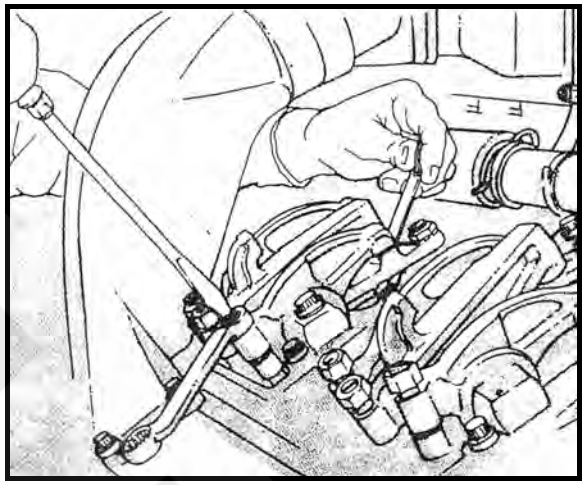


Fig. 2-29 Adjust valve clearance

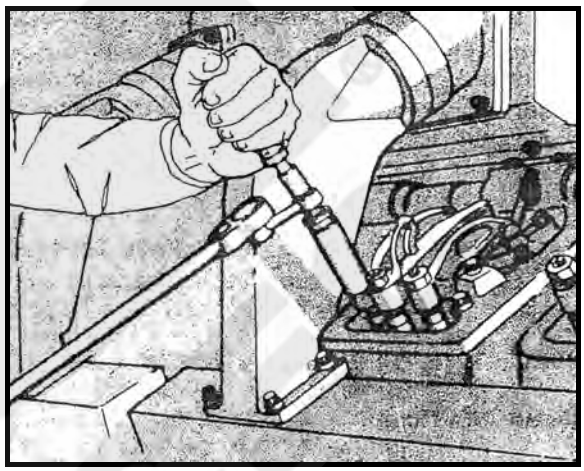


Fig. 2-30 Tighten the lock nut with a ST-669 Adapter

"D" Maintenance Checks

At each "D" maintenance check, perform all "A, "B" and "C" checks in addition to those follo-wing. Most of these checks should be performed by a Chongqing-Cummins Distributor or Dealer and where Cummins Shop Manuals are available for complete instructions.

Lean and Calibrate Injectors

Clean and calibrate injectors regularly to prevent restriction of fuel delivery to combustion chambers. Because of the special tools required for calibration, most owners and fleets find it more economical to let a Chongqing-Cummins Distributor do the cleaning and calibration operations.
To clean an calibrate injectors, refer to Bulletin No. 3379071 and revisions thereto.
After removing injectors from KT/KTA-19 and KT/KTA-38 Engines for cleaning, the seal seat should be removed from the injector (Fig. 2-31), or injector "well" for cleaning, examination and/or replacement as necessary.

Caution: There must be only one (1) seal seat used in each injector "well". Use of more than one seal seat per injector will change in-jector protrusion and cause combustion inefficiency.

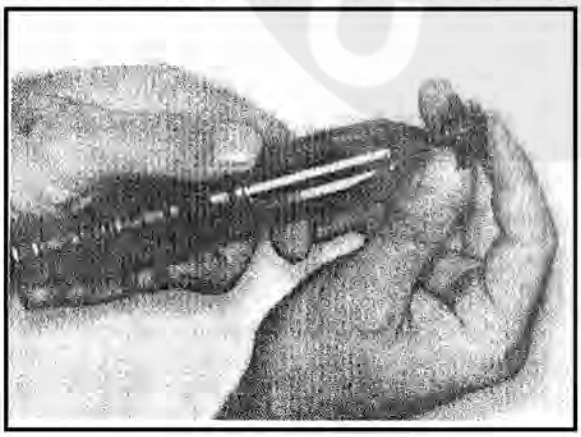


Fig. 2-31 Injector seal seat

Clean and Calibrate Fuel Pump

Check fuel pump calibration on engine if required. See the nearest Chongqing-Cummins Distributor or Dealer for values.

Rebuild or Replace the Following Assemblies

Inspect Water Pump

Inspect water pump for wobble and evidence of grease leakage. Replace with rebuilt prelubricate units as necessary.

Inspect/Install Rebuilt Unit as Necessary

The following assemblies should be inspected at this time. The options are: inspect and reuse, rebuild per shop manual instructions, replace with new or Distributor/Dealer exchange units or Cummins Diesel ReCon Inc. Units.

Inspect Turbocharger

Check Turbocharger Bearing Clearance

Check bearing clearances. This can be done with out removing the turbocharger from the engine, by using a dial indicator to indicate end-play of the rotor shaft and a feller gauge to indicate radial clearance (Fig. 2-32).

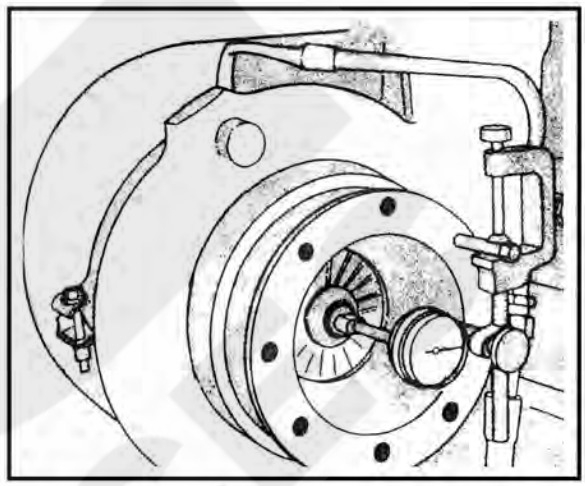


Fig. 2-32 Checking turbocharger bearing end clearance

Checking Procedure

1. Remove exhaust and intake piping from the turbocharger to expose ends of rotor assembly.
2. Remove one capscrew from the front plate (compressor wheel end) and replace with a long capscrew. Attach an indicator or the long capscrew and register indicator point on end or rotor shaft. Push shat from end-to –end making note of total indicator reading. On HC5A/HX80 Turbocharger which is used on K series engines end clearance should be 0.002 to 0.049inch [0.051 to 0.125 mm].
    a. Push wheel toward side of bore.
    b. Using feeler gauge, check distance between tip of wheel vanes and bore. On HC5A/HX80 Turbo-

charger end clearance should be 0.0191 to 0.0294 inch [0.051 to 0.746 mm].

3. Check radial clearance on compressor wheel only.
4. If end clearances exceed limits, remove turbocharger from engine and replace with a new or rebuilt unit.
5. Install exhaust and intake piping to turbo-charger(s).

Inspect Vibration Damper

Viscous Dampers

Check damper for evidence of fluid loss dents and wobble. Visually insect the vibration damper`s thickness for any deformation or raising of the damper`s front cover plate.

1. If lack of space around damper will not permit a visual inspection, run finger around inside and outside of front cover plate. If any variations or deformations are detected, remove vibration damper and check as follows.
2. Remove paint from front and rear surface of damper in four (4) equal spaced areas. Clean surface with paint solvent and fine emery cloth.
3. Using micrometer measure and record thickness of dampers at four (4) areas cleaned in Step 3. Take reading approximately 0.125 inch [3.18] from outside edge of front cover plate.
4. Replace damper if variation of the four (4) reading exceed 0.010 inch [0.25 mm].

Seasonal Maintenance Checks

Seasonal Maintenance checks generally should be done at the beginning of each season or once a year. If engine is in continuous usage, check twice per year. Certain items require more frequent checks.

Clean Cooling System

The cooling system must be clean to do its work properly. Scale in the system slows down heat absorption from water jackets and heat rejection through the exchanger. Use clean water which will not clog any of the hundreds of small passages in the heat exchanger of water passages in the block.

Chemical Cleaning

The best way to insure an efficient cooling system is to prevent formation of rust and scale by using a Fleetguard DCA Water Filter, but if they have collected the system must be chemically cleaned. Use a good cooling system cleaner such as sodium bisulphate or oxalic acid followed by neutralizer and flushing.

Inspect Hose

Failure of engine lubricating oil hose or marine gear oil hose can result in extensive damage to the engine if the oil supply is depleted, or even the possibility of a fire if the oil sprays on hot surfaces.
It is mandatory that a thorough visual inspection be made of all hose to assure:

1. No sign of corrosion or abrasion.
2. Hose properly supported.
3. No seepage or leaks of hose or fittings.
4. Hose or fittings not rubbing or abrading any part of engine, marine gear, engine mounts or hull.
5. Clamps installed parallel and not binding or twisting the hose.

The inspection should be performed under operating conditions with engine running. No twisting or bending force should be applied during inspection since flexible hose may "take a set" after being in service. The turbocharger and exhaust system insulation blankets should also be inspected to assure that all hot surfaces are properly covered to prevent any possibility of oil spraying directly on the hot surfaces.

Clean Engine/Marine Gear

Wipe unit down with an approved solvent and dry thoroughly.

Tighten Engine Mounting Bolts and Nuts

Engine mounting bolts will occasionally work loose and cause supports and brackets to wear rapidly. Tighten all mounting bolts or nuts and replace any broken or lost bolts or capscrews. If necessary, recheck alignment of marine unit to propeller shaft. Shim and tighten all mounting bolts.

Check Crankshaft End Clearance

The crankshaft of a new or newly rebuilt engine must have end clearances as listed in Table 2-6. An engine must not be operated with more than the worn limit end clearance.
If engine is disassembled for repair, and thrust ring wear permits end clearance in excess of 0.018 inch [0.46 mm], install new thrust rings.
The check can be made by attaching an indicator to rest against the damper or pulley (Fig. 2-33) while prying against the front cover and back side of damper hub. End clearance must be present (as stated in Table 2-6) with engine mounted in the craft and assembled to marine gear.

Check Safety Controls

Engine safety controls should be hooked up to a horn or other warning device.

Checking High Water Temperature Control

1. Removing sensing unit from water passage.
2. The opening of the circuit can be checked against a thermometer, while immersed in water, as the water is heated to activate temperature control.
3. Horn should sound at about 200 ℉ [93℃].

Table 2-6: Crankshaft End Clearance---Inch[mm]

Engine C.I.D.	New Minimum	New Maximum	Operating Worn Limit
1150	0.004[0.10]	0.017[0.43]	0.021[0.53]
2300 3067	0.005[0.13]	0.017[0.43]	0.020[0.51]

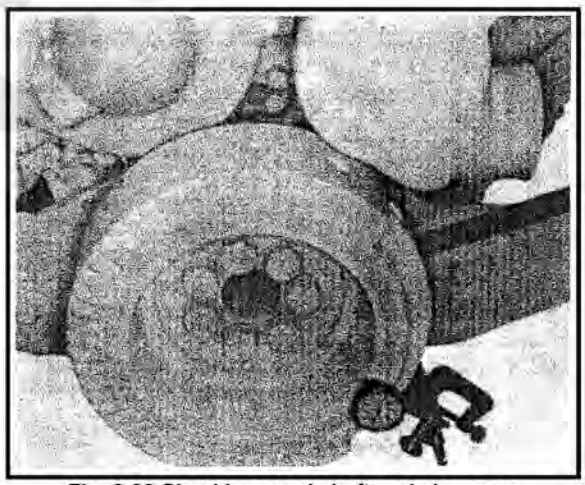


Fig. 2-33 Checking crankshaft end clearance

Engine Storage

The following are items that should be completed before placing engine in storage for the winter moths.

