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| **Technical information** |
| **KDI 2504TCR / KDI 2504TCRE5 Workshop Manual (Rev. 17.5)** |



Sommario

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# Technical information

## Engine specifications

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| --- | --- | --- | --- |
| **MANUFACTURER SPECIFICATIONS AND OPERATION** | | | |
| **GENERAL INFORMATION** | **UNIT OF MEASURE** | **KDI 1903 TCR** | **KDI 2504 TCR** |
| Operating cycle |  | diesel - 4 stroke | |
| Cylinders | N° | 3 | 4 |
| Bore x stroke | mm | 88x102 | |
| Displacement | cm 3 | 1861 | 2482 |
| Compression ratio |  | 17.4:1 | |
| Intake |  | Supercharged with Turbocharger | |
| Cooling |  | Liquid | |
| Crankshaft rotation (view from flywheel side) |  | Counterclockwise | |
| Combustion sequence |  | 1-3-2 | 1-3-4-2 |
| **Timing System** | | | |
| Valves per cylinder | N° | 4 | |
| Timing System |  | Rods and rocker arms - Camshaft in the crankcase | |
| Tappets |  | Hydraulic | |
| Injection |  | Direct - Common Rail | |
| Engine dry weight | Kg | 233 | 267 |
| **MAX** inclination 30' continuous operation | α | 25° | |
| **MAX** inclination 1' continuous operation | α | 35° | |
| Volume of aspirated air (2600 rpm) | m 3 /h | 2.4 | 2.8 |
| **POWER AND TORQUE** | | | |
| **GENERAL INFORMATION** | **UNIT OF MEASURE** | **KDI 1903 TCR** | **KDI 2504 TCR** |
| **MAX** operating speed | Rpm | 2600 | |
| **MAX** operating power (ISO TR 14396 - SAE J1995 - CE 97/68) | kW | 42 | 55.4 |
| Maximum torque (at 1500 rpm) | Nm | 225 | 300 |
| Admissible axial load on crankshaft | Kg | 300 | |
| **CONSUMPTIONS** | | | |
| **GENERAL INFORMATION** | **UNIT OF MEASURE** | **KDI 1903 TCR** | **KDI 2504 TCR** |
| Specific fuel consumption (best point) | g/kWh | 210 | |
| Oil consumption | %Fuel | < 0.05 | |
| **FUEL SUPPLY SYSTEM** | | | |
| **GENERAL INFORMATION** | **UNIT OF MEASURE** | **KDI 1903 TCR** | **KDI 2504 TCR** |
| Type of fuel |  | Diesel UNI-EN590 - ASTM D975 | |
| High-pressure fuel injection pump |  | DENSO HP3 | |
| Fuel supply |  | Low pressure electric pump (if necessary) | |
| **Fuel filter** | | | |
| Filtering surface | cm 2 | 2300 | |
| Degree of filtration | µm | 5 | |
| Maximum pressure at injection pump inlet | bar | 0,2 | |
| **LUBRICATION CIRCUIT** | | | |
| **GENERAL INFORMATION** | **UNIT OF MEASURE** | **KDI 1903 TCR** | **KDI 2504 TCR** |
| **Lubrication** | | | |
| Recommended oil |  | See [**Par. 2.4**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=55&parent=1000) | |
| Circuit forced |  | Lobe pump | |
| Oil sump capacity ( **MAX** ) | Lt. | 8,9 | 11,5 |
| **Oil pressure switch** | | | |
| Intervention pressure ( **MIN** ) | bar | 0.8±0.1 | |
| **Oil filter** | | | |
| Maximum operating pressure | bar | 4.0 | |
| Degree of filtration | µm | 17±2 | |
| Filtering surface | cm 2 | 1744 | | |
| **COOLING CIRCUIT** | | | |
| **GENERAL INFORMATION** | **UNIT OF MEASURE** | **KDI 1903 TCR** | **KDI 2504 TCR** |
| Coolant | % | See [**Par. 2.6**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=195&parent=1000) | |
| Coolant pump | Lt./min | 75 | |
| **Thermostatic valve** | | | |
| Opening temperature | °C | +79 | |
| Stroke at 91°C | mm | 7.50 | |
| Liquid recirculation | Lt./h | 9 | |
| **ELECTRICAL SYSTEM - ELECTRIC FAN** | | | |
| **GENERAL INFORMATION** | **UNIT OF MEASURE** | **KDI 1903 TCR** | **KDI 2504 TCR** |
| Circuit rated voltage | V | 12 | |
| External alternator (rated current) | A | 80 | |
| Starter motor power | kW | 2 | |
| System electrical consumption, excluding: heater, electric pump, electric fan, starter motor | W | 25 | |
| **Coolant temperature indicator light** | | | |
| Indicator light operating temperature | °C | +100/+110 | |

## Engine dimensions (mm)

**NOTE** : Dimensions vary according to engine configuration.



**Fig 2.1**

## Performance

|  |
| --- |
| Diagrammi_2504_TCR.jpg  **Fig. 2.3** |
| **N**  =  Automotive rating curve  **MN**  =  Torque curve  **C**  =  Specific fuel consumption curve   |  | | --- | | **NOTE:**  Refer to  **KOHLER**  for power curves, torque curves and specific consumptions at speeds other than those given above. |   ***Key***     * **N ( ISO TR 14396 - SAE J1995 - CE 97/68 )  AUTOMOTIVE RATING CURVE :** Intermittent duty at variable speed and load.  Engine capacity at intermittent conditions with variable speed and load.        * **MN:** =  **TORQUE RATING CURVE :** Also called twisting moment, it is the push generated by the engine through transmission. The highest engine performance is obtained at the maximum torque.        * **C**  =  **SPECIFIC CONSUMPTION CURVE :** Engine fuel consumption in a given time at a certain revolution value.  Expressed in g/kW (grams/kilowatt), it expresses fuel yield.       \* The above curves express indicative values, in that the overall performance depends on the type of application and the ECU control uni.     * The ratings reported in the diagram regard the run-in engine, fitted with air and exhaust filters, at the atmospheric pressure of 1 Bar and at a room temperature of +20°C * Maximum rating is guaranteed with a 5% tolerance.     Z_Avvertenza.jpg  **Warning**       * Non approval by  **KOHLER**  for any modification releases the company from liability for damage incurred on the engine. |

## Oil

Z_importante.jpg **Important**

* The engine may be damaged if operated with improper oil level.
* Do not exceed the **MAX** level because a sudden increase in engine rpm could be caused by its combustion.
* Use only the recommended oil to ensure adequate protection, efficiency and service life of the engine.
* The use of lubricants other than recommended may shorten the engine life.
* Viscosity must be appropriate to the ambient temperature to which the engine is to be exposed.

Z_Pericolo.jpg **Danger**

* Prolonged skin contact with the exhausted engine oil can cause cancer of the skin.
* If contact with oil cannot be avoided, thoroughly wash your hands with soap and water as soon as possible.
* For the exhausted oil disposal, refer to the **Par.** **DISPOSAL and SCRAPPING** .

**2.4.1 SAE oil classification**

* In the SAE classification, oils are identified according to viscosity without considering any other qualitative characteristic.
* The code is composed of two numbers, which indicate, and must correspond to, the ambient temperature in which the engine operates, the first number refers to the viscosity when cold, for use during winter (" **W** "), while the second number is for viscosity at high temperatures.

**2.2**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **RECCOMENDED OIL** | | | | |
|  | | **TCR STAGE-V (\*1) (\*2)** | **TCR TIER IV FINAL (\*1)** | **TCR/D TIER III o NON CERTIFICATO (\*3)** |
| **WITH SPECIFICATIONS** | **API** | CJ-4 Low S.A.P.S  CK-4 Low S.A.P.S | CJ-4 Low S.A.P.S  CK-4 Low S.A.P.S | CI-4 Plus  CI-4  CH-4 |
| **ACEA** | E6 Low S.A.P.S. | E6 Low S.A.P.S. | E7  E4 |
| **VISCOSITY** | **SAE** | 10w-30 (-25°c ÷ +40°C) 10w-40 (-25°C ÷ +50°C)  5w-30 (-30°c ÷ +40°C)  5w-40 (-30°c ÷ +50°C)  0w-40 (-40°c ÷ +50°C) | 10w-30 (-25°c ÷ +40°C) 10w-40 (-25°C ÷ +50°C)  5w-30 (-30°c ÷ +40°C)  5w-40 (-30°c ÷ +50°C)  0w-40 (-40°c ÷ +50°C) | 10w-30 (-25°c ÷ +40°C) 10w-40 (-25°C ÷ +50°C)  5w-30 (-30°c ÷ +40°C)  5w-40 (-30°c ÷ +50°C)  0w-40 (-40°c ÷ +50°C) |

* Low S.A.P.S. technology (oil with low Sulfated Ash, Phosphorus, Sulfur content) keeps catalyst in good working conditions. The presence of sulfated ash, phosphorus and sulfur causes with time the catalyst clogging and its consequent inefficiency.
* For Mid S.A.P.S oil sequence the sulfated ash level is the same as API CJ-4 ≤ 1.0% but as per ACEA standardization those oils are referenced as mid SAPS.
* Filtration of oils is critical to proper operation and lubrication; always change filters regularly as specified in this manual.

**(\*1) NOTA** : Do NOT use fuel with sulphur content above 15ppm.

**(\*2) - On all engines compliant with Stage-V emission regulation (engines with DPF device), the oil to use must comply with the specification API CJ-4 Low S.A.P.S or ACEA E6 Low S.A.P.S.**

**(\*3) -** **NOTE** : Do NOT use fuel with sulphur content above 500ppm.

**(\*3) -** **NOTE** : Low S.A.P.S. oils, sulfate ashes <1% may not be used with fuels with a sulfur content >50ppm.

## Fuel

Z_importante.jpg **Important**

* Use of other types of fuel could damage the engine. Do not use dirty diesel fuel or mixtures of diesel fuel and water since this will cause serious engine faults.
* **Any failures resulting from the use of fuels other than recommended will not be warranted.**

Z_Avvertenza.jpg **Warning**

* Clean fuel prevents the fuel injectors from clogging. Immediately clean up any spillage during refuelling.
* Never store diesel fuel in galvanized containers (i.e. coated with zinc). Diesel fuel and the galvanized coating react chemically to each other, producing flaking that quickly clogs filters or causes fuel pump and/or injector failure.