1. Fill all fuel tanks with clean diesel fuel.
2. Check all hose and belts and replace as required.
3. Check the sacrificial zinc plugs and replace as required.
4. Drain and refill engine oil. Change oil and fuel filter.
5. Seal all lubricating oil openings the filler and breather cap outlets.
6. Check engine cooling system to make sure the proper concentrations of permanent type antifreeze and rust inhibitor is present.
7. Cover all intake system openings to prevent entrance of dirt.
8. Disconnect battery to prevent electrical drain. The battery may be reconnected to start engine periodically.

The following are items that should be completed before removing an engine from storage and put into service.

1. Clean all accumulated dirt from exterior of engine.
2. Remove all paper covers, tape and wrappings.
3. Check the concentration of permanent type antifreeze and rust inhibitor in the engine coolant system.
4. Change engine oil and filters.
5. Check all hose and belts for cracks, evidence of deterioration and hardness. Replace as required.
6. Check the marine gear oil level as requireed. Refer to manufacturer`s recommenddations.
7. Check the sacrificial zinc plugs and replace as required.
8. Visually inspect engine for leaks of engine oil, gear oil, raw water and engine coolant. Check and clean strainers supplying raw water to raw water pump. Open any valves in raw water plumbing.

Caution: Do not start engine with intake and lube oil systems sealed.

9. Start engine and observe for normal lubricating oil pressure and raw water flow.

Specifications and Torque

Providing and maintaining an adequate supply of clean, high-quality fuel, lubricating oil, grease and coolant in an engine is one way of insuring long life and satisfactory performance.

Lubricant, Fuel and Coolant

The Functions of Lubricating Oil

The lubricating oil used in a Chongqing-Cummins engine must be multifunctional. It must perform the primary functions of:

Lubrication by providing a film between the moving parts to reduce wear and friction.

Cooling by serving as a heart transfer media to carry heat away from critical areas.

Sealing by filling in the uneven surfaces in the cylinder wall, valve stems and turbocharger oil seals.

Cleaning by holding contaminants in suspension to prevent a build up of deposits on the engine surfaces.
In addition, it must also provide:

Dampening and cushioning of components that operate under high stress, such as gears and push tubes.

Protection from oxidation and corrosion.
Engine lubricating oil must be changed when it can no longer perform its functions within an engine. Oil does not wear out, but it becomes contaminated to the point that it can no longer satisfactorily protect the engine. Contamination of the oil is a normal result of engine operation. During engine operation a wide variety of contaminants are introduced into the oil. Some of theses are:

Byproducts of Engine Combustion ----
aspartames, soot and acids from partially burned fuel.

Acids, varnish and sludge which are formed as a result of the oxidation of the oil as it breaks down or decomposes.

Dirt entering the engine through the combustion air, fuel, while adding or changing lubricating oil.
The oil must have an additive package to combat theses contaminates. The package generally consists of:

Detergents/Dispersants which keep insoluble matter in suspension until they are filtered from the oil or are removed with the oil change. This prevents sludge and carbon deposits from forming in the engine.

Inhibitors to maintain the stability of the oil, prevent acids from attacking metal surfaces and prevent rust during the periods the engine is not operating.

Other Additives that enable the oil to lubricate highly loaded areas, prevent scuffing and seizing, control foaming and prevent air retention in the oil.

Oil Performance Classification System
The performance of oil which has been used in Chongqing-Cummins to see another document 3165408.

Break-In Oils
Special “break-in” lubricating oils are not recommended for new or rebuilt Chongqing-Cummins engines. Use the same lubricating oils used in normal engine operation.

Viscosity Recommendations
The viscosity of an oil is a measure of its resistance to flow. The Society of Automotive Engineers has classified engine oils in viscosity grades; Table 3-1 shows the viscosity range for these grades. Oil that meet the low temperature (0 ℉[-18℃]) requireement carry a grade designation with a “W” suffix. Oils that meet both the low and high temperature requirements are referred to as multigrade or multiviscosity grad oils.
Multigrade oils are generally produced by adding viscosity index improver additives to retard the thinning effects low viscosity base oil will experience at engine operating temperatures. Multigrade oils that meet the requirements of the API classifications are recommended for use in Chongqing-Cummins engines.

Caution: If engine oils are used in transmitssions or gear boxes the respective manufacturers should be contracted regarding the required oil viscosity and content for these components.
Cummins and CQAEP Recommend the use of multigrade lubricating oil with the viscosity grades shown in Table 3-2. Table 3-2 shows Cummins viscosity grade recommendations at various

ambient temperatures. The only viscosity grades recommended are those shown in this table.
Cummins has found that the fuse of multigrade lubricating oil improve oil consumption control, improved engine cranking in cold conditions while maintaining lubrication at high operating temperatures and may contribute to improved fuel consumption. Cummins and CQAEP do not recommend the use of single grade lubricating oils. In the event that the recommended multigrade oil is not available, single grade oils may be substituted.

Caution: When single grade oil is used, be sure that the oil will be operating within the temperature ranges shown in Table 3-3.
The primary criterion for selecting an oil viscosity grade is the lowest temperature the oil will experience while in the engine oil sump. Bearing problems can be caused by the lack of lubrication during the cranking and start up of a cold engine when the oil being used is too viscous to flow properly. Change to a lower viscosity grade if oil as the temperature of the oil in the engine oil sump reaches the lower end of the ranges shown in Table 3-2.

Synthetic Lubricating Oil
Synthetic oils for use in diesel engines are primarily blended from synthesized hydrocarbons and esters. These base oils are manufactured by chemically reacting lower molecular weight materials to produce a lubricant that has planned predictable properties.
Synthetic oil was developed for use in an extreme environment where the ambient temperature may be as low as -50 ℉ [-45℃] and extremely high engine temperatures at up to 400 ℉ [205℃]. Under these extreme conditions petroleum base stock lubricates (mineral oil) do not perform satisfactorily.
Cummins Engine Co., Inc. and CQAEP recommends synthetic lubricating oil for use in Cummins engines operating in areas where the ambient temperature is consistently lower than -13 ℉ [-25℃]. Synthetic lubricating oils may be used at higher ambient temperatures provided they meet the appropriate API Service categories and viscosity grades.
Cummins Engine Co., Inc. and CQAEP recommend the same oil change interval be followed for synthetic lubricating oil as that for petroleum based lubricating oil.

Artic Operations
For engine operation in areas where the ambient temperature is consistently below -13 ℉ [-25℃] and where there is no provision to keep the engine warm when it is not operating, the lubricating oil should meet the requirements in Table 3-4. Oil meeting these requirements usually has synthetic base stocks. SAE 5 W viscosity grade synthetic oils may be used provided they meet the minimum viscosity requirement at 212 ℉ [100℃].

Grease
Cummins Engine Company, Inc., recommends use of grease meeting the specifications of MIL-G-3545, excluding those of sodium or soda soap thickeners. Contact the lubricant supplier for grease meeting these specifications.

Caution: Do not mix brands of grease. Damage to the bearings may result. Excessive lubrication is as harmful as inadequate lubrication. After lubricating the fan hub, replace both pipe plugs. Use of fittings will allow the lubricant to be thrown out, due to rotate speed.

Fuel Oil
Chongqing-Cummins Diesel Engines have been developed to take advantage of the high energy content and generally lower cost of No. 2 Diesel Fuels. Experience has shown that a Chongqing-Cummins Diesel Engine will also operate satisfactorily on No.1 fuels or other fuels within the following specifications Table 3-5.

Coolant
Water should be clean and free of any corrosive chemicals such as chloride, sulphates and acids. It should be kept slightly alkaline with pH value in range of 8.5 to 10.5. Any water which is suitable for drinking can be treated as described in the following paragraphs for use in an engine.
Maintain the Fleetguard DCA Water Filter on the engine. The filter by-passed a small amount of coolant from the system via a filtering and treating element which must be replaced periodically.

1. In summer, with no antifreeze, fill system with water.
2. In winter, select an antifreeze except antifreeze with anti-leak additive and use with water as required by temperature.

Note: Some antifreeze also contains anti-leak additives such as inert inorganic fibers, polymer particles or ginger root. These antifreeze should not be used in conjunction with the water filter. The filter element will filter out the additives and/or become clogged and ineffective.

3. Install or replace DCA Water Filter as follows and as recommended in Section 2.

New Engines Going Into Service Equipped With DCA Water Filters

1. New engines shipped from the factory are equipped with water filters containing a DCA pre-charge element. This element is compatible with plain water or all permanent-type anti-freezes except Methoxy

Pro-panel. See Table 3-6 for Methoxy Pro-panel pre-charge instructions.

2. At the first “B” check (oil change period) the DCA pre-charge element be changed to DCA Service Element. See Table 3-6.
3. Replace the DCA Service Element at each succeeding “B” check.
   a. If make-up coolant must be added between element changes, use coolant from a pretreated supply, see “Make-Up Coolant Specifications”, Section 2.
   b. Each time system is drained, pre-charge according to Table 3-6.
4. Service element may be changed at “C” check if 3300858 (DCA-4L) direct chemical additive is added to the cooling system at each “B” check between service element changes. One bottle of direct additive should be used for every 10 gallon of cooling system capacity. Add one bottle for every 15 gallon capacity if methoxy propanel antifreeze is used in the cooling system.
5. To insure adequate protection have the coolant checked at each third element change or more often. See “Check Engine Coolant”, Section

Table: 3-1: SAE Viscosity Numbers for Lubricating Oils

SAE Viscosity Grade	Viscosity Range		
	Mill Pascal-second, mPa.s (centipoise,cP) @ 0℉[-18℃]	Millimetre^2/second, mm^2/s (centistokes, cSt) @ 212℉[100℃]	
	Maximum	Minimum	Maximum
5W	1250	3.8	----
10W	2500	4.1	----
15W	5000	5.6	----
20W	10000	5.6	----
20	----	5.6	Less than 9.3
30	----	9.3	Less than 12.5
40	----	12.5	Less than 16.3
50	----	16.3	Less than 21.9

1. SAE Recommended Practice J300d
2. 1mPa.s=1 cP
3. 1mm^2/s=cSt

Table 3-2: Cummins Recommendations for Viscosity Grade vs. Ambient Temperature

SAE Viscosity Grade*	Ambient Temperature**
Recommended	
10W-30	-13℉ to 95℉ [-25℃ to 35℃]
15W-40	14℉ and above [-10℃ and above]
20W-40	32℉ and above [0℃ and above]

*** SAE-5W mineral oils should not be used.**

**** For temperature consistently below -13℉[-25℃] See Table 3-4.**

Table 3-3: Alternate Oil Grades

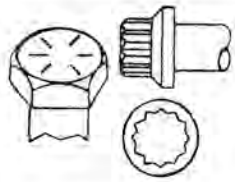
10W	-13℉ to 32℉ [-25℃ to 0℃]
20W	23℉ to 68℉ [-5℃ to 20℃]
20W-20*	23℉ to 68℉ [-5℃ to 20℃]
20	23℉ to 68℉ [-5℃ to 20℃]
30	39℉ and above [4℃ and above]
40	50℉ and above [10℃ and above]