**2.3**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **FUEL COMPATIBILITY** | | | | | | | | |
| EN 590 (biodiesel content max. 7% (V/V)) | | | | | | | | |
| ASTM D 975 Grade 1-D S15 | | | | | | | | |
| ASTM D 975 Grade 2-D S15 | | | | | | | | |
| NATO F-54, equivalent to diesel fuel in accordance with EN 590 | | | | | | | | |
| EN 590 or ASTM D 975 Grade 1, 2 -D S15 Arctic Diesel | | | | | | | | |
| JIS K 2204 No. 1, No. 2 | | | | | | | | |

**NOTE** : In a warranty case the customer must prove by a certificate from the fuel supplier that an allowed fuel was used.

***KDI Electronic Injection Tier 4 final – Stage IIIB – Stage IV- Stage V certified Engines***

* Those engines are designed for fuels in accordance with EN 590 and ASTM D975 for a cetane number of at least 45. Since those engines are equipped with exhaust gas after-treatment such as Diesel Oxidation Catalyst (DOC), Diesel Particulate Filter (DPF), Selective Catalytic Reduction (SCR), they may only be operated with sulfur-free diesel fuels (EN 590, DIN 5168, ASTM D975 Grade 2-D S15, ASTM D975 Grade 1-D S15). Otherwise, compliance with the emission requirements and durability are not guaranteed.  
  Insufficient lubricating capacity can lead to serious wear problems above all in common rail injection systems. Too low a lubricating capacity is particularly a problem in fuels with a low sulfur content (and in this respect sulfur contents ‹500 mg/kg can already be considered low). An adequate lubricating capacity is guaranteed by the appropriate additives in low-sulfur (‹50 mg/kg) or sulfur-free (‹10 mg/kg or ‹15 mg/kg) diesel fuels according to EN 590 and ASTM D 975. In low-sulpur and sulfur-free diesel fuels which do not comply with this standard, the lubricating capacity may have to be guaranteed by additives. The parameter for sufficient lubricating capacity is a maximum wear spot of 460 micrometers in the HFRR test (EN ISO 12156-1).

***KDI Electronic Injection Tier 3 – Stage IIIA emission equivalent certified Engines (EGR engines)***

* Those engines are designed for fuels in accordance with EN 590 and ASTM D975 for a cetane number of at least 45. Since those engines are not equipped with exhaust gas after-treatment, they can be operated with diesel fuels with sulfur content up to 500 mg/kg (ppm). Compliance with the emission requirements is guaranteed only with sulfur content up to 350 mg/kg (ppm).  
  Fuels with a sulfur content > 50 mg/kg demand a shorter lubricating oil change interval. This is set at 250hrs. However, the engine oil must be changed when the Total Base Number TBN is reduced to 6.0 mgKOH/g test method ASTM D4739. Do not use low SAPS engine oils.

***KDI Electronic Injection uncertified Engines (no EGR engines)***

* Those engines are designed for fuels in accordance with EN 590 and ASTM D975 for a cetane number of at least 45. Since those engines are not equipped with exhaust gas after-treatment, they can be operated with diesel fuels with sulfur content up to 2000 mg/kg (ppm). Fuels with a sulfur content > 15 mg/kg demand a shorter lubricating oil change interval. This is set at 250hrs. However, the engine oil must be changed when the Total Base Number TBN is reduced to 6.0 mgKOH/g test method ASTM D4739.

**2.5.1** **Fuel for low temperatures**

* When operating the engine in ambient temperatures lower than 0 degrees C, use suitable low temperature fuel normally available from fuel distributors and corresponding to the specifications of **Tab. 2.3** .
* These fuels reduce the formation of paraffin in diesel at low temperatures.
* When paraffin forms in the diesel, the fuel filter becomes blocked interrupting the flow of fuel.

**2.5.2 Biodiesel fuel**

* Fuels containing 10% methyl ester or B10, are suitable for use in this engine provided that they meet the specifications listed in the Tab. 2.3.
* **DO NOT USE** vegetable oil as a biofuel for this engine.

**2.4**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **BIODIESEL COMPATIBILITY** | | | | | | | | |
| Biodiesel according to EN 14214 (only permissible for mixture with diesel fuel at max. 10% (V/V)) | | | | | | | | |
| US biodiesel according to ASTM D6751 – 09a (B100) (only permissible for mixtures with diesel fuel at 10% (V/V)) | | | | | | | | |

**2.5.3 Synthetic fuels: GTL, CTL, BTL, HV**  
 It is a well-known fact that engines which are operated for longer periods with conventional diesel fuel and then converted to synthetic fuels suffer shrinkage of polymer seals in the injection system and thus fuel leaks. The reason for this behavior is that the aromatic-free synthetic fuels can lead to a change in the sealing behavior of polymer seals.  
Therefore, conversion from diesel fuel to synthetic fuel may only be done after changing the critical seals. The problem of shrinkage does not occur when an engine was operated with synthetic fuel from the start.

**2.5.4 Non-Road Fuels**

*Only for KDI De- Contented Electronic Injection Tier 3 – Stage IIIA emission equivalent certified Engines (EGR engines) and KDI De- Contented Electronic Injection Uncertified Engines (no EGR engines).*

Other non-road fuels may be used if they comply with all the limit values of EN 590 except for the fuel density, the cetane number and the sulfur content.  
The following limits apply for these parameters:

**2.5**

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| --- | --- | --- |
| **FUEL PARAMETER** | **UNIT** | **LIMIT VALUE** |
| Cetane number |  | Min. 49 |
| Fuel density at 15°C | Kg/m 3 | 820 - 860 |
| Sulfur content | mg/kg or ppm | max. 500 |

**2.5.5 Jet Fuels**  
 *Only for KDI De- Contented Electronic Injection Uncertified Engines (no EGR engines).*  
The following jet fuels can be used but only adopting an additional fuel filter with lubricity doser:

**2.6**

|  |  |
| --- | --- |
| **FUEL** | |
| F-34/F-35 (kerosene, NATO designation) | JP-8 (kerosene, US military designation) |
| F-44 (kerosene, NATO designation | JP-5 (kerosene, US military designation) |
| F-63 (kerosene, NATO designation, equivalent to F-34/F-35 with additives) | Jet A (kerosene for civil aviation) |
| F-65 (kerosene, NATO designation, 1:1 mixture of F-54 and F-34/F-35) | Jet A1 (kerosene for civil aviation) |

**2.5.6 Emission-Related Installation Instructions** Failing to follow the instructions in the applications guidebook when installing a certified engine in a piece of nonroad equipment violates federal law (40 CFR 1068.105(b)), subject to fines or other penalties as described in the Clean Air Act.

OEM must apply a separate label with the following statement: “ULTRA LOW SULFUR FUEL ONLY” near the fuel inlet.

Ensure you are installing an engine appropriately certified for your application. Constant speed engines may only be installed on constant speed equipment for constant speed operation.

If you install the engine in a way that makes the engine's emission control information label hard to read during normal engine maintenance, you must place a duplicate label on the equipment, as described in 40 CFR 1068.105.

## Coolant recommendation

|  |
| --- |
| A mixture of 50% demineralized water and 50% low silicate ethylene glycol based coolant liquid must be used. Use a Long Life or Extended Life Heavy Duty OAT coolant free of: silicates, phosphates, borates, nitrites and amines.    The following ethylene-glycol based engine coolant for all models within KDI engine family may be used:     * OAT (Organic Acid Technology) Low Silicate: **ASTM D-3306 D-6210** * HOAT (Hybrid Organic Acid Technology) Low Silicate: **ASTM D-3306 D-6210**   The above coolants in concentrated formulation must be mixed with distilled, deionized, or demineralized water. A pre-mixed formulation (40-60% or 50-50%) can be used directly when available.  Importante.png  **Important**   * Do not mix ethylene glycol and propylene glycol based coolants. Do not mix OAT and HOAT based coolant. OAT performance life can be drastically reduced if contaminated with nitrite-containing coolants. * Never use automotive-type coolants. These coolants do not contain the correct additives to protect heavy – duty diesel engines.   OAT coolants are maintenance free up to 6 years or 6000hrs of operation , provided that the cooling system is topped up using the same type of coolant. Do not mix different coolant types. Test the coolant condition annually with coolant test strips. HOAT are not all maintenance free and it is recommended to have SCA (Supplemental Coolant Additives) added at the first maintenance interval. |

## Battery recommendation

**Battery not supplied by Kohler**

**Tab. 2.7**

|  |  |
| --- | --- |
| **RECOMMENDED BATTERIES** | |
| **AMBIENT TEMPERATURE** | **BATTERY TYPE** |
| ≥ - 15°C | 100 Ah - 800 CCA/SAE |
| < -15°C | 120 Ah - 1000 CCA/SAE |

## Periodic maintenance

The intervals of preventive maintenance in **Tab. 2.8, Tab. 2.9, Tab. 2.10 and Tab. 2.11**  refer to the engine operating under normal operating conditions with fuel and oil meeting the recommended specifications.

**2.8**

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| --- | --- | --- | --- | --- |
| **CLEANING AND CHECKING** | | | | |
| **OPERATION DESCRIPTION** | **PERIOD (HOURS)** | | | |
| **100** | **250** | **500** | **5000** |
| Engine oil level (8) |  |  |  |  |
| Coolant level (8) (9) |  |  |  |  |
| Cartridge dry-type air filter (2) |  |  |  |  |
| Radiator heat-exchange surface and Intercooler (2) (8) |  |  |  |  |
| Standard alternator belt (8) |  |  |  |  |
| Poly-V alternator belt (8) |  |  |  |  |
| Rubber hose (intake air / coolant) |  |  |  |  |
| Fuel hose |  |  |  |  |
| Starter Motor |  |  |  |  |
| Alternator |  |  |  |  |

**2.9**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **REPLACEMENT** | | | | |
| **OPERATION DESCRIPTION** | | **PERIOD (HOURS)** | | |
| **500** | **2000** | **5000** |
| Cartridge dry-type air filter (2) | |  |  |  |
| Intake manifold hose (air filter - intake manifold) (7) | |  |  |  |
| Coolant hoses (7) | |  |  |  |
| Fuel line hose (7) | |  |  |  |
| Alternator belt | Standard alternator belt (trapezoidal) (3) |  |  |  |
| Poly-V belt heavy environmental condition |  |  |  |
| Poly-V belt standard condition |  |  |  |
| Coolant | OAT |  |  |  |
| HOAT (10) |  |  |  |

**2.10**

|  |  |  |
| --- | --- | --- |
| **ENGINE OIL AND OIL FILTER CARTRIDGE REPLACEMENT** | | |
| **ENGINE VERSION** | **PERIOD (HOURS)** | |
| **250** | **500** |
| KDI TCR Tier 4 final – Stage IIIB – Stage IV- Stage V (1) |  |  |
| KDI TCR/D Tier 3 – Stage IIIA (1) (11) |  |  |
| KDI TCR/D uncertified (1) |  |  |

**2.11**

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| --- | --- | --- |
| **FUEL FILTER AND PREFILTER CARTRIDGE REPLACEMENT** | | |
| **ENGINE VERSION** | **PERIOD (HOURS)** | |
| **250** | **500** |
| KDI TCR Tier 4 final – Stage IIIB – Stage IV- Stage V (1) |  |  |
| KDI TCR/D Tier 3 – Stage IIIA (1) |  |  |
| KDI TCR/D uncertified (1) |  |  |

(1) - In case of low use: 12 months.

(2) - The period of time that must elapse before checking the filter element depends on the environment in which the engine operates. The air filter must be cleaned and replaced more frequently under very dusty conditions.

(3) - In case of low use: 36 months.

(7) - The replacement interval is only an indication, it strongly depends from environmental condition and hose status detected during regular visual inspection.

(8) -  The first check must be done after 10 hours.

(9) - Test the coolant condition annually with coolant test strips.

(10) - It is recommended to have SCA (Supplemental Coolant Additives) added at the first maintenance interval.

(11) - Read Cap. 2.5, "KDI De- Contented Electronic Injection Tier 3 – Stage IIIA emission equivalent certified Engines (EGR engines)" and "KDI De- Contented Electronic Injection Uncertified Engines (no EGR engines)".

## Fuel system

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **2.9.1 Injection circuit (pressure 2000 bar) (Fig 2.4)**  The materials of the fuel system components (pipes, tank, filters, etc.) and any surface treatments must be free from chemical elements that, transported in the fuel, compromise the operation of the injectors over time (hole clogging).    The most critical chemical element is Zinc (Zn), therefore it is forbidden to use galvanised components.    Other damaging elements are indicated in the table below.  **Tab 2.12**   |  |  |  | | --- | --- | --- | | **METALS** | **LIMIT VALUES OF PRESENCE IN FUEL** | **LIMIT VALUE** | | **Zn** (Zinc) | * Zinc (Zn) is eluted from the rubber (NBR) in the fuel line. Thus, the growing carboxylate (Zn) was adhered on the parts in the injection system for reacting carboxylic acid in the fuel. * In case that the changed injection quantity, nozzle coking occurs the fuel contents Zn≥1ppm. * Zinc (Zn) is ≤ 0.3ppm is the limited value to avoid occur coking. | **Zn ≤ 0.3ppm** | | **Pb** (Lead) | * Lead (Pb)is eluted from Pd coading in the fuel tank. Thus, the growing carboxylate (Pd) was adhered on the injection system for reacting carboxylic acid in the fuel. * In case that the changed injection quantity and nozzle coking occurs the fuel contents Pd. * As interim, the identical level is the limited value with Zn. | **Pd ≤ 0.3ppm** | | **Na** (Sodium) | * The growing carboxylate (Na) was adhered on the parts in the injection system for reacting carboxylic acid in the fuel with fuel contents Na ≥ 0.5ppm. Thus, sliding malfunction was occurred. * In case that the changed injection quantity and nozzle coking occurs the fuel contents Na. * Especially concerns of occurring defects, NaOH is residue for using production process of bio fuel. * ≤ 0.3ppm is the limited value to avoid occur nozzle coking and carboxylate. Combine K with Na equivalent alkali metal that are less than 0.3ppm. | **Na + K ≤ 0.3ppm** | | **K** (Potassium) | | **Ca** (Calcium) | * In case that carboxylate (Ca) was adhered the injection system inside. * Under study on the results in the moment. * Maximum value is 0.3ppm when using fuel that is B100 fuel with regulation EN14214 of contents 7%. | **Ca + Mg ≤ 0.3ppm** | | **Mg** (Magnesium) | | **Cu** (Copper) | * Copper (Cu) on the fuel that can be acted wear and catalyst for making decline. * In case that the changed injector quantity and nozzle coking occurs in the fuel contents Cu. * As interim, the identical level is the limited value with Zn. | **Cu ≤ 0.3ppm** | | **Ba** (Barium) | * In case that changed injection quantity and nozzle coking occurs in the fuel contents Barium (Ba). * As interim, the identical level is the limited value with Zn. | **Ba ≤ 0.3ppm** | | **P** (Phosphorus) | * Phosphorus (P) in the fuel can poison catalyst. * No failure case is in the injection system in the moment. * Maximum value is 0.3ppm when using a B100 fuel with regulation EN 14214 of contents 7%. | **P ≤ 0.3ppm** | | **Na - K - Ca - Mg - P** | These metals are regulated in EN14214 | |     Z_importante.jpg **Important**       * The high pressure supply injection system is highly susceptible to damage if the fuel is contaminated. * It is crucial that all components of the injection circuit are thoroughly cleaned before the components are removed. * Thoroughly wash and clean the engine before maintenance. * Contamination in the injection system may cause a reduction in in performance or engine faults. * If the engine is cleaned with high pressure washer, then the nozzle must be kept at a minimum distance of 200mm from the surface, and not directed at electrical components and connectors. |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| The fuel supply system is under low pressure from fuel tank **1** to the high-pressure fuel injection pump **5** .  **NOTE** : The representation of fuel tank is purely  indicative. Component not necessarily supplied by **KOHLER** .  **Tab 2.13**   |  |  | | --- | --- | | **POS.** | **DESCRIPTION** | | 1 | Fuel tank | | 2 | Fuel pipe under low pressure from the tank to the fuel filter | | 3 | Fuel filter | | 4 | Low-pressure fuel tube from the fuel filter to the high-pressure injection pump | | 5 | High-pressure fuel injection pump | | 6 | High-pressure fuel tube from the high-pressure fuel injection pump to the Common Rail | | 7 | Common Rail | | 8 | Fuel pipes under high pressure from the Common Rail to the electronic injectors | | 9 | Electronic injectors | | imm2_4.jpg **Fig 2.4** |
| **2.9.2 Fuel return circuit**    The fuel return circuit is under low pressure.  **NOTE** : The representation of fuel tank is purely  indicative. Component not necessarily supplied by **KOHLER** .  **Tab 2.14**   |  |  | | --- | --- | | **POS.** | **DESCRIPTION** | | 1 | Electronic injectors | | 2 | Common Rail | | 3 | Low-pressure fuel return tube from the Common Rail to the fuel return distributor | | 4 | Low-pressure fuel return tube from the electronic injectors to the fuel return distributor | | 5 | Low-pressure fuel return distributor | | 6 | Low-pressure fuel return tube from the return distributor to the fuel tank | | 7 | High-pressure fuel injection pump | | 8 | Low-pressure fuel return tube from the injection pump to the fuel return distributor | | 9 | Fuel tank | | imm2_5.jpg **Fig 2.5** |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| **2.9.3 High-pressure injection pump (2000 bar)**    Z_importante.jpg **Important**       * **DO NOT** use the cylinder connecting pipe (item 5) to carry the pump during movement as this may cause damage resulting in fuel leakag; to handle the injection pump, refer  [**Par. 2.17.1.**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=112&parent=1000) * The injection pump **CANNOT** be repaired. * **DO NOT** attempt to remove the temperature sensor 7 from the pump. Should the sensor 7 be defective, replace the injection pump. * It is **NOT** possible to perform any maintenance on the fuel intake regulating valve 6 as it is an integral part of the injection pump. * **DO NOT** attempt to remove the fuel intake regulating valve 6 from the injection pump. Should the valve be defective, replace the injection pump.   **NOTE:** In the event of leakage from the high pressure circuit do not intervene when the engine is running, but turn it off and wait 5 - 10 minutes before checking the leakage.   The inlet pressure to the high pressure pump must be between 300 mbar (suction pump without electric supply) and 200 mbar (with electric pump power) to the high pressure rail.  The high pressure pump is operated via the pump control gear and sends high pressure fuel to the common rail.  **NOTE:** The supply tube (on union 8) and fuel return (on union 9), have different diameters.  **Tab 2.15**   |  |  | | --- | --- | | **POS.** | **COMPONENTS DESCRIPTION** | | 1 | High-pressure fuel injection pump | | 2 | Name plate with QR code | | 3 | Fitting for high pressure outlet to Common Rail | | 4 | Plunger housing | | 5 | Connection pipe plunger housing | | 6 | Fuel intake regulating valve | | 7 | Fuel temperature sensor | | 8 | Fuel inlet fitting | | 9 | Fuel return fitting | | 10 | Shaft key positioning on the pump control gear | | 11 | Pump control shaft | | 12 | Gasket | | imm2_6.jpg **Fig 2.6**imm2_7.jpg **Fig 2.7** |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **2.9.4 Electronic injector**  The electronic injector is equipped with an integral solenoid valve which, when excited electronically, manages a valve controlled from    inside the electronic injector to commence fuel injection.      The ECU output signal is digital.      Z_importante.jpg **Important**       * The electronic injector is **NOT** repairable. * The electronic injectors are calibrated individually. * They are **NOT** interchangeable with the other cylinders of the same - or other - engines. * It is assembled on the engine; the new calibration code (QR code) must be inserted in the ECU by means of a diagnostics instrument [**(ST\_01).**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) * Do **NOT** fit new or different electronic injectors without the instruments required to enter the injector calibration code. * Fuel containing impurities causes serious damage to the electronic injectors. * The electronic injector for Stage V engines is different and it is not interchangeable with other engine | imm2_8.jpg **Fig 2.8  Tab 2.16**   |  |  | | --- | --- | | **POS.** | **COMPONENTS DESCRIPTION** | | 1 | Connector for solenoid control | | 2 | Solenoid and valve closure ring | | 3 | High pressure pipe inlet fitting | | 4 | Electronic injectors body | | 5 | Nozzle closure ring nut | | 6 | Nozzle | | 7 | QR code (Visual reading) | | 8 | QR code (Electronic reading) | | 9 | Return pipe fitting | | 10 | Electronic injector identification code | |
| **2.9.5 Common Rail**  Fuel is injected under pressure into the Common Rail ( **Pos.3** ), from the high-pressure fuel injection pump.   * The internal volume of the Common Rail is optimised to obtain the best compromise in order to minimise pressure peaks due to the cyclical flow of the injection pump; * Opening the electronic injectors; * The high speed response of the system to the requests of the ECU control unit.   The pressure sensor **5** measures the pressure of the fuel in the Common Rail. Safety valve **2** , only opens if internal pressure of the Common Rail exceeds the maximum value of 2400 bar. Pressure inside the Common Rail is regulated by the highpressure fuel injection pump by means of the fuel intake regulation valve ( **Pos. 6 Fig. 2.6** ).    The fuel ejected from the safety valve is introduced in the circuit of rejection returning to the tank.    Z_importante.jpg **Important**       * Common Rail is **NOT** reparaible. * It is **NOT** possible to perform any maintenance on the fuel pressure sensor **5** , as it is an integral part of the Common Rail unit. * Do **NOT** remove the pressure sensor or the fuel pressure limit valve from the Common Rail. * If the pressure sensor or the pressure limit valve are not working, replace the entire Common Rail unit.   imm2_9.jpg **Fig 2.9**    **Tab 2.17**   |  |  | | --- | --- | | **POS.** | **DESCRIPTION** | | 1 | Common Rail | | 2 | Pressure limit valve (return due to overpressure) | | 3 | Tube inlet union from high-pressure fuel injection pump | | 4 | Outlet fittings for supply pipes to electronic injectors | | 5 | Fuel pressure sensor | | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **2.9.6 Fuel filter**  The fuel filter is situated on the crankcase of the engine or it may be assembled on the frame of the vehicle.      **Tab 2.18**   |  |  | | --- | --- | | **POS.** | **COMPONENTS DESCRIPTION** | | 1 | Fuel filter support | | 2 | Fuel system filling button | | 3 | Cartridge | | 4 | Water in fuel sensor | | 5 | Wing nut, filter drainage |   **Tab 2.19**   |  |  | | --- | --- | | **DESCRIPTION** | **VALUE** | | Filtering surface | 2.300 cm 2 | | Degree of filtration | 5 µm | | Max operating pressure | 2.0 Bar | | Max flow rate | 190 litres/hour | | imm2_10.jpg **Fig 2.10** |