***20w-20 is not considered a multigrade even though it meets two grades.**

Table 3-4: Arctic Oil Recommendations	
Parameter (Test Method)	**Specifications**
Performance Quality Level	**API Classification CC/SC**
Viscosity	**10,000 mPa.s Max. at -31℉[-35℃] 4.1mm²/s Min. at 212℉[100℃]**
Pour Point (ASTM D-97)	**Min. of 9℉[5℃] Below the Lowest Expected Ambient Temperature**
Sulfated Ash Content	**1.85% by Weigh Maximum**

Table 3-5: Recommended Fuel Oil Properties:	
Viscosity (ASTM D-445)	**1.3 to 5.8 centistokes [1.3 to 5.8 mm² per second] at 104℉[40℃]**
Cetane Number (ASTM D-613)	**40 minimum except in cold weather or in service with prolonged low loads, a higher cetane number**
Sulfur Content (ASTM D-129 or 1552)	**Not to exceed 1% by weight.**
Water and Sediment (ASTM D1796)	**Not to exceed 0.1% by weight.**
Carbon Residue (Ransbottom ASTM D-524 or D-189)	**Not to exceed 0.25% by weight on 10% residue.**
Flash Point (ASTM D-93)	**125℉ [52℃] minimum. Certain marine registries require higher flash points.**
Density (ASTM D-287)	**30℉ to 40℉ [-1℃ to 6℃] A.P.I. at 60℉ [16℃] (0.816 to 0.876 Sp. Gr.).**
Cloud Point (ASTM D-97)	**10℉ [-12℃] below lowest temperature expected to operate at.**
Active Sulfur-Copper Strip-Corrosion (ASTM D-130)	**Not to exceed No. 2 rating after 3 hours at 122℉ [50℃].**
Ash (ASTM D-482)	**Not to exceed 0.02%by weight.**
Distillation (ASTM D-86)	**The distillation curve should be smooth an continuous. At least 90% of the fuel should evaporate at less than 680℉ [360℃]. All of the fuel should evaporate at less than 725℉ [385℃]**

Table 3-6: Spin-On Type DCA Water Filter			
Ethylene Glycol Base Antifreeze			
Cooling System Capacity (U.S. Gallons)	**DCA-4L Precharge (P/N 3300858)**	**Service Element(s)**	**[New Part No.]**
0-8	**1**	**WF-2010 (P/N 299080)**	**[2051]**
9-15	**2**	**WF-2010**	**[2051]**
16-30	**5**	**WF-2010**	**[2051]**
31-60	**10**	**(2)WF-2010**	**[2051]**
35-90	**12**	**(2)WF-2016 (P/N 299086**	**[2053]**
70-90 (KT38)	**16**	**(4)WF-2010**	**[2051]**
Notes: A "DCA Unit"=1.5dry ounces(42.5 grams) or 4 liquid ounces (0.12 liters).			
Methoxy Propanol Base Antifreeze			
DCA-4L Precharge Service			**DCA Units**
DCA Units	**(P/N 3300858)**	**Elemtnt(s) [New Part No.]**	
4	**1**	**WF-2011[2050] (P/N 3300721)**	**2**
4	**2**	**WF-2011[2050]**	**2**
4	**4**	**WF-2011[2050]**	**2**
4	**8**	**WF-2011[2050]**	**2**
8	**8**	**WF-2017[2052] (P/N 300724)**	**6**
4	**16**	**WF-2011[2050]**	**2**

Capscrew Markings and Torque Values				
Current	**Much Used**	**Much Used**	**Used at Times**	**Used at Times**
Minimum Tensile Strength PSI MPa	To 1/2~69,000[476] To 3/4~64,000[441] To 1~55,000[379]	To 3/4~120,00[827] To 1~115,000[793]	To 5/8~140,000[965] To 3/4~133,000[917]	150,000[1034]
Quality of Material	Indeterminate	Minimum Commercial	Medium Commercial	Best Commercial
SAE Grade Number	1 or 2	5	6 or 7	8
Capscrew Head Markings Manufacturer's marks may vary **These are all SAE Grade 5（3 line）**				

Capscrew Body Size (Inch)-(Thread)		Torque Ft-Lb[N.m]	Torque Ft-Lb[N.m]	Torque Ft-Lb[N.m]	Torque Ft-Lb[N.m]
1/4	-20	5[7]	8[11]	10[14]	12[16]
	-28	6[8]	10[14]		14[19]
5/6	-18	11[15]	17[23]	19[26]	24[33]
	-24	13[18]	19[26]		27[37]
3/8	-16	18[24]	31[42]	34[46]	44[60]
	-24	20[27]	35[47]		49[66]
7/16	-14	28[38]	49[66]	55[75]	70[95]
	-20	30[41]	55[75]		78[106]
1/2	-13	39[53]	75[102]	85[115]	105[142]
	-20	41[56]	85[115]		120[163]
9/16	-12	51[69]	110[149]	120[163]	155[210]
	-18	55[75]	120[163]		170[231]
5/8	-11	83[113]	150[203]	167[226]	210[285]
	-18	95[129]	170[231]		240[325]
3/4	-10	105[142]	270[366]	280[380]	375[508]
	-16	115[153]	295[400]		420[569]
7/8	-9	160[217]	395[563]	440[597]	605[820]
	-14	175[237]	435[590]		675[915]
1	-8	235[319]	590[800]	660[895]	910[1234]
	-14	250[339]	660[895]		990[1342]

Note:

1. Always use the torque values listed above when specific torque values are not available.
2. Do not use above values in place of those specified in other sections of this manual; special attention should be observed when using SAE Grade 6,7 and 8 capscrews.
3. The above is based on use of clean, dry threads.
4. Reduce torque by 10% when engine oil is used as a lubricant.
5. Reduce torque by 20% if new plated capscrews are used.
6. Capscrews threaded into aluminum may require reductions in torque of 30% or more of Grade 5 capscrews torque and must attain two capscrew diameters of thread engagement.

Caution: If replacement capscrews are of a higher grade than originally supplied, adhere to torque specifications for that placement.

Troubleshooting

The term “troubleshooting” as used in this section covers the investigation, analysis and corrective action required to eliminate faults in engine operation. It does not mean routine rebuilding, nor does this usage of troubleshooting cover complete failure analysis.

Chongqing-Cummins Diesel Engines

The chart on the next page does not give all the answers for correction of problems listed, but it is meant to stimulate a train of thought and indicate a work procedure directed toward the source of trouble. To use the troubleshooting chart, find the complaint at top of chart; then follow down that column until you come to a black dot. Refer to left of dot for the possible cause.

Think Before Acting

Study the problem thoroughly. Ask these questions:

1. What were the warning signs preceding the trouble?
2. What previous repair and maintenance work has been done?
3. Has similar trouble occurred before?
4. If the engine still runs, is it safe to continue running it to make further checks?

The answers to these questions can usually be obtained by:

1. Questioning the operator.
2. Reading the Daily Operator’s Report.
3. Consulting the Maintenance Check Sheet.
4. Taking time to think the problem through.
5. Looking for additional symptoms.
6. Consulting the Troubleshooting Chart.
7. Checking the simplest things first.
8. Checking with calibrated instruments.
9. Double checking all conclusions before “disassembly of the engine or units”.

Most troubles are simple and easily corrected; examples are “low-power” complaints caused by loose throttle linkage or dirty fuel filters, “excessive lubricating oil consumption” Caused by leaking gaskets or connections, etc.

Always check the easiest and obvious things first; following this simple rule will save time and trouble.

Double-Check Before Beginning Disassembly Operations

The source of most engine troubles can be traced not to one part alone but to the relationship of one part with another. For instance, excessive furl consumption may mot be due to an incorrectly adjusted fuel pump, but instead to a clogged air cleaner or possibly a restricted exhaust passage, causing excessive back pressure. Too often, engines are completely disassembled in search of the cause of a certain complaint and all evidence is destroyed during disassembly operations. Check again to be sure an easy solution to the problem has not been overlooked.

Find and Correct Basic Cause of Trouble

After a mechanical failure has been corrected, be sure to locate and correct the cause of the trouble so the same failure will not be repeated. A complaint of “sticking injector plungers” is corrected by replacing the faulty injectors, but something caused the plungers to stick. The cause may be improper injector adjustment, or more often, water in the fuel.