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **2.9.7 Electric fuel pump (optional)** When the electric fuel pump is installed in a diesel engine, one must:   1. Remove any filters installed on the inlet of the electric injection pump; 2. Insert a pre-filter between the tank and the electric pump; 3. The electric pump may be assembled on application at a maximum height of 500 mm from the position of the fuel tank. 4. Insert a shut-off valve to prevent dry operation due to the emptying of the intake manifold; 5. The supply pressure given from the electric pump must not exceed the pressure of 0.2 bar to the input of highpressure injection pump.   **Tab 2.20**   |  |  | | --- | --- | | **POS.** | **DESCRIPTION** | | 1 | Arrival pipe from the tank | | 2 | Electric pump | | 3 | Flow pipe to the fuel filter | | 4 | Fuel filter | | imm2_11.jpg **Fig 2.11** |
| **2.9.8 Guards for fuel injection circuit components**  High-pressure injection circuit components are particularly sensitive to impurities.    To prevent impurities, even microscopic ones, from accessing the fuel input or output unions, you are required to close these accesses by means of specific caps as soon as the various tubes are disassembled and disconnected.  Disassembly of any component of the injection circuit must not occur in dusty environments.  Cap protections must remain closed in their housing [**(ST\_40)**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000) until the moment they are to be used.  Pay special attention when using the caps and avoid any contamination of dust or dirt of any kind.  Even after using the caps illustrated in this paragraph, all components of the injection circuit must be placed with care in environments that are free of any type of impurity.  **Fig. 2.13, 2.14 and 2.15** illustrate the caps that must be used on components of the injection circuit.  Cap protections must be accurately washed after use and placed back in their housing [**(ST\_40).**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=822&parent=1000)    Z_importante.jpg **Important**       * It is highly recommended to have this page visible during disassembly operations of the components of the fuel injection circuit. | imm2_13.jpg **Fig 2.13**imm2_14.jpg **Fig 2.14**imm2_15.jpg **Fig 2.15** |

## Lubrication circuit

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **2.10.1 Lubrication circuit diagram**  The oil pump is driven by the crankshaft on the timing system side.    On the parts of the systems shown in green on In the parts in green, the oil is in intake, in the parts in red, the oil is under pressure and    in those in yellow the oil is returning towards the oil sump **2** (not under pressure).  **Tab 2.21**   |  |  | | --- | --- | | **COLOUR** | **DESCRIPTION** | |  | Oil in intake | |  | Oil under pressure | |  | Oil returning to the oil sump |   **Tab 2.22**   |  |  | | --- | --- | | **POS.** | **DESCRIPTION** | | 1 | Oil pump rotors | | 2 | Oil sump | | 3 | Crankshaft | | 4 | Camshaft | | 5 | Turbocharger | | 6 | Rocker arm pin | | 7 | Hydraulic tappets | | 8 | Rocker arm cover | | 9 | Cylinder head | | 10 | Upper crankcase | | 11 | Lower crankcase | | 12 | Oil filter | | 13 | Oil Cooler | | 14 | Housing | | imm2_16.jpg **Fig 2.16**imm2_17.jpg **Fig 2.17** |
| **NOTE** : Click by side to play the procedure. | <https://www.youtube.com/embed/Ig3XosQ8h0s?rel=0> |
| **2.10.2 Oil pump** The oil pump rotors are trochoidal (with lobes) and are activated from the crankshaft by means of the key.    The pump body is situated inside the distribution guard.    It is imperative to assemble the rotors with reference **A** visible by the operator.      **Tab 2.23**   |  |  | | --- | --- | | **POS.** | **DESCRIPTION** | | 1 | Internal rotor | | 2 | External rotor | | 3 | Oil pump crankcase | | 4 | Pump control key | | 5 | Timing system crankcase | | 6 | Crankshaft | | imm2_18.jpg **Fig 2.18** |

|  |  |
| --- | --- |
| **2.10.3 Oil filter and Oil Cooler**  imm2_19.jpg  **Fig** **2.1** **9**    **NOTE** : unscrewing the cartridge holder cover makes the oil in support 7 flow towards the oil sump by means of the drain duct 4. | |
| **Tab 2.24**   |  |  | | --- | --- | | **POS.** | **DESCRIPTION** | | 1 | Oil arriving from the pump | | 2 | Oil cooling | | 3 | Oil filtering | | 4 | Oil drain duct (oil sump return) | | 5 | Oil returning into the circuit | | 6 | Outgoing fitting from filter | | 7 | Oil filter support | | 8 | Cartridge holder cover | | 9 | Oil filter cartridge | | 10 | Oil Cooler | | 11 | Crankcase | | 12 | Oil directly from the cartridge | | 13 | Coolant | | 14 | Oil drain duct closure gasket | | 15 | Oil filtering chamber closure gasket | | 16 | Cartridge holder cover gasket |   **Tab 2.25** ***Cartridge characteristics.***   |  |  | | --- | --- | | **DESCRIPTION** | **VALORE** | | Filtering surface | 2.300 cm 2 | | Degree of filtration | 2 µm | | Max operating pressure | 4.0 Bar | | Max flow rate | 190 litres/hour | | 2.19.jpg   **Fig 2.20** |