Trouble Shooting

Chongqing-Cummins Engines

CAUSES	COMPLAINTS	Hard Starting or Failure to Start	Engine Misses	Excessive Black Smoke at Idle	Excessive White Smoke at Idle	Excessive Smoke Under Load	Excessive-Acceleration Smoke	Low Power or Loss of Power	Cannot Reach Governed RPM	Low Air Output	Sluggish Engine Acceleration	Excessive Fuel Consumption	Poor Deceleration	Erratic Idle Speed	Engine Dies	Surging at Governed RPM	Excessive Oil Consumption	Crankcase Sludge	Dilution	Low Oil Pressure	Coolant Temperature too Low	Coolant Temperature too High	Oil Temperature too High	Piston, Liner and Ring Wear	Wear of Bearings and Journals	Worn Valve and Guides	Fuel Knocks (Combustion Noise)	Mechanical Knocks	Gear Train Whine	Excessive Engine Vibration	Excessive Noise	Excessive Crankcase Pressure
Air System	Restricted Air Intake					●	●	●		●		●																				
	High Exhaust Back Pressure					●	●	●				●																				
	Thin Air in Hot Weather or High Altitude					●	●	●		●																						
	Air Leaks Between Cleaner and Engine						●	●		●														●	●	●						
	Dirty Turbocharger Compressor					●	●	●		●		●																				
	Improper Use of Starter Aid/Air Temp.	●			●																			●	●		●					
Fuel System	Stuck Drain Valve			●		●	●					●	●																		●	
	Out of Fuel or Fuel Shut Off Closed	●													●																	
	Poor Quality fFuel/Grade Fuel	●	●		●	●		●				●		●	●			●									●					
	Air Leaks in Suction Lines	●	●					●			●		●	●	●	●											●					
	Restricted Fuel Lines	●	●	●		●	●	●			●	●	●																			
	External or Internal Fuel Leaks							●				●			●				●													
	Plugged Injector Spray Holes		●	●		●	●	●				●																				
	Broken Fuel Pump Drive Shaft	●													●																	
	Scored Gear Pump or Worn Gears	●						●																								
	Wrong Injector Cups			●	●	●	●	●				●																				
	Cracked Injector Body or Cup	●	●	●	●	●	●	●				●							●									●				
	Damaged Injector O-Ring		●					●				●	●						●													
	Excessive Injector Check Ball Leakage												●																			
	Throttle Linkage or Adjustment							●	●				●	●	●	●																
	Incorrectly Assembled Idle Springs												●	●	●																	
	Incorrectly Assembled Governor Weights														●	●	●															
	High-Speed Governor Set Too Low							●	●																							
	Water in Fuel and/or Waxing	●	●						●		●				●	●																
	AFC Calibration Incorrect	●					●	●			●																				●	
	Damaged/Worn AFC plunger Seal/Barrel										●																					
	Fuel Pump Calibration Incorrect					●	●	●	●		●	●	●	●	●																●	
	Injector Flow Incorrect		●			●	●	●	●		●	●																				
	Plugged ASA							●			●																					
	ASA/AFC Air Leak, Bellows							●			●																					
																															●	
Lubricating System	External and Internal Oil Leaks																●			●												
	Dirty Oil Filter																	●		●					●	●						
	Faulty Cylinder Oil Control			●													●		●						●							
	Clogged Oil Drillings																			●					●	●	●					
	Oil Suction Line Restriction																			●					●	●	●					
	Faulety Oil Pressure Regulator																			●												
	Crankcase Low or Out of Oil																			●		●	●	●	●	●	●					
	Wrong Grade Oil for Weather Conditions																●			●					●	●						
	Oil Level Too High							●				●					●							●								
Cooling System	Insufficient Coolant/Worn Pump																			●		●	●									
	Faulty Thermostats																	●		●	●	●	●									
	Damaged Hose/Loose Belts																			●		●	●									
	Radiator Shutters Stuck Open				●													●			●											
	Internal Water Leaks																	●	●													
	Clogged Oil Cooler or Water Passages																			●				●								
	Exterior Leaks/Air in System																			●		●	●									
	Heat Exchanger Core Dirty/Low Coolant Capacity																			●		●	●									
	Coolant Temerature Low				●													●	●		●							●				
Operation and Maintenance Practices	Dirty Filters/Screens/Breather							●	●											●					●	●	●					
	Lonid Idle Periods	●	●	●	●	●		●										●	●		●											
	Engine Overloaded							●	●			●													●	●		●				
	Oil Needs Changing																	●							●	●	●					
	Engine Exterior Dirty																					●	●									
Mechanical Adjustments or Repair	Gasket Blow-By or Leakage	●	●	●		●	●	●	●		●	●	●	●	●	●	●		●	●												
	Faulty Damper/Flywheel Balance																												●		●	●
	Valver Leakage/Adjustment Bad	●	●			●	●	●																			●				●	
	Broken or Worn Piston Rings	●	●	●		●		●										●							●				●			●
	Incorrect Bearing Clearances							●				●									●					●			●	●		
	Excessive Crankshaft End Clearance																									●			●	●		
	Broken Cam Lobes						●																									
	Main Bearing Bore Out of Alignment																									●			●		●	
	Engine Due for Overhaul	●		●		●		●				●						●			●				●	●	●		●	●	●	●
	Damage Main or Rod Bearings																				●					●			●			
	Geartrain Backlash/Broken Tooth																												●	●	●	
	Misalignment-Engine to Marine Gear											●														●				●	●	
	Loose Mounting Bolts/Head Capscrew																												●		●	
	Incorrect Valve and Injector Timing	●			●	●	●	●				●																●			●	
	Worn Or Scored Liners or Pistons			●			●	●									●				●							●			●	●
	Injectors Need Adjustment		●	●	●	●	●	●	●		●	●																●				
	Broken/Bent Push Rod or Cam Box						●																						●		●	
	Bent Shaft							●																								
	Bent Wheel							●																								
	Over Wheeled							●	●																							

Operating Principles

Dependable service can be expected from a Chongqing-Cummins Diesel Engine when the operating procedures are based up in a clear understanding of the engine working principles. Each part of the engine affects the operation of every other working part and of the engine as a whole. Chongqing-Cummins Diesel Engines treated in this manual are four-stroke-cycle, high-speed, full-diesel engines.

Chongqing-Cummins Diesel Engines

Chongqing-Cummins Diesel Cycle

Chongqing-Cummins Diesel Engines differ from spark ignited engines in a number of ways. Compression ratios are higher; the charge taken into combustion chamber during the intake stroke consists of air only with no fuel mixture. Cummins Injectors receive low-pressure fuel from the fuel pump and deliver it into individual combustion chambers at the proper time, in equal quantity and atomized condition for burning. Ignition of fuel is caused by heat of compressed air in the combustion chamber.

It is easier to understand the function of engine parts if it is known what happens in the combustion chamber during each of the four pistons strokes of the cycle. The four strokes and order in which they occur are: Intake Stroke, Compression Stroke, Power Stroke and Exhaust Stroke.

In order for the four strokes to function properly, valves and injectors must act in direct relation to each of the four strokes of the piston. The intake valves, exhaust valves and injectors are camshaft actuated, linked by tappets or cam followers, push rods, rocker levers and valve crossheads. The camshaft is gear driven by the crankshaft gear, thus rotation of the crankshaft directs the action of the camshaft which in turn controls the opening and closing sequence of the valves and the injection timing (fuel delivery).

Intake Stocks

During intake stroke, the piston travels downward; intake valves are open, and exhaust valves are closed. The down ward travel of the piston allows air from the atmosphere to enter the cylinder. On turbocharged engines the intake manifold is pressurized as the turbocharger forces more air into the cylinder through the intake manifold. The intake charge consists of air only with no fuel mixture.

Compression Stroke

At the end of the intake stroke, intake vales close and piston starts upward on compression stroke. The exhaust valves remain closed.

At end of compression stroke, air in combustion chamber has been forced by piston to occupy a smaller space (depending upon engine model and one-fourteenth to one-sixteenth as great in volume) than it occupied at beginning of stroke. Thus, a compression ratio is the direct proportion in the amount of air in the combustion chamber before and after being compressed.

Compressing air into a small space causes temperature of the air to rise to a point high enough for ignition of fuel.

During last part of compression stroke and early part of power stroke, a small metered charge of fuel is injected into combustion chamber.

Almost immediately after fuel charge is injected into combustion chamber, fuel is ignited by the existing hot compressed air.

Power Stroke

During the beginning of the power stroke, the piston is pushed downward by the burning and expanding gases; both intake and exhaust valves are closed. As more fuel is added and burns, gases get hotter and expand more to further force piston down ward and thus add driving force to crankshaft rotation.

Exhaust Stroke

During exhaust stroke, intake valves are closed, exhaust valves are open, and piston on upstroke.

Upward travel of piston forces burned gases out of combustion chamber through open exhaust valve ports and into the exhaust manifold.

Proper engine operation depends upon two things--- first, compression for ignition; and second, that fuel be measured and injected into cylinders improper quantity at proper time.

Fuel System

The PT fuel system is used exclusively on Cummins Diesels. The identifying letters, “PT”, are an abbreviation for “pressure-time”.

The operation of the Cummins PT fuel System is based on the principle that the volume of liquid follow is proportionate to the fluid pressure, the time allowed to flow and the passage size through which the liquid flows. To apply this simple principle to the Cummins PT Fuel System, it is necessary to provide:

1. A fuel pump.
2. A means of controlling pressure of the fuel being delivered by the fuel pump to the injectors so individual cylinders will receive the right amount of fuel for the power required of the engine.
3. Fuel passages of the proper size and type so fuel will be distributed to all injectors and cylinders with each pressure under all speed and load conditions.
4. Injectors to receive low-pressure from the fuel pump and deliver it into the individual combustion chambers at the right time, in equal quantities and proper condition to burn.

The PT fuel system consists of the fuel pump, supply lines, drain lines, fuel passages and injectors. See Fig. 5-1 and the PT (type G) Fig. 5-2, VS (Variable Speed) fuel pump is shown in Fig. 5-3.

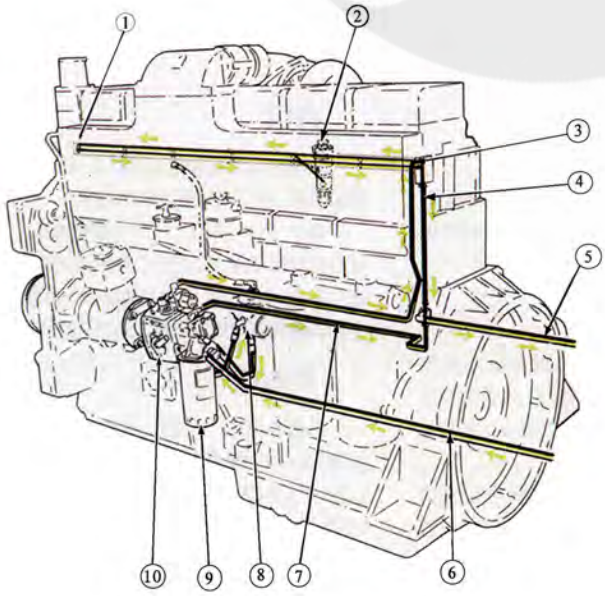


Fig. 5-1 Fuel flow schematic - KT(A)19

1. **Fuel Manifold**
2. **Injector**
3. **Fuel Supply**
4. **Fuel Drain**
5. **Fuel Return to Tanks**
6. **Fuel Supply From Tanks**
7. **Fuel Pump Coolant Line**
8. **Aneroid**
9. **Fuel Filter**
10. **Fuel Pump**

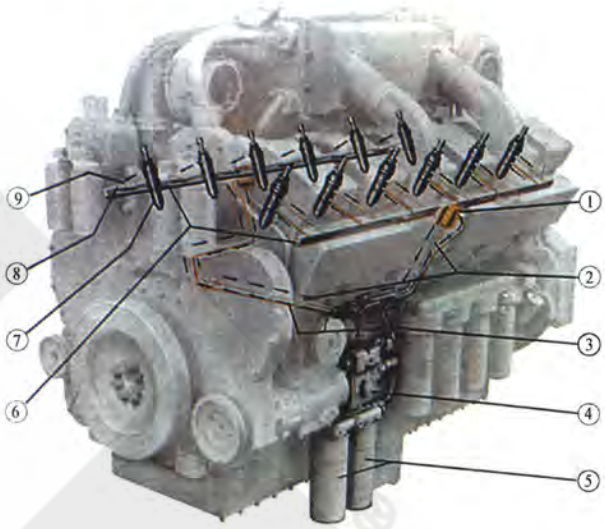


Fig. 5-2 Fuel flow schematic - KT(A)38

1. **Junction Block**
2. **Drain Lines**
3. **Supply Lines**
4. **Fuel Pump**
5. **Fuel Filter**
6. **Fuel Manifolds**
7. **Injector**
8. **Fuel Supply Passage**
9. **Fuel Drain Passage**

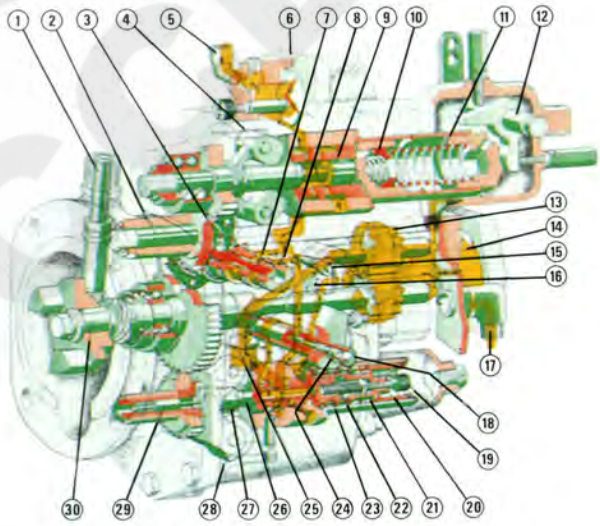


Fig. 5-3 PT(Type G) VS(variable speed) AFC fuel pump and fuel flow

1. **Tachometer Drive**
2. **Idler Gear and Shaft**
3. **AFC Piston**

4. VS Governor Weights
5. Fuel to Injector
6. Shutdown Valve
7. AFC Control Plunger
8. AFC Fuel Barrel
9. Vs Governor Plunger
10. VS Idle Spring
11. VS High Speed Spring
12. VS Throttle Shaft
13. Gear Pump
14. Pulsation Damper
15. AFC Needle Valve
16. Pressure Regulator Valve
17. Fuel from Filter
18. Throttle Shaft
19. Idle Adjusting Screw
20. Spring Spacer
21. High Speed Spring
22. Idle Spring
23. Idle Spring Plunger
24. Fuel Adjusting Screw
25. Filter Screen
26. Governor Plunger
27. Torque Spring
28. Governor Weights
29. Governor Assist Plunger
30. Main Shaft

Fuel Pump

The fuel pump is coupled to the fuel pump drive which is driven from the engine gear train. Fuel pump main shaft in turn drives the gear pump, governor and tachometer shaft assemblies.

Gear Pump and Pulsation Damper

The gear pump is driven by the pump main shaft and contains a singles set of gears to pick up a deliver fuel throughout the fuel system. Inlet is at the rear of the gear pump. A pulsation damper mounted to the gear pump contains a steel diaphragm which absorbs pulsations and smoothes fuel flow through the fuel system. From gear pump, fuel flows through the filter screen and to the governor assemblies as shown in Fig. 5-4

Throttle

The throttle provides a means for the operator to manually control engine speed above idle as required by varying operating conditions of speed and load.

In the fuel pump, fuel flows through the governor to the throttle shaft. At idle speed, fuel flows through the idle port in the governor barrel, past the throttle shaft. To operate above idle speed, fuel flows through the main governor barrel port to the throttling hole in the shaft.

PT (type G) VS Fuel Pump

The PT (type G) VS fuel pump is made up of four main units: the gear pump, standard governor, throttle and a VS (Variable Speed) governor.

Governors

The “standard” governor is actuated by a system of springs and weights, and has two functions:

1. The governor maintains sufficient fuel for idling with the throttle control in idle position.
2. It cuts off fuel to the injectors above maximum rated rpm.

During operation between idle and maximum speeds, fuel flows through the governor to the injectors. This fuel is controlled by the throttle and limited by the size of the idle spring plunger counter bore. When the engine reaches governor speed, the governor weights move the governor plunger, and fuel passages to the injectors are shut off. At the same time another passage opens and dumps the fuel back into the main pump body.

In this manner, engine speed is controlled and limited by the governor regardless of throttle position.

The VS governor, in the upper portion of the fuel pump housing, operates in series with the standard governor to permit operation at any desired (near constant) speed setting within the range of the standard governor. Speed can be varied with the VS speed control lever, located at top of pump. This pump gives surge free governing throughout the engine speed range with a speed droop smaller than the standard governor and is suited to the varying speed requirements of power takeoff etc.

When operating the PT (type G) VS fuel pump at any desired constant speed, the VS governor lever should be placed in operating position and the throttle locked in full open position to allow a full flow of fuel through the standard governor.

PT (type D) Injectors

The injector provides a means of introducing fuel into each combustion chamber. It combines the acts of metering, timing and injection. Principles of operation are the same for Inline and V-engines but injector size and internal design differs slightly. Fig’s 5-4 and 5-5.

Fuel supply and drain flow are accomplished through internal drillings in the cylinder heads. A radial groove around each injector mates with the drilled passages in the cylinder head and admits fuel through an adjustable (adjustable by burnishing to size at test stand) orifice plug in the injector body. A fine mesh screen at each inlet groove provides final fuel filtration.

The fuel grooves around the injectors are separated by o-rings which seal against the cylinder head injector bore. This forms a leak-proof passage between the injectors and the cylinder head injector bore surface.

Fuel flows from a connection atop the fuel pump shut-down valve through a supply line into the lower drilled passage in the cylinder head. A second drilling in the head is aligned with the

upper injector radial groove to drain away excess fuel. A fuel drain allows return of the unused fuel to the fuel tank.

The injector contains a ball check valve. As the injector plunger moves down ward to cover the feed opening , an impulse pressure wave seats the ball and at the same time traps a positive amount of fuel in the injector cup for injection. As the continuing downward plunger movement injects fuel into the combustion chamber, it also uncovers the drain opening and the ball rose from its seat. This allows free flow through the injector and out the drain for cooling purposes and purging gases from the cup.

Fuel Lines, Connections and Valves

Supply and Drain Lines

Fuel is supplied through lines to cylinder heads. A common drain line returns fuel not injected, to supply tank.

Connections

Fuel connectors are used between the Inline engine cylinder heads to bridge the gap between each supply and drain passage.

Shut-Down Valve

Either a manual or an electric shut-down valve is used on Cummins Fuel pumps (Fig. 5-9).

With a manual valve, the control lever must be fully clockwise or open to permit fuel flow through the valve.

With the electric valve, the manual control knob must be fully counterclockwise to permit the solenoid to open the valve when the “switch key” is turned on. For emergency operation in case of electrical failure, turn manual knob clockwise to permit fuel to flow through the valve.

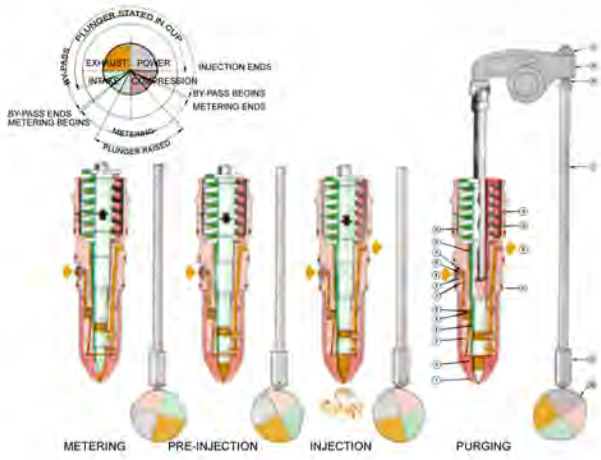


Fig. 5-4 (FWC-29). Fuel injection cycle -PT (Type D) injector 5/16 inch diameter plunger

1. CUP
2. CUP RETAINER
3. BARREL
4. PLUNGER
5. GASKET
6. CLIP
7. SCREEN
8. FUEL IN
9. ORIFICE
10. ORIFICE GASKET
11. COUPLING
12. ADAPTER
13. SPRING
14. LINK
15. FUEL OUT
16. “O” RING
17. NUT
18. ROCKER LEVER
19. ADJUSTING SCREW
20. PUS ROD
21. TAPPET
22. CAMSHAFT LOBE

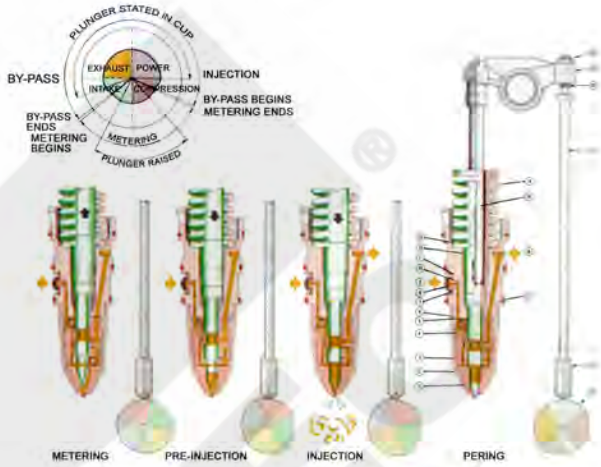


Fig. 5-5 (FWC-28). Fuel injection cycle - PT (Type D) injector 3/8 inch diameter plunger

1. CUP
2. CUP RETAINER
3. BARREL
4. PLUNGER
5. GASKET
6. CLIP
7. SCREEN
8. FUEL IN
9. ORIFICE
10. ORIFICE GASKET
11. COUPLING
12. ADAPTER
13. SPRING
14. LINK
15. FUEL OUT
16. “O” RING
17. NUT
18. ROCKER LEVER
19. ADJUSTING SCREW
20. PUS ROD
21. TAPPET
22. CAMSHAFT LOBE

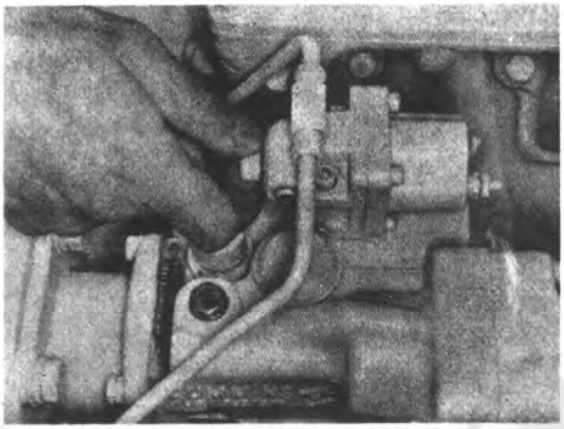


Fig. 5-6 Fuel pump manual override knob

Lubricating System

Chongqing-Cummins engines are pressure lubricated; pressure is supplied by a gear-type lubricating oil pump located in oil pan or on side of the engine.
A pressure regulator is mounted in the lubricating oil pump to control lubricating oil pressure.
Filters and screens are provided in lubricating oil system to remove foreign material from circulation and prevent damage to bearings or mating surfaces. A by-pass valve is provided in full-flow oil filter head as insurance against interruption of oil flow by a dirty or clogged element.
Maximum cleansing and filtration is achieved through use of both by-pass and full-flow, lubricating oil filters. Full-flow filters are standard on all engines; by-pass filters are used on all turbocharged models and optionally on all other engines.
Some engines are equipped with special oil pans and filters for some applications, and others with auxiliary oil coolers to maintain closer oil temperature regulation.
Turbochargers are lubricated and cooled by same lubricating oil used for engine lubrication.
Fuel pumps and injectors are lubricated by fuel oil.

KT/KTA 19 Engines
The KT-19 engines are pressure lubricated by a gear-type lubricating oil pump located on the exhaust manifold side of the engine directly below the water pump inside the gear case cover.
Lubricating oil is drawn from the pan through a suction tube, by the lubricating oil pump then transferred from the suction cavity by the pump gears into the pressure cavity. A pressure regulator valve dumps excess oil directly into the pump intake rather than back into the pan. From the lubricating oil pump, oil flows to lubricating oil cooler, through the cooler, then across the block. On air intake side of block it flows to filter head. A by-pass valve is provided in the oil inlet cavity to assure against interruption of oil flow if filter elements become clogged.
From the filter head oil enters the shells and passed through the elements then up, splitting into two passages. One flows to the main engine oil passage and the other to the piston-cooling passage. A second pressure control valve, located in the base of the filter head, limits the flow of lubricating oil to nozzles depending on pump supplied pressure.
Main bearings are lubricated through intersecting drillings, directly from the main oil passage. Oil flows from the main passage into camshaft bushings; from these, by constant flow, it goes to cam follower shafts and up through the cylinder heads. The cam followers are individually drilled to supply lubricating oil to rollers and push tube seats. The rocker lever bushings are also shaft lubricated.
Adjusting screws are lubricated through drillings in levers and bushings.
The connecting rod bearings get lubrication from cross drillings in the crankshaft, oil then flows through angle drillings in the connecting rods to lubricate piston pins and bushings. It is then routed from the main passage through drillings in the gear housing and cover to the camshaft and water pump idler gears. It then moves across to the gear cover and is routed by drillings to the rest of the gears and bushings.
Filtered and cooled lubricating oil is routed to the turbocharger though an external drilling in the gear housing. Turbocharger drain oil is dumped directly into the crankcase.