## Cooling circuit

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **2.11.1 Cooling circuit diagram**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **Tab 2.26**   |  |  | | --- | --- | | **POS.** | **DESCRIPTION** | | 1 | Coolant pump | | 2 | Coolant intake | | 3 | Coolant, cylinder | | 4 | Coolant, cylinder head | | 5 | EGR gas coolant | | 6 | Coolant to radiator | | 7 | Coolant into radiator | | 8 | EGR valve coolant | | 9 | Coolant in the Oil Cooler | | 10 | Coolant input into the Oil Cooler | | 11 | Coolant output from the Oil Cooler | | 12 | Vent line from radiator (to 15) | | 13 | Vent line to expansion vase (to 15) | | 14 | Return from compensation tank | | 15 | Compensation tank | | 16 | Thermostatic valve | | imm2_21.jpg **Fig 2.21** |   2.21.jpg **Fig 2.22**     |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **2.11.2 Water pump  Tab 2.27**   |  |  | | --- | --- | | **POS.** | **DESCRIPTION** | | 1 | Coolant pump control pulley | | 2 | Coolant intake fitting | | 3 | Coolant return hose from the Oil Cooler | | imm2_23.jpg **Fig 2.23** | | **2.11.3 Radiator with Intercooler (optional)  Tab 2.28**   |  |  | | --- | --- | | **POS.** | **DESCRIPTION** | | 1 | Radiator with intercooler | | 2 | Coolant refill cap | | 3 | Radiator coolant vent tube or return | | 4 | Air hose (from Intercooler to manifold) | | 5 | Intercooler air delivery hose | | 6 | Coolant flow manifold | | 7 | Coolant intake manifold | | 8 | EGR Cooler coolant vent tube or return | | 2.23.png **Fig 2.24** | | **2.11.4 Thermostatic valve  Tab 2.29**   |  |  | | --- | --- | | **POS.** | **DESCRIPTION** | | 1 | Cylinder head | | 2 | Coolant outlet cover | | 3 | Thermostatic valve | | 4 | Gaskets | | 5 | Air bleeding hole |   Starting opening temperature of +79° ± 2°C. | imm2_25.jpg **Fig 2.25** | | **2.11.5 EGR gas circuit cooling (EGR Cooler)**    Device that cools exhaust gas    **Tab 2.30**   |  |  | | --- | --- | | **POS.** | **DESCRIPTION** | | 1 | EGR valve | | 2 | EGR gas passage tubes | | 3 | Coolant outlet hose | | 4 | EGR Cooler | | 5 | Coolant draining union | | 6 | Coolant delivery hose | | 7 | Intake manifold | | imm2_26.jpg **Fig 2.26** | |

## Intake and exhaust circuit

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **2.12.1 Turbocharger** The turbocharger is controlled by means of exhaust gas that activates the turbine.    Z_importante.jpg **Important**       * See [**Par 2.18**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=113&parent=1000) .   **Tab 2.31**   |  |  | | --- | --- | | **POS.** | **DESCRIPTION** | | 1 | Air intake hose | | 2 | Air compression volute | | 3 | Turbo charger central body | | 4 | Turbine housing with Waste Gate valve | | 5 | Gas exhaust flange | | 6 | Waste Gate control valve hose | | 7 | Waste Gate valve control actuator | | 8 | Waste Gate control valve linkage | | 9 | Engine crankcase breather | | 10 | Air compressed flow hose to intercooler | | 11 | Oil drain pipe | | 12 | Turbo charger lubrication pipe | | 2.26.png **Fig 2.27** |
| **2.12.2** **ATS device**  **2.12.2.1 DOC**  The DOC is a device to filter exhaust gas by means of its oxidation.    Internally, it is composed of hundreds of small ducts that enable the passage of exhaust gas.    It contains precious metals (platinum, palladium, iridium).      **NOTE:** The image is indicative only. The installation of the catalyst must be approved by KOHLER, for each application. In order to prevent breakage on the connection flange, the catalyst is normally connected via a hose.    Z_importante.jpg **Important**       * In order to prevent breakage on the connection flange, the catalyst must be connected via a flexible exhaust tube.   **Tab 2.32a**   |  |  | | --- | --- | | **POS.** | **DESCRIPTION** | | 4 | Turbocharger | | 5 | Gas exhaust flange | | 13 | DOC | | 14 | Flexible exhaust tube | | 2.27.png **Fig 2.28** |
| **2.12.2.2 Intake and exhaust circuit diagram with DOC**   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | |  | Air in intake |  | Gas in recycle |  | Gas in exhaust |   imm2_29.jpg **Fig 2.29**imm2_30.jpg **Fig 2.30** | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Z_importante.jpg **Important**         * The diagrams in **Fig. 2.29 and Fig. 2.30** do not have an air filter, which must always be present and connected by means of an intake hose to the turbocharger. * The air temperature inside the intake manifold must never exceed that of the environment by 10°C.   Filtered air is sucked by the turbocharger, which compresses and sends it to the intercooler (as a consequence of compression, the air increases the temperature - the Intercooler cools it - this process enables better performance during combustion inside the cylinders). From the Intercooler, it is sent to the    intake manifold and, via ducts in the cylinder head, enters the cylinders. Compressed air inside the cylinders and mixed with the fuel transforms into Gas after combustion. The gas is expelled from the cylinders and sent to the exhaust manifold. The exhaust manifold sends the Gases to 2 ducts:     * **1st duct** : to the turbocharger body (the expelled Gases activate the turbine), the Gases then proceed towards the catalyst, which break down the pollutants contained in them before being definitely expelled. * **2nd duct** : to the EGR circuit, which takes care of recovering a part of the Gases that return to intake (this process burns less oxygen when power is not requested, thus breaking down pollutants further).   The EGR circuit is managed by ECU, which controls the EGR valve that provides for the recovery of Gases when the engine does not require power. The EGR circuit is furnished with a heat exchanger (EGR Cooler), which cools the recovered Gases (this process enables better performance during combustion inside the cylinders). | **Tab 2.32b**   |  |  | | --- | --- | | **POS.** | **DESCRIPTION** | | 1 | Air in intake from air filter | | 2 | Air in compression | | 3 | Air in intercooler flow | | 4 | Air cooling | | 5 | Air in intake manifold flow | | 6 | Air in head intake | | 7 | Air in cylinder intake | | 8 | Gas in cylinder outlet | | 9 | Gas in head outlet | | 10 | Gas in outlet towards DOC | | 11 | Gas in oxidation | | 12 | Gas in recycle towards EGR valve | | 13 | Gas in EGR valve outlet | | 14 | Gas cooling (in EGR Cooler) | | 15 | Exhaust gas recirculation into intake manifold | | A | Intake manifold | | B | Exhaust manifold | | C | Upper crankcase | | D | Lower crankcase | | E | Oil sump | | F | Catalyst | | G | Radiator/intercooler | |
| **2.12.2.3 DOC+DPF**  The DOC+DPF system reduces emissions because the DPF eliminates the particulate generated by Diesel fuel combustion. The system triggers automatic DPF regeneration cycles depending on the degree of clogging.  The smell of the gases out of the exhaust line is different than the traditional one of gases from Diesel engines. Moreover, during regeneration stages, the exhaust gases could temporarily be white.    **NOTE:**  During regeneration, engine idling will increase.    2_12_2_3.png  **Fig 2.30a** | |
| **Tab 2.32c**   |  |  | | --- | --- | | **POS.** | **DESCRIPTION** | | 1 | turbocharger | | 2 | exhaust pipe from turbine | | 3 | DOC | | 4 | DPF | | 5 | ETB | | 6 | EGTS (Black) | | 7 | EGTS (Yellow) | | 8 | Delta-P (Delta Pressure) | | |
| **2.12.2.4** **DPF regeneration strategy**  You can intervene on the machine control panel for the DPF regeneration operations "only if requested by means of specific warning lights or messages on the control panel".  **Tab. 2.32d**  describes the level of particulate accumulation, the relationship with the warning lights that will light up on the panel, the performance limitations of the engine and the operator’s options intervention.  Forced regeneration must be executed in accordance with the machine instructions.  **Tab 2.32d**   |  |  |  |  |  | | --- | --- | --- | --- | --- | | **SOOT LEVEL** | **WARNING LAMPS \*1** | **ENGINE DE-RATE** | **OPERATOR POSSIBLE ACTIONS** | **OPERATING CONDITIONS** | | **Level 0** |  |  |  | * No condition | | **Level** **1** | | **Level** **2** | | **Level** **3** | DPF_high_soot.png  Fixed | Forced Regeneration is Necessary | * Coolant temperature at 60 °C * Do not switch the engine off * Stationary vehicle * No load applied to the engine \*2 | | **Level** **4** | DPF_high_soot.png  Flashing | Engine de-rate | Forced Regeneration is Necessary | * Coolant temperature at 60 °C * Do not switch the engine off * Stationary vehicle * No load applied to the engine \*2 | | **Level** **5** | DPF_STOP.png  Flashing | Strong Engine de-rate | Contact an authorized KOHLER workshop.  Service Regeneration Required | REGENERATION via **KOHLER** software |   **\*1:**  The warning lights be different – consult the machine manual.  **\*2:**  Unless stated otherwise in the machine manual.  Z_Avvertenza.jpg      **Warning**     * Forced regenerations must only be executed if required by the ECU when the "HIGH SOOT" warning light goes on (due to a Level 3 - 5 particulate accumulation). * Do NOT execute the forced regenerations if not required by the ECU (due to a Level 0 - 2 particulate accumulation). * The minimum engine speed increases during the forced regeneration phases. * Repeated forced regenerations cause significant engine oil contamination by the fuel. * The oil level check must be executed after every forced regeneration. * If the regeneration inhibition function is misused, the particulate accumulation level will increase within a short time. * The engine oil filter and oil must be changed after a Service Regeneration is completed via KOHLER software * (Level 5 Particulate accumulation). * Fuel contamination allowed in the engine oil is 3% MAX. * Any engine load must be eliminated during forced regeneration so as to prevent damaging the ATS \*2 system. * Do not switch the engine off during level 3, 4 and 5 regeneration so as to prevent damaging the ATS system. | |
| **2.12.2.5** **Intake and exhaust circuit diagram with** **DOC+DPF**  2_12_2_5.png  **Tab 2.32e**   |  |  | | --- | --- | | **POS.** | **DESCRIPTION  (pos. For DPF components only)** | | 1 | Air in intake from air filter | | 2 | Air in compression | | 10 | Gas in outlet towards DOC | | 11 | Gas in oxidation | | 12 | Gas in recycle towards EGR valve | | 16 | DPF | | F | DOC | | G | Radiator/intercooler | | H | ATS | | |
| **2.12.3 Air filter**  **NOTE:** Component not necessarily supplied by **KOHLER** .    Z_importante.jpg **Important**       * The air filter is a dry type of filter with a paper filtering element; element **s H and L** are replaceable (refer to **Tab. 2.8 and Tab.2.9** for procedure frequency on components). * Filter suction must be positioned in a cool place. * Should a hose be used, the length must not exceed **400** **mm** and is to be as straight as possible.   2.30.png **Fig 2.31** | **Tab 2.33**   |  |  | | --- | --- | | **POS.** | **DESCRIPTION** | | H | Air filter cartridge | | L | Air filter safety cartridge | | M | Filter cover | | N | Filter support | | Q | Dust exhaust valve | | R | Filter cover hook | |

## Electric system

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| **2.13.1 ECU input and output signals diagram**   |  |  |  | | --- | --- | --- | | **SENSOR/SWITCH (INPUT)** |  | **DEVICES (OUTPUT)** | | Power relay | **ECU** | Electronic injector 1 | | Engine Revolution Sensor | Electronic injector 2 | | Engine phase sensor | Electronic injector 3 | | Coolant temperature sensor | Electronic injector 4 | | Common Rail pressure sensor | EGR valve control | | Oil pressure switch | Fuel intake adjustment valve | | EGR valve position | Revolution indicator | | Fuel temperature sensor | Heater relay | | T-MAP sensor | Diagnosis indicator lights | | ACACT Sensor | Throttle body adjustment | | Main accelerator pedal (double track) | Electric fan control (1-2 speeds or variable speed) | | Secondary accelerator pedal (optional) | CAN 1 (ISO15765 diagnostics) | | Hydraulic oil pressure sensor (optional) | CAN 2 (Vehicle SAE J1939) | | Fuel level sensor (optional) |  | | Air filter clogging sensor (optional) | | Sensor to detect water in the fuel | | Throttle body position | | EGTS (black) Sensor | | EGTS (yellow) Sensor | | Delta-P Sensor | | |
| **2.13.2** **Control unit (ECU)**  The ECU is a central processor, which monitors and controls engine operation.    The electronic control unit is responsible for engine management.    It is fitted on the frame of the vehicle, or in the cab (refer to the technical documentation of the vehicle).    Z_importante.jpg **Important**       * The ECU must only be used with the configuration defined by **KOHLER** , for each individual engine. * To look up ECU errors, refer to the Help File manual | **2.13.2.1 T** **echnical features**   * Operating temperature: -40°C - +100°C. * Storage temperature: -40°C - +100°C. |
| **Fig 2.32 -** **Fig  2.33**imm2_32_e_33.jpg  **Tab. 2.35**   |  |  | | --- | --- | | **ECU AND ENGINE IDENTIFICATION PLATES** | | | **POS.** | **DESCRIPTION** | | 1 | Engine model | | 2 | Validation code | | 3 | Engine specifications | | 4 | Bar Code of the engine chassis number | | 5 | Engine chassis number | | 6 | ECU identification code | | A | Connector A (ECU A) | | B | Connector B (ECU B) | | C | Barometric capsule | | D | Fastening points |      * Do **NOT** mount or replace the control unit with that of another engine. * Although externally each ECU seems to be identical, internally they are specifically configured only for use on the engine that they are supplied with. * To install a new control unit, is required to recharge on it's the original configuration relating to that specific engine . * **The control units are not interchangeable nor modifiable.** * **Each control unit is accompanied by its adhesive identification plate.** | |
| **2.13.3 Engine electrical wiring**  Tab_2_36___2186_493_cablaggio.png  Tab_2_36___2186_489_briglia_DPF.png  **Fig 2.34** | |

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| **Tab. 2.36**   |  |  | | --- | --- | | **RIF.** | **DESCRIZIONE** | | 1 | Vehicle interface connector  **(Fig. 2.34a)** | | 2 | ECU Connector A  **(Fig. 2.34b)** | | 3 | ECU Connector B  **(Fig. 2.34b)** | | 4 | Fuel pressure regulating valve connector | | 5 | Fuel temperature sensor connector | | 6 | T-MAP sensor connector | | 7 | Common Rail pressure sensor connector | | 8 | Injectors connectors | | 9 | EGR valve connector | | 10 | Engine speed sensor connector | | 11 | Engine phase sensor connector | | 12 | Oil pressure switch connector | | 13 | Coolant temperature sensor connector | | 14 | D+ Connector Alternator | | 15 | Starter motor connector (50) | | 16 | Starter motor connector 3,2kW (50) | | 17 | Wiring support | | 18 | ETB connector (Stage V versions only) | | 19 | ACACT  connector (Stage V versions only) | | 20 | Ground | | 21 | CAN resistor | | 22 | ATS wiring connector (Stage V versions only) | | 23 | ATS interface wiring (Stage V versions only) | | 24 | Engine wiring connector | | 25 | DPF temperature connector (yellow) | | 26 | DPF temperature connector (black) | | 27 | Delta-P sensor connector | | imm2_34a.jpg **Fig 2.34a**imm2_34b.jpg **Fig 2.34b** |
| **NOTE:** Click by side to play the procedure. | <https://www.youtube.com/embed/6-0TbYG2EkY?rel=0> |
| **2.13.3.1 Wiring disconnection**  All sensor connectors and electronic control devices are sealed.  The connectors must be disconnected by means of pressure on tabs **A** or unblock the retainers **B** , as illustrated from **Fig. 2.34c to Fig. 2.34r.** | Fig._2.34c.jpg **Fig 2.34c** |
| imm2_34d.jpg **Fig 2.34d** | imm2_34e.jpg **Fig 2.34e** |
| imm2_34f.jpg **Fig 2.34f** | imm2_34g.jpg **Fig 2.34g** |
| imm2_34h.jpg **Fig 2.34h** | imm2_34i.jpg **Fig 2.34i** |
| imm2_34l.jpg **Fig 2.34l** | inn2_34m.jpg **Fig 2.34m** |
| imm2_34n.jpg **Fig 2.34n** | imm2_34o.jpg **Fig 2.34o** |
| imm2_34p.jpg **Fig 2.34p** | imm2_34q.jpg **Fig 2.34q** |
| imm2_34r.jpg **Fig 2.34r** |  |