KT/KTA 38 and KTA 50 Engines
The KT/KTA38 engines are pressure lubricated by a gear-type lubricating oil pump located in the oil pan at the rear of the engine. The pump is mounted to block directly below crankshaft and is driven from rear crankshaft gear.
Lubricating oil is drawn from the pan, through a suction tube, by the pump then transferred from suction cavity by pump gears into pressure cavity. A pressure regulator valve dumps excess oil back into the oil pan.
From lubricating oil pump, oil flows through block drillings to lubricating oil cooler located in block “V”, through cooler, then to filters which may be mounted on either side of block. A by-pass valve is provided in filter head oil inlet cavity to assure against interruption of oil flow if filter elements become clogged.
From filter head, oil enters and passes through filter elements; it then flows to the main oil passage located in block “V”. This passage feeds two (2) camshafts and two (2) piston cooling drillings in the block. Pressure control valves limit the flow of lubricating oil to piston cooling nozzles, depending on lubricating oil pump pressure.
Main bearings are lubricated through intersecting drillings, directly from the main oil passage. Oil flows from main passages into camshaft bushing; from there by constant flow, it goes to cam follower shafts and up through cylinder heads. The cam followers are lubricated from their shaft; cam followers are individually drilled to supply lubricating oil to rollers and push tube seats. Rocker lever bushings are also shaft lubricated. Adjusting screws and valve guides are lubricated through drillings in rocker levers and bushings.
Connecting rod bearings are lubricated from cross drillings in the crankshaft; oil then flows through angle drillings in connecting rods to lubricate piston pins and bushings. Lubricating oil is routed from main oil passage through passages in gear

housing and cover to lubricate front gear train gears, bushings and idler shafts. The rear gear train receives lubrication through an intersecting drilling from the right bank camshaft passage.
Filtered and cooled lubricating oil is routed from camshaft passages to each turbocharger th-rough external lines from drillings in cylinder block. Turbocharger drain oil is dumped back into oil pan through drilling in cylinder block.

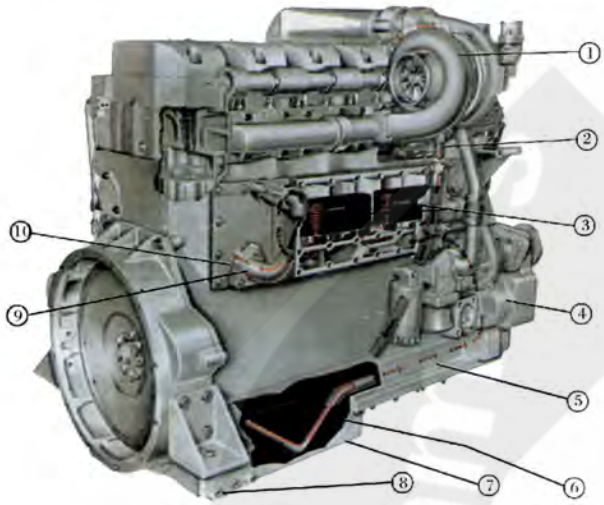


Fig. 5-7 Lubricating oil flow (exhaust side) KT38 Engines

1. TURBOCHARGER SUPPLY
2. TURBOCHARGER DRAIN
3. OIL COOLER ELEMENTS
4. OIL PUMP
5. OIL PAN ADAPTER
6. SUCTION TUBE
7. OIL PAN
8. OIL PAN DRAIN PLUG
9. TRANSFER TUBE
10. TO LUBRICATING OIL FILTER

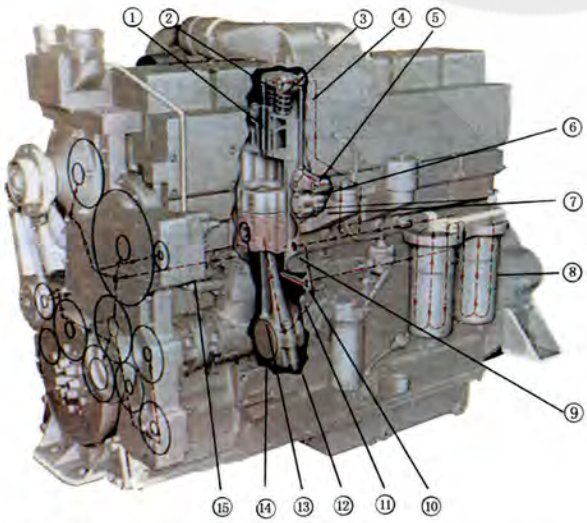


Fig. 5-8 Lubricating oil flow (intake side) KT-38 engines

1. INJECTION
2. ROCKER LEVER
3. ROCKER LEVER SHAFT
4. PUSH TUBE
5. CAM FOLLOWER
6. CAM FOLLOWER SHAFT
7. CAMSHAFT
8. LUBRICATING OIL FILTERS
9. MAIN OIL PASSAGE
10. PISTON COOLING OIL PASSANGE
11. PISTON COOLING NOZZLE
12. CONNECTION ROD
13. PISTON PIN
14. PISTON PIN
15. CANKSHAFT
16. OIL FLOW TO GEAR TRAIN

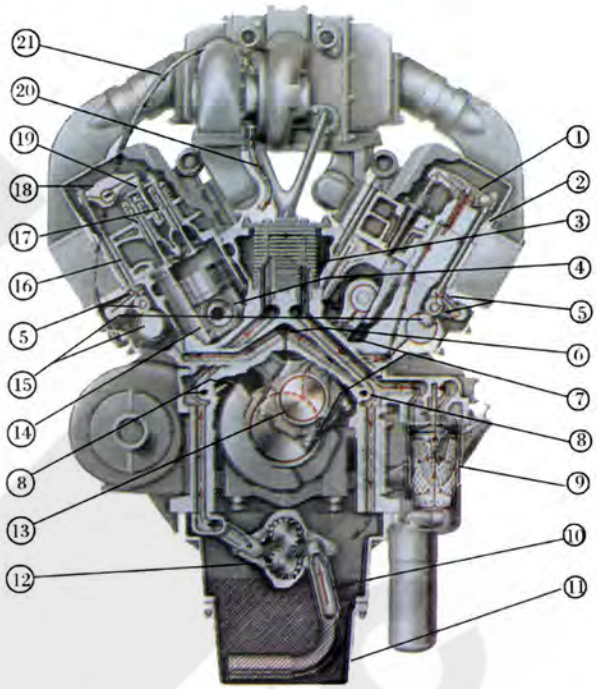


Fig. 5-9 lubricating oil flow (front view) KTA-38 Engine

1. INJECTOR ROCKER LEVER
2. INJECOR PUSH TUBE
3. OIL COOLER ELEMENT
4. PISTON PIN
5. CAM FOLLOWER
6. MAIN OIL RIFLE
7. CONNECTING ROD
8. PISTON COOLING RIFLE
9. FULL FLOW OIL FILTER
10. OIL FUCTION TUBE
11. OIL PAN
12. OIL PUMP
13. CRANKSHAFT
14. CYLINDER LINER
15. CAMSHAFT
16. VALVE PUSHROD
17. VALVE GUIDE
18. VALVE ROCKER ARM
19. VALVE CROSS HEAD
20. TURBO DRAIN LINE
21. TURBO SUPPLY HOSE

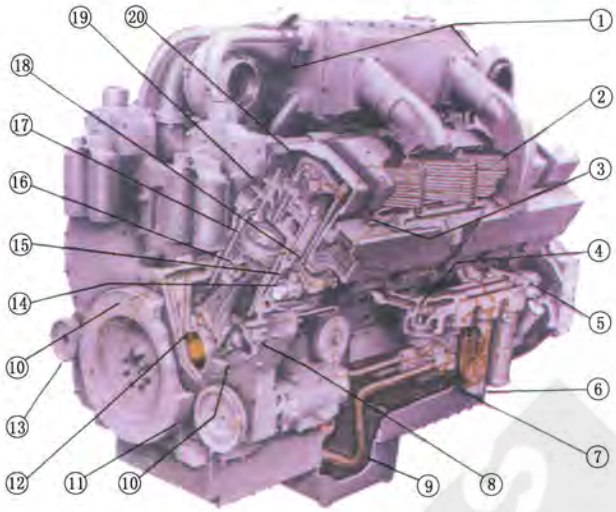


Fig. 5-10 Lubricating oil flow (3/4 front view KTA-38)

1. TURBOCHARGER
2. OIL COOLER ELEMENTS
3. OIL SUPPLY TO COOLER
4. OIL TO ENGINE FROM FILTERS
5. PRESSURE REGUALTOR
6. FULL FLOW OIL FILTERS
7. LUBRICATING OIL PUMP
8. PISTON COOLING NOZZLE
9. OIL SUCTION TUBE
10. OIL FLOW AT CAM BUSHINGS
11. ACCESSORY DRIVE
12. MAIN BEARING
13. WATER PUMP DRIVER
14. CAMSHAFT
15. CAM FOLLOWER
16. PISTON PIN
17. PISTON
18. PUSH TUBE
19. VALVE GUIDE
20. INJECTOR ROCKER LEVER

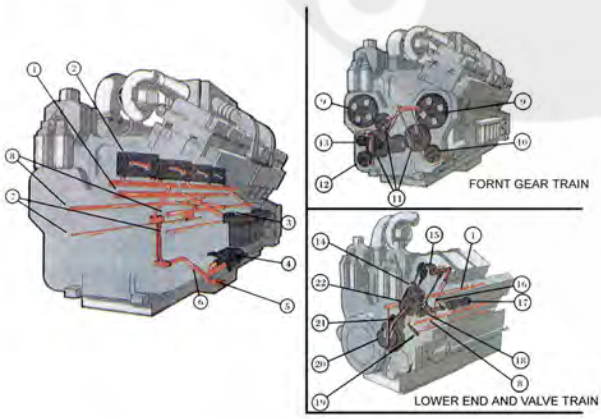


Fig. 5-11 Lubricating oil flow schematic
- KTA50 Engine

1. MAIN OIL RIFLE
2. OIL COOLER
3. FILTER HEAD
4. LUBRICATING OIL PUMP
5. SUCTION TUBE
6. DISCHARGE TUBE
7. PISTON COOLING OIL RIFLES
8. CAMSHAFT OIL RIFLES
9. CAMSHAFT DRIVE GEAR
10. ACCESSORY DRIVE GEAR
11. IDLER GEARS
12. HYDRAULIC PUMP DRIVE GEAR
13. WATER PUMP DRIVE GEAR
14. EXHAUST VALVES
15. ROCKER LEVER
16. OIL CONTROL ORIFICE
17. CAMSHAFT
18. CONNECTING ROD
19. PISTON

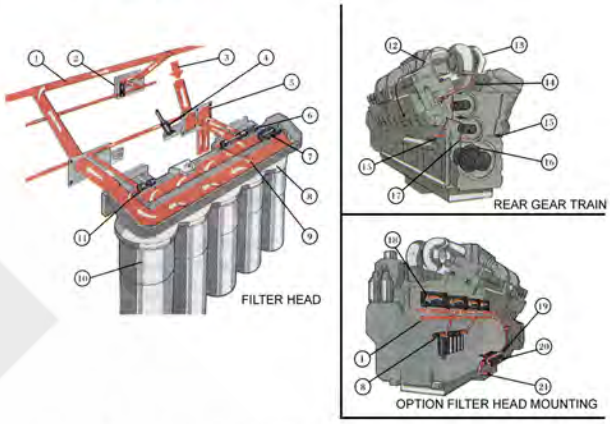


Fig. 5-12 Option lubricating oil flow schematic –
KTA50 Engine

1. MAIN OIL RIFLE
2. PISTON COOLING REGULATOR R.B.
3. FLOW FROM OIL COOLERS
4. PISTON COOLING NOZZLE
5. BYPASS TO OIL PAN
6. PRESSURE REGULATOR
7. BYPASS VALVE
8. FILTER HEAD
9. REQULATOR CONTROL RIFLE
10. FILTERS
11. PISTON COOLING REGULATOR L.B.
12. TURBOCHARGER OIL SUPPLY LINE
13. TURBOCHARGER
14. TURBOCHARGER OIL DRAIN LINE
15. CAMSHAFT OIL RIFLE
16. THRUST BEARINGS
17. FROM MAIN OIL RIFLE
18. OIL COOLINGS
19. DISCHARGE TUBE
20. LUBRICATINGOIL PUMP
21. SUCTION TUBE

Cooling System

Water is circulated by a centrifugal water pump mounted either in or on the front of the engine belt driven from the accessory drive or crankshaft. Water circulates around wet-type cylinder liners, through the cylinder heads and around the injector sleeves. Fig. 5-11 through Fig. 5-13. The injector sleeves, in which the injectors are mounted, are designed for fast dissipation of heat. The engine has a thermostat or thermostats to control the engine operating temperature. The engine coolant is cooled in a heat exchanger or keel coder. Sea water is circulated through heat exchanger by the raw water pump, mounted on front of engine, and discharge through connections on the heat exchanger.

The Fleetguard Water Filter is standard on Chongqing-Cummins Engines. The filter by-pass a small amount of coolant from the system via a filtering and treating element which must be replaced periodically.

KT/KTA 19 Engines

Water is circulated by a centrifugal water pump. Mounted on the exhaust side of the block. The pump is driven by an idler gear from the crankshaft. Coolant flows from the water pump volute into the oil cooler housing, through the cooler housing (serving as a water distribution manifold) into the block, maintaining an equal flow around all cylinder liners. From the liner area coolant flows into individual cylinder heads through holes drilled between the valves and around the injector "wells". From the cylinder heads water flows to the rocker housing (water outlet manifold) then to the thermostat housing. At the thermostat housing water is returned to the water pump via a by-pass tube until the engine coolant temperature activates dual thermostats. Coolant flow is then directed through a heat exchanger or Keel cooler.

KT/KTA 38 and 50 Engines

Water is circulated by a centrifugal water pump mounted on the right bank side of the block. The pump is driven by an idler gear from the crankshaft. Coolant flows from the water pump volute into the center of the "V" of the cylinder block, around the lubricating oil cooler elements. The center of the "V" serves as a water distribution manifold to supply a flow of coolant through the aftercooler elements and around the cylinder liners.

From the liner area coolant flows into individual cylinder heads through passages between the valves and around the injector "wells". From the cylinder heads coolant flows to the rocker housing (water outlet manifold) then to the thermostat housings. At the thermostat housings coolant is returned to the water pump via a by-pass tube until the engine coolant temperature activates the thermostats. Coolant flow is then directed through a heat exchanger or Keel cooler. Coolant circulated through the aftercooler is also returned into the thermostat housings.

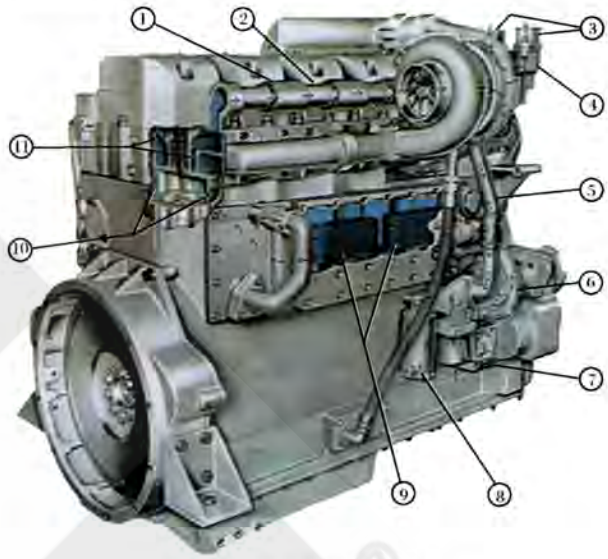


Fig. 5-13 Coolant flow --- KT(A)-19

1. **WATER MANIFOLD**
2. **TRANSFER TUBE**
3. **WATER "OUT"**
4. **THERMOSTAT HOUSING**
5. **BY-PASS TUBE**
6. **WATER PUMP**
7. **WATER "IN"**
8. **WATER FILTER**
9. **LUBRICATING OIL COOLERS**
10. **WATER "THROUGH" BLOCK**
11. **WATER "THROUGH" HEADS**

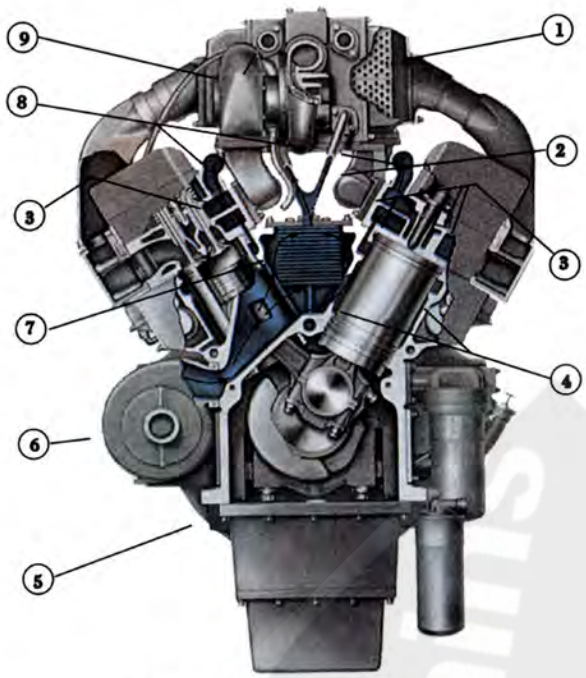


FiG. 5-14 Coolant flow --KTA38 Engine

1. AFTERCOOLER ELEMENTS
2. AFTERCOOLER COOLANT SUPPLY
3. COOLANT PASSAGES IN HEADS
4. LOOANT AROUND LINERS
5. COOLANT INLET
6. WATER PUMP
7. COOLANT IN BLCK "V"
8. COOLANT TRANSFER TUBE (HEAD TO HEAD)
9. AFTERCOOLER OUT TO THERMOSTAT HOUSING

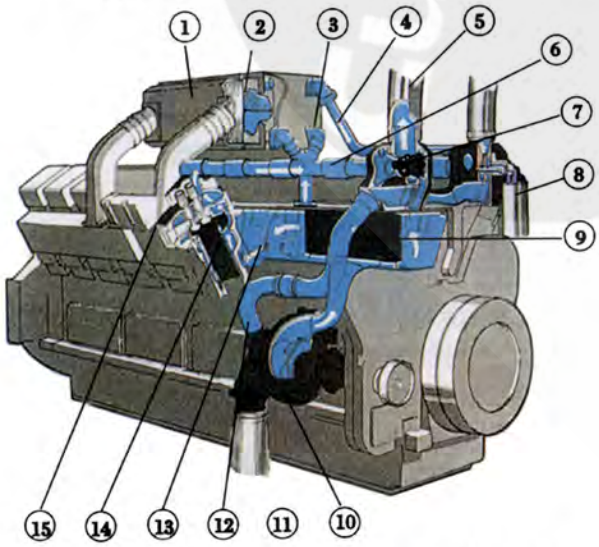


Fig. 5-15 Coolant flow schematic - KTA-50 Engine

1. AFTERCOOLER HOUSING
2. AFTERCOOLER CORE
3. AFTERCOOLER COOLANT SUPPLY
4. AFTERCOOLER COOLANT RETURN
5. COOLANT RETURN TO RADIATOR
6. COOLANT TRANSFER TUBE (HEAD TO HEAD)
7. THERMOSTAT
8. COOLANT FILTERS
9. OIL COOLANT
10. WATER PUMP
11. COOLANT SUPPLY FROM RADIATOR
12. BYPASS TUBE
13. COOLANT IN BLOCK "V"
14. CYLINDER LINER
15. CYLINDER HEAD

Air System

The engine requires hundreds of gallons of air for every gallon of fuel that it burns. For the engine to operate efficiently it must breathe freely; intake and exhaust systems must not be restricted.
The intake air should always be routed through an air cleaner. The cleaner may be mounted on the engine or equipment and may be oil bath, paper element or composite type depending upon engine application. Air is routed from the air cleaner directly to the intake air manifold, or turbocharger.

KT/KTA 19 Aftercooler
An aftercooler (or intercooler as it is sometimes called) is a device in the engine intake system designed to reduce intake air temperature and/or preheat intake air temperature.
The aftercooler consists of housing, used as a portion of the engine intake air manifold, with an internal core. The core is made of tubes through which engine coolant circulates. Air is cooled or heated by passing over the core prior to going into the engine combustion chambers.Therefore, improved combustion results from better control of the intake air temperature cooling or warming as applied by the aftercooler.

KT/KTA 38 and KTA 50 Aftercooler
The aftercooler consists of housing, mounted above the cylinder block, with (2) internal cores. The cores through which engine coolant circulates, cools or heats the air passing over the core prior to going into the engine combustion chambers. Therefore, improved combustion results. Fig 5-25 and 5-26.

Turbocharger
The turbocharger forces additional air into the combustion chambers so the engine can burn more fuel and develop more horsepower than if it were naturally aspirated. In some cased the turbocharger is used for the engine to retain efficiency (balanced fuel to air ratio) at altitudes above sea level.
The turbocharger consists of a turbine wheel and a centrifugal blower, or compressor wheel, separately encased but mounted on and rotating with a common shaft.
The power to drive the turbine wheel --- which in turn drives the compressor --- is obtained from the energy of the engine exhaust gases. The rotating speed of the turbine changes as the energy level of gas changes; therefore, the engine is supplied with enough air to burn fuel for its load requirements. Fig's.5-27, and 5-28. The turbocharger is lubricated and cooled by engine lubricating oil.