## Sensors and switches

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| **2.14.1 Revolution sensor on target wheel**    Speed sensor **A** is situated on the timing system carter.  The sensor detects the signal from the target wheel **B** (60 - 2teeth) situated on the crankshaft pulley. It sends it to the ECU as an analogical signal.  The sensor sends and analogue signal to the ECU.  The sensor produces a 5V square wave signal having a Hall effect while the crankshaft in rotation detects its position and speed.  The data sent by this sensor enables the ECU to pilot fuel anticipation injection for each piston.  For gap adjusting see [**Par. 9.15.1.5**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=171&parent=1000) . | imm2_35.jpg **Fig 2.35** |
| **2.14.2 Camshaft sensor**    Camshaft sensor **C** is situated on the timing system carter.    The purpose of the camshaft sensor **C** is to identify the position of the camshaft control gear **E** with respect to the engine shaft and consequently the position of the pistons with respect to the T.D.C.. The sensor produces a 5V square wave signal having a Hall effect while the camshaft in rotation detects the phases of the 4 strokes of the 1st cylinder. As a consequence, ECU by means of internal calculations, also recognises the phases of the other cylinders.    The data sent by this sensor enables the ECU to pilot fuel anticipation injection for each piston.  For gap adjusting see [**Par. 9.15.1.4**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=171&parent=1000) . | imm2_36.jpg **Fig 2.36** |
| **2.14.3 T-MAP sensor**  The T-MAP **F** sensor is situated on the intake manifold. It detects the input pressure in the intake manifold by means of electrical voltage variation and the air temperature by means of an electrical resistor.    The sensor sends signals to the ECU, which determines the values and modifies the injection strokes.    **Tab. 2.36** reports the electrical resistor values according to the intake air temperature.  **NOTE** : **R** indicates the pin where it is possible to measure electrical resistance.  **Tab 2.37**   |  |  | | --- | --- | | **°C (°F)** | **R ( Ω )** | | -30 (-22) | 23475 - 25945 | | 0 (32) | 5370 - 5935 | | 25 (77) | 1900 - 2100 | | 50 (122) | 772 - 854 | | 100 (212) | 177 - 195 | | 120 (248) | 107 - 119 | | **KDI TCR**  2.37.png  **KDI TC**  1903_TC_T-MAP.png  **Fig 2.37** |
| **2.14.4 ACACT** **sensor (versions with DPF filter only)**  The ACACT sensor **J** is located on the intake manifold, before the T-Map sensor, and it measures the temperature of the air coming from the turbocharger.  **Tab. 2.37b** shows the electric resistance values based on the intake air temperature.  **Tab 2.37b**   |  |  | | --- | --- | | **°C (°F)** | **R (k Ω )** | | -40 (-40) | 130.3 | | 0 (32) | 33.87 | | 25 (77) | 17.17 | | 50 (122) | 9.603 | | 100 (212) | 3.739 | | 150 (302) | 1.796 | | 200 (392) | 1.000 | | 2_14_4.png  **Fig 2.37a** |
| **2.14.5** **EGTS sensor (yellow - black)**  The EGTS sensors **K1** and **K2** are placed on the ATS system, **K1** with black wire before the DOC, **K2** with yellow wire after the DOC.  They are both needed for the DPF filter regeneration strategies.  **Tab. 2.37b** shows the electric resistance values based on the intake air temperature.  **Tab 2.37c**   |  |  | | --- | --- | | **°C (°F)** | **R (k Ω )** | | -40 (-40) | 133,8 | | 0 (32) | 34,49 | | 50 (122) | 9,749 | | 100 (212) | 3,771 | | 150 (302) | 1,803 | | 200 (392) | 1,002 | | 250 (482) | 0,6173 | | 300 (572) | 0,4127 | | 350 (662) | 0,2934 | | 400 (752) | 0,2186 | | 450 (842) | 0,1690 | | 500 (932) | 0,1345 | | 550 (1022) | 0,1097 | | 600 (1112) | 0,0912 | | 650 (1202) | 0,0771 | | 700 (1292) | 0,0661 | | 750 (1382) | 0,0574 | | 800 (1472) | 0,0503 | | 850 (1562) | 0,0445 | | 2_14_5.png  **Fig 2.37b** |
| **2.14.6** **Delta-P sensor**  The Delta-P sensor **J** detects the clogging level of the DPF filter.  Operating temperature: -30°C - +120°C.    Z_importante.jpg    **Important**   * Connect the **J1** and **J2** pipes to the Delta-P sensor exclusively as shown in **Fig. 2.37d** . | 2_14_6.png  **Fig 2.37c**  2_14_6a.png  **Fig 2.37d** |
| **2.14.7 Common Rail pressure sensor**    Fuel pressure sensor **G** assembled on the Common Rail, detects the fuel pressure inside it by means of electrical voltage variation. Depending on the signal sent, ECU manages the fuel intake valve on the injection pump and, if necessary, modifies the injection strokes.    Z_importante.jpg **Important**       * Refer to [**Par. 2.9.5**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=103&parent=1000) | imm2_38.jpg **Fig 2.38** |
| **2.14.8 Fuel filter water detection sensor**    The water presence sensor **H** is situated in the fuel filter, which is there to indicate the presence of water in the fuel.    Water, if present in the fuel, because of its greater specific weight separates and settles in the lower part of the filter where there is a specific sensor that, by means of the ECU activates an alarm signal on the dashboard.  The butterfly valve nut **M** situated in the lower part of the body sensor enables the elimination of any water present in the fuel and prevent malfunctions on components of the injection circuit. | imm2_39.jpg **Fig 2.39** |
| **2.14.9 Fuel temperature sensor on the fuel injection pump**    The fuel temperature sensor **L** is situated on the high-pressure fuel injection pump. The fuel temperature sensor **L** , measures the temperature of the fuel entering the pump at high pressure. The signal sent to the ECU is analogue.    The resistance detected by the ECU is proportional to the fuel temperature.    Z_importante.jpg **Important**       * Refer to [**Par. 2.9.3**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=103&parent=1000) | imm2_40.jpg **Fig 2.40** |
| **2.14.10 Oil pressure switch**  Oil pressure switch **N** is assembled on the crankcase.  It is a N/C sensor, calibrated at 0.6 bar ± 0.1 bar.  With oil low pressure the sensor closes the electrical circuit and the warning lamp in the panel board switches on. | imm2_41.jpg **Fig 2.41** |
| **2.14.11 Coolant temperature sensor**  The **P** coolant temperature sensor of the coolant circuit is applied to the cylinder head on the side of the thermostatic valve.  It is used by the ECU to obtain information regarding the coolant temperature (via PIN **R** ) and control the warning light high-temperature signal and control the electric fan of the coolant radiator. Indicator light operation temperature +106°C / +108°C.  **NOTE** : **R** indicates the pin where it is possible to measure electrical resistance.    **Tab 2.38**   |  |  |  | | --- | --- | --- | | **CHARACTERISTICS** | | | | Temperature °C | R min Ω | R max Ω | | -40 | 38.313 | 52.926 | | 0 | 5.227 | 6.623 | | +140 | 0.067 | 0.076 | | 2.42.jpg **Fig 2.42** |
| **2.14.12 Air cleaner clogging switch**    **NOTE:** Component not necessarily supplied by **KOHLER.**  The switch is assembled on the air cleaner. When the filter is clogged, it sends a signal to the panel.    **Features** :   * Operating temperature: - **30 °C / +100°C** * Contact usually open. * Contact closed by vacuum: **-50 mbar.** | 2.43.png  **Fig. 2.42 a** |
| **2.14.13 ACAT** **Sensor (KDI 1903 TC model only)**  The ACAT **Q** sensor is placed on the air intake line and measures the temperature of the air coming from the turbocharger. **Tab. 2.38a** shows the electric resistance values based on the intake air temperature.  **Tab 2.38a**   |  |  | | --- | --- | | **°C (°F)** | **R (k Ω )** | | -40 (-40) | 130.3 | | 0 (32) | 33.87 | | 25 (77) | 17.17 | | 50 (122) | 9.603 | | 100 (212) | 3.739 | | 150 (302) | 1.796 | | 200 (392) | 1.000 | | 1903_TC_ACAT.png  **Fig. 2.42b** |
| **2.14.14 EGR-T** **Sensor (KDI 1903 TC model only)**  The EGR-T **R** sensor is placed on the air intake manifold after the EGR gas inlet and measures the temperature of the air mixed with EGR gas coming from the turbocharger. **Tab. 2.38b** shows the electric resistance values based on the intake air temperature.  **Tab 2.38b**   |  |  | | --- | --- | | **°C (°F)** | **R (k Ω )** | | -40 (-40) | 130.3 | | 0 (32) | 33.87 | | 25 (77) | 17.17 | | 50 (122) | 9.603 | | 100 (212) | 3.739 | | 150 (302) | 1.796 | | 200 (392) | 1.000 | | 1903_TC_EGR-T.png  **Fig. 2.42c** |

## Electrical components

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| **2.15.1 Alternator (A)**    Externally controlled by the crankshaft by means of a belt.   * Ampere 80 A * Volt 12V | imm2_43.jpg **Fig 2.43** |
| **2.15.2 Alternator for Poly-V belt (optional) (B)**    Externally controlled by the crankshaft by means of a belt.   * Ampere 80 A * Volt 12V | imm2_44.jpg **Fig 2.44** |
| **2.15.3 Starter Motor (C)**     * Type Bosch 12 V * Power 2 kW * Anticlockwise rotation (seen from timing system side)      * Type Mahle 12 V * Power 3.2 kW * Anticlockwise rotation (seen from timing system side) | imm2_45.jpg **Fig 2.45a**  2_15_3b.png  **Fig 2.45b** |
| **2.15.4 EGR Valve (D)**    A device that provides for exhaust gas recovery that is controlled by ECU, which, according to acceleration parameters, RPM and power requested, varies the opening and closing of the valve.    The device has an integrated ECU, which, on each start-up of the control panel, executes an operation self-check.    In the event of a malfunction, it sends a signal to ECU, which, in turn, signals the anomaly on the control panel.    Characteristics:   * Type Dell'Orto EGV A16 * Operating/storage temperature: -30°C / +130°C. | imm2_46.jpg **Fig 2.46** |
| **2.15.5 Cold starting device (Heater)**  The cold starting device consists of a resistance, managed by the ECU, which is activated when the ambient temperature is ≤ -16° C.    The intake air is heated through the resistance and facilitates starting.      Characteristics:   * Type Hidria AET 12 V * Power 550 W | imm2_47.jpg **Fig 2.47** |
| **2.15.6 Fuel intake regulating valve (SCV)**    Valve E is situated on the high-pressure fuel injection pump.  It is managed by ECU, which regulates fuel intake by means of fuel pressure values inside the Common Rail, choking the input entrance of fuel in the injection pump. The digital signal varies the opening of the valve in proportion to the quantity of fuel required for the Common Rail.    Z_importante.jpg **Important**       * Refer to [**Par 2.9.3**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=103&parent=1000) | imm2_48.jpg **Fig 2.47 a** |
| **2.15.7 Electric fuel pump (optional)**  **NOTE:** Component not necessarily supplied by **KOHLER.**    The electric pump is located before the fuel filter. One of the following pumps can be assembled **A1 - A2 - A3 - A4.**    **Tab. 2.39** **(a-d)** indicates pump features.    **Tab. 2.39**   |  |  | | --- | --- | | **POS.** | **Description** | | **B** | Electrical connection | | **C** | Prefilter pump | | **IN** | Ingoing fitting (IN) from tank | | **OUT** | Outgoing fitting (out) to fuel filter |   **Tab. 2.39a**   |  |  | | --- | --- | | **A1** | **Value** | | Voltage | 12 V - 24 V | | Delivery | 100 L/h @ 0.44 - 0.56 bar |   **Tab. 2.39b**   |  |  | | --- | --- | | **A2** | **Value** | | Voltage | 12 V | | Delivery | 60.56 L/h @ 0.41 bar |   **Tab. 2.39c**   |  |  | | --- | --- | | **A3** | **Value** | | Voltage | 12 V | | Delivery | 24 L/h @ 0.1 bar |   **Tab. 2.39d**   |  |  | | --- | --- | | **A4** | **Value** | | Voltage | 12 V | | Delivery | 30 L/h @ 0.4 bar | | 2.50a.png  **Fig 2.48**  2.50b.png  **Fig 2.48a**  2.50c.png  **Fig 2.48b**  2.50d.png  **Fig 2.48c**  2.50e.png  **Fig 2.48d** |
| **2.15.8** **ETB (versions with DOC+DPF device - Stage V only)**  The ETB valve  **F**  is controlled by the ECU during the DPF filter regeneration strategies. | 2_15_8.png  **Fig 2.48e** |