Fig. 5-16 Intake air flow schematic -KT(A)-19 engine

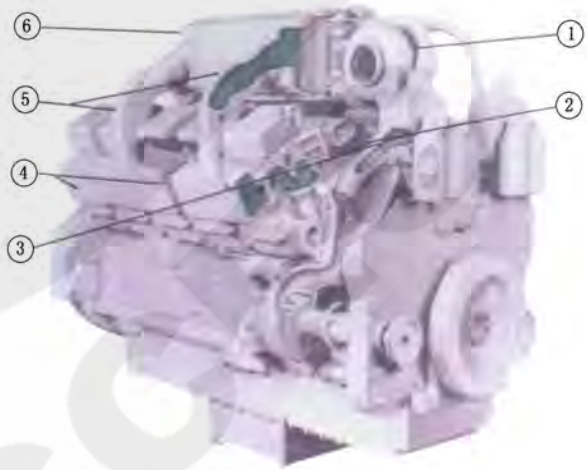


Fig.5-20 Intake air flow -KT(A)-38 Engine

1. **TURBOCHARGER**
2. **INTAKE VALVES**
3. **INTAKE PORT**
4. **INTAKE MANIFOLD**
5. **INTAKE CROSSOVER**
6. **AFTERCOOLER**

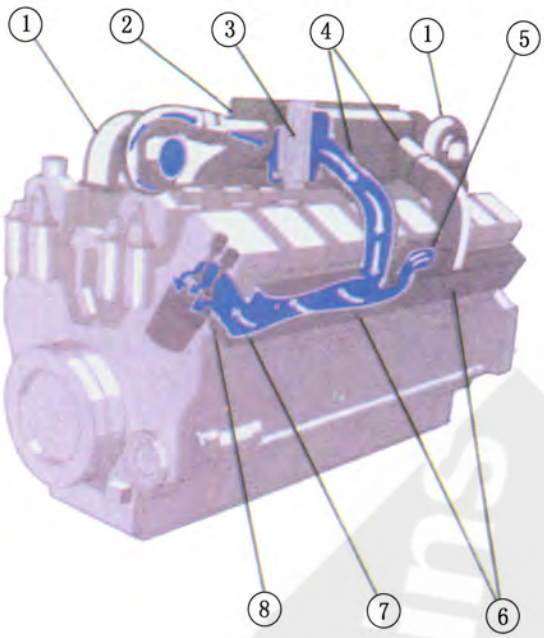


Fig. 5-21 Intake air flow schematic - KTA50 Engine

1. TURBOCHARGER
2. AFTERCOOLER HOUSING
3. AFTERCOOLER CORE
4. INTAKE CORSSOVEER TUBES
5. MANIFOLD EQUALIZER
6. INTAKE MANIFOLD
7. INTAKE PORT
8. INTAKE VALVE

Filters

Air Cleaners

The dust in the air is the primary reason on abrasion for cylinder liner, piston, piston ring , valves, valve stem guide and other athletic parts, the more the dust in the intake of the engine is, the more the abrasion of the engine's parts is . It is founded by wearing test of engine that the dust less than a diameter 0.001mm has an very small effect on engines, the dust with a diameter between 0.001mm and 0.01mm has an measured effect on the engine. If the diameter of the dust in the intake is larger than the thickness of the bearing oil film, it will affect the life of the main and connecting bearing and the piston ring. Therefore, it is very important that air cleaner should be chose careful.

The air cleaners used on Chongqing-Cummins engines are dry type, it can be divided into normal duty and heavy duty air cleaners according to their applications. The minimum efficiency for normal duty cleaner at any flow between 15% and 100% of the rated air flow is 99.5%, and its minimum dust holding capability is 3.0 grime/CFM (or 6.4 grime/L.S) at rated air flow, it will be applied primarily to those generator drive engines and marine engines.

The Minimum efficiency for heavy duty cleaner at any flow between 15% and 100% of the rated air flow is 99.9%, and it's minimum dust holding capability is 25.0 grime/CFM (or 53 grime/L.S) at rated air flow, it will be applied primarily to the mining product, construction product, automotive product, off-high heavy duty, etc. those engines (and generator drive engines) and marine engines (and generator drive engines).

After the air cleaners have been used for period of time, it's element(s) will be dirtied, and the restrictiton of the air intake will increase. When the restriction increases to above 6.25 kPa, the engine can not get sufficient ari, therefore, the engine will discharge the black smoke and the engine's power will be down.

The customer can estimate the air-logged conditions of the air cleaner by the air induction indicator or annunciate, if the indicating window of the indicator changes from green to red, or the annunciate gives an alarm, the air intake restriction had exceeded the limit value, the element will need to be cleaned up or replaced.

The following methods can be used to clean up the element(s) of the air cleaner:

a. Lightly knock the end plate of the element(s) to shake off the dust accumulating on the element(s);
b. Open the dust discharging jaws on the air cleaner to remove the dust in the air cleaner shell.
c. Open the end cover of the cleaner, and pull out the element(s).
d. Clean up the element(s) with the dry compressed air.

Note:

I. It is not permitted to clean up the element(s) with oil or water;
II. For the heavy duty air cleaner, there are many convolute pipes, these pipes can not be taken down, and it can be washed up with not alkaline water, flush it with cleanly water, then blow it with compressed air.
III. The secondary (or safty) element of the heavy duty air cleaner can not be cleaned up.

When the following problems are founded, the primary element must be replaced with a new element.

I. The primary element is in disrepair;
II. After assembly the element(s), the indicator indicates red or the annunciate gives an alarm again.
III. The primary element have been cleaned up for five times.

Note: For heavy duty air cleaner, when it's primary element is disrepair or cleaned up for five time, it's secondary must be replaced.

Spring on Filters

Oil Filter

Engine oil will be polluted by the parts wearing particle and outer impurity which enters into the engines, also , for being subjected to heat radiation of the hot parts, it will be oxidized , and produces acidic material which can dissolve in oil and colloidal deposit which is not soluble. These impurity and contamination are very harmful to the engines, if they are not be filtered, the hard particle in the oil will accelerate parts to abase, and jam the oil passage; the acidic material will bring the corrosive abrasion of the alloy bearings. The colloidal deposit will lead the pistons and piston rings and valves and valve stem guide to cement, even the engine can not run, and shorten the oil drain interval. It is said that if the total value of the solid contamination in the oil is less than 0.15%, the harm to the engine is limited, if this value is more than 0.5%, the harm to the engine is very serious. Therefore, the oil filters should be assembled in the lubrication system of the engine. All Chongqing-Cummins engines use the following filters: oil filter, bypass oil filter, fuel filter and corrosion resistor.

Full flow oil filter
The grain contamination with a diameter more than 0.04mm in the oil can be filtrated by this filter.
The element of this filter is made from synthetic fiber filter paper; it can not be collapsed on high temperature and high pressure and filter jamming.
There is bypass valve in the filter head, when the restriction arrives at or exceeds a pressure which is pre-confirmed, the oil will not pass the filter and flow the filter head to the main rifle directly, so that there are sufficient oil to lubricate the engine's parts.
There is a alarming equipment in the filter head in some engines, when the restriction arrives at or exceed a pressure which is pre-confirmed, it can give a alarming signal to the alarming lamp which can remind the drive to replace the oil filter A.S.A.P.
There are some jamming types about the oil filter:

a. The filter is polluted unduly. When the carbon deposit an oxid and buring byproduct in the engine oil exceed the limit that the oil can absorb, this will appear. It may be the primary reason for that the oil drain interval is very long and the maintenance or service is very bad, or the blowby is very high.
b. The ability that the oil disperse the deposit is weakened. When the coolant leaks into the oil pan, the humidity will be formed, the humidity will weaken the dispersing ability of the oil, this will cause the lampblack and chary dust to agglutinate and deposit. It is the primary reason for the coolant leaks into the oil pan and the engine idles for long time at cold status.
c. The additives separate form the oil. The additives will separate from the oil for coolant or humidity in the oil, this will cause jam.
d. Gel and latex. When the oil have been polluted by the coolant, this things will form in the oil.
e. Oxide. When the oil is diluted and the oil is eradiated by the high temperature, the oxide will form in the oil.
f. Abrasion material. This things are caused by the triturate and the dust in the lubrication system.

Full flow oil filters must always be used with bypass filters, but a bypass filter can not be used to instead of a full flow oil filter.

Bypass oil filter
This filter will filtrate out those granules which can not be percolated by the full flow oil filter. Because the oil flow which passes the filter is very small, it is allowable that the restriction of this filter maybe greater than the full flow oil filter. Granule dimension after filtrating by the bypass oil filter is between 0.005mm and 0.010mm.
Some customers think that the full flow oil filter has been assembled on the engine, it is not necessary to use the bypass oil filter again. At the same times, they consider the using cost will increase if the oil filter is replaced by a new one after the engine runs for 250 hours or 6 months or 16000kilometres, therefore, they don't replace the filter. It is proven that when the engine only use for full flow oil filter, the abrasion of the engine's parts are very serious. When the engine use full flow an bypass oil filters, the abrasion of the engine's parts will be decreased observably.
The combo filter has the function of full flow oil filter and bypass oil filter.

Fuel filter
There are two types fuel filters assembled on Chongqing-Cummins engines, normal and heavy duty fuel filter. The first one is applied to those engines whose power is below 700BHP. The second one is applied to those engines whose power is above 700BHP.
After the filter has been used for a period of time, the filter will be contaminated and jammed, it must be replaced trebly. The interval of the oil and fuel filters can be determined by the consumption curve of the oil and fuel, also, it is recommended that the oil and fuel filter is replaced every 250hours, 16000kilometers or 6 months.
The methods for replacing the filters can be seen on the filters.
For fuel/water separator, the user can drain the water from the separator by burning on the drain valve. When you estimate that the water have been drained drastically, you can turn off the drain valve.

Corrosion resistors

One of the essentialities for maintaining to the coolant system is to replace the corrosion resistor. If the customer do not use the corrosion resistor recommended by the engine manufacturer correctly, it will cause the following problems:

a. The deposit will be formed on the surface of the water pump and the cylinder liner;
b. The parts in the coolant system will be eroded and abased, and the thermostat will be jammed;
c. The tube of the oil cooler and radiator and aftercooler and the coolant hose and passage will be jammed.
d. Greasy deposit will be formed on the surface of which Transmitting the heat of the engine.

The above problems are caused by the followings in the coolant: sand, dirty, dust, oil dust, oil, mineral, corrosive product, alterative and dissipative chemical additives and the chip of the sealing. The coolant in the engine must be filtrated, the corrosion resistor is a better filtration equipment. If you use corrosion resistor correctly, the life of the engine and it's parts will be extended.

Note: When the engines are running, the chemical additives in the coolant will be depleted and diluted gently, so the customers must check the concentration for the additives termly. The check methods can be seen in the engine's service bulletin.

When the corrosion resistor is mot used or needed or be replaced, the customer can turn the valves on the inlet and outlet coolant tubes to the close position. When it will be needed to use, you can turn the valves on the inlet and outlet coolant tube to the full open position.

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