## Timing system and tappets

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| The timing system is equipped with hydraulic tappets that automatically recover the operation of the rocker rods assembly. No registration is therefore required.  **2.16.1 Components identification**imm2_49.jpg **Fig 2.49** | |
| **Tab 2.40**   |  |  | | --- | --- | | **POS.** | **DESCRIPTION** | | 1 | Crankshaft | | 2 | Camshaft | | 3 | Camshaft tappets | | 4 | Rocker arm control rod | | 5 | Rocker arms | | 6 | Valves | | 7 | High-pressure fuel injection gear pump control | | 8 | Camshaft control gear | | 9 | Intermediate gear | | 10 | Intermediate gear pin | | 11 | Crankshaft gear | | 12 | Target wheel positioning reference pin on camshaft | | 13 | Camshaft target wheel | | 14 | Valve control bridge | | 15 | Articulation control valves | | 16 | Hydraulic tappets | | imm2_50.jpg **Fig 2.50**imm2_51.jpg **Fig 2.51** |
| **2.16.2 Timing system phasing angles**    Z_importante.jpg **Important**       * For information purposes, **Tab. 2.41**  reports the timing system diagram phasing angle values. * It should be noted that the said values may be verified by rotating the crankshaft **(Pos. 1 of Fig. 2.49)** , by means of handling the rocker arm control rod **(Pos. 4 of Fig. 2.49)** .   **NOTE:** Detecting the value by means of handling the rocker arm/valves may not be correct due to the hydraulic tappets, which may compress and create clearances that alters the actual value. **Tab 2.41**   |  |  |  | | --- | --- | --- | | **ENGINE** | **INTAKE** | **EXHAUST** | | 1903 TCR | opens 20° before TDC | opens 32° before BDC | | closes 32° after BDC | closes 16° after TDC | | 2504 TCR | opens 10° before TDC | opens 20° before BDC | | closes 14° after BDC | closes 4° after TDC | | 2.50EN.png **Fig 2.52** |
| **2.16.3 Rocker arm pin  Tab 2.42**   |  |  | | --- | --- | | **POS.** | **DESCRIPTION** | | 1 | Rocker arm pin | | 2 | Rocker arm distancing spring | | 3 | Rocker arm pin support | | 4 | Exhaust rocker arm | | 5 | Intake rocker arm | | imm2_53.jpg **Fig 2.53** |
| **2.16.4 Rocker arms**  **Tab 2.43**   |  |  | | --- | --- | | **POS.** | **DESCRIPTION** | | **1** | Rocker arm body | | **2** | Hydraulic tappet oil refill line | | **3** | Valve tappet lubrication line | | **4** | Valve tappet | | **5** | Hydraulic tappet | | **6** | Oil flow line | | imm2_54.jpg **Fig 2.54** |
| **2.16.5 Hydraulic tappets  Tab 2.44**   |  |  | | --- | --- | | **POS.** | **DESCRIPTION** | | A | Hydraulic tappets | | B | Hight pressure chamber | | 1 | Hydraulic tappets oil refill pipe | | 2 | Retaining ring | | 3 | Piston | | 4 | Unidirectional valve | | 5 | Tappet body | | 6 | Spring |   **2.16.5.1 Hydraulic tappet operation**  The operating principle of the hydraulic tappet is based on the incompressibility of the liquids and on controlled leakage.  The oil under pressure enters the tappet chamber **A** , providing a constant supply of oil in the low-pressure chamber. Through the non-return valve, **4** the oil can only access the high-pressure chamber **B** and exit via the clearance between the piston **3** and the tappet body **5** (controlled leakage). The chamber **B** is filled when the rocker arm is on the base radius of the cam and the spring **6** keeps the piston **3** against the valve stem, thus eliminating any system play. Thanks to the spring extension, the tappet "extends", creating a small depression in the chamber **B** , making the non-return valve **4** open, and allowing the oil in the chamber **A** to pass to chamber **B** , restoring the proper amount of oil required to eliminate any play in the valves. | imm2_55.jpg **Fig 2.55** |

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| **2.16.5.2 Difficult operating conditions**  For proper operation on the hydraulic tappets it is essential that the low pressure chamber of the piston 3 is always full of oil.    In some conditions this may not occur (due to the fact that the oil leaks away when the engine is switched off, which can also partially drain the tappets). This situation will be the cause of clearances that will result in a characteristic noise similar toa ticking sound.   1. When the engine is cold, the tappet filling time could be very long if the oil used is not suitable for the specific environmental conditions ( [**Tab. 2.2**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=55&parent=1000) ) 2. If the engine is very hot: at idle speed, oil pressure may be low, and small air bubbles could form in the circuit. Because of this, this compressing the tappet slightly and producing valve play which is responsible for the ticking sound. On account of this, the tappet compresses slightly giving rise to a valve clearance, thus generating a slight ticking sound, which however disappears rapidly ( **MAX** 10 seconds) once normal operating conditions have been restored.     Anyway the duration of ticking Anyway the duration of ticking sound must be **MAX** 30 seconds. If not, the problem is surely due to the poor quality of the oil, wear or impurities that, transported by the oil, can infiltrate between the ball valve and its seat inside the piston, compromising the operation of the tappet itself; In these cases, the only solution is to replace the oil or hydraulic tappets.    The prolonged persistence of the ticking sound or abnormal noise must be investigating in order to prevent any malfunctions; if necessary, replace the hydraulic tappets and engine oil. |

## Components handling

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| **2.17.1 High-pressure fuel injection pump**  - Only handle by means of the points marked by **Y** . - It is forbidden to handle using the points marked by **N** . | imm2_57.jpg **Fig 2.56** |
| **2.17.2 Electronic injector**  - Only handle by means of the points marked by **Y** . -It is forbidden to handle using the points marked by **N** . | imm2_58.jpg **Fig 2.57** |
| **2.17.3 Common Rail**  - Only handle by means of the points marked by **Y** . - It is forbidden to handle using the points marked by **N** . | imm2_59.jpg **Fig 2.58** |
| **2.17.4 Turbocharger**    - Only handle by means of the points marked by **Y** . - It is forbidden to handle using the points marked by **N** .    Z_importante.jpg **Important**       * Refer to [**Par. 2.18**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=113&parent=1000) . | imm2_60.jpg **Fig 2.59** |
| **2.17.5** **ACACT** **(versions with DOC+DPF device - Stage V only)**  - Only handle by means of the points marked by  **Y** . - It is forbidden to handle using the points marked by  **N** .  **NOTE:** The sensor includes ceramic material.  - Do not install sensors which suffered impacts or falls.  - Do not install sensors in case of external contamination  - Do not install visibly damaged sensors  - Use exclusively the socket wrench to install the sensor | 2_17_5.png  **Fig 2.59a** |
| **2.17.6** **EGTS (** **versions with DOC+DPF device - Stage V only** **)**  - Only handle by means of the points marked by  **Y** . - It is forbidden to handle using the points marked by  **N** .  **NOTE:** The sensor includes ceramic material.  - Do not install sensors which suffered impacts or falls.  - Do not install visibly damaged sensors  - Do not install sensors in case of external contamination  - Do not apply any force on the cable or the metal elbow | 2_17_6a.png  **Fig 2.59b**  2_17_6b.png  **Fig 2.59c** |

## Turbocharger

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| **2.18.1 What to do and what not to do**  **What to do:**   * Before assembling the turbocharger, make sure that the protection caps are fitted on all openings of the turbo. * Ensure pre-lubrication of the turbocharger. * Periodically check that the joints are sealed against oil and air. * Use lubricating oil according to the specifications described in [**Par. 2.4**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=55&parent=1000) . * Check the engine oil level. * Before switching it off after it has been used, make the engine run idle, or without a load, for approximately 1 minute. * Ensure that controls and maintenance intervals of the engine are observed as specified in [**Tab. 2.8 and 2.9** .](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=102&parent=1000) * Make sure that the engine and equipment are used correctly so as not to compromise the life of the turbocharger. | **What not to do:**   * Do not store turbocharges in damp, wet places if they are not in their original packaging. * Do not expose the turbocharger to dust and dirt if it is not in its original packaging. * Do not lift of hold the turbocharger from the actuator rod if it is not in its original packaging. * Do not apply additives to the lubricating oil and fuel, unless instructed to do so by Kohler. * Do not increase engine speed, or apply loads, immediately after start-up. * Do not intervene on the actuator settings  **A (Fig. 2.61)** . * Do not let the vehicle / engine run at idle speed for more than 20-30 minutes at a time. |
| **2.18.2 Practical operating rules**  Users can help to maximise the duration of their turbocharger by following the rules described below.   1. **Start-up** Start the engine at idle speed, or without a load, for approximately one minute. Oil operating pressure is reached within a few seconds and enables the moving parts to warm up and be lubricated.     Immediately increasing the engine speed upon start-up means making the turbocharger run at high speed with suboptimal lubrication, which may compromise the life of the turbocharger.   1. **After maintenance or a new installation** Proceed with pre-lubrication by filling new oil into the oil supply duct **B** until filling it completely. Start the engine at idle speed, or without a load, for a few minutes in order to ensure that the oil and bearings system operate satisfactorily. 2. **Low temperature air or engine inactivity** If the engine has been inactive for some time, or the air temperature is very low, start the engine at idle speed or without a load for a few minutes. 3. **Engine shutdown** Before switching the engine off after intense activity, one must allow the turbocharger to cool down. One must therefore let the engine run at idle speed or without a load for at least 2 minutes, thus allowing the turbocharger to cool. 4. **Engine at idle speed** Avoid using the engine at idle speed or without a load for long periods (more than 20-30 minutes). When operating at idle speed or without a load, the turbocharger is at low pressure in the exhaust chamber **C** and air supply **D** ; this may cause oil leaks from seals **E** to the extremity of the shaft. Even if this does not cause damage, it can cause blue smoke from the exhaust when the engine speed and load are increased. | imm2_61.jpg **Fig 2.60**imm2_62.jpg **Fig 2.61** |
| **2.18.3 Before installing a new turbocharger**    Z_importante.jpg **Important**       * Do not lift the turbocharger with one hand from the  box. * Do not lift turbocharger from Comp hsg side. * Lift the turbocharger with both hands from box. * Make sure to use clean gloves. * Handle the turbocharger as indicated in [**Par. 2.17.4.**](https://iservice.lombardini.it/jsp/Template2/manuale.jsp?id=112&parent=1000) | imm2_63.jpg **Fig 2.62** |
| 1. Avoid lifting from the intake side **G** . 2. Remove cap guard **F** and check that there is no excessive shaft axial and radial clearances. | imm2_64.jpg **Fig 2.63** |
| 1. Check for any signs of friction of the turbine on the turbocharger body. 2. Check for any traces of oil leaks on the turbocharger body. 3. After having check everything, reapply cap **F** on intake opening **H** of the turbocharger and do not remove it until assembly has been completed. | 2.65.jpg **Fig 2.64** |
| 1. Check the correct assembly of the capscrews and the presence of paint on them. | imm2_67.jpg **Fig 2.65** |
| **2.18.4 Installation instructions**   1. **Remove the cap guards with care only when assembling.** Handle carefully avoiding erratic movements. | imm2_65.jpg **Fig 2.66** |
| **2.18.5 Replacement instructions**    Always understand the cause of the breakage of the turbocharger before replacing it.    Correct the cause of the breakage before replacing it with a new turbocharger.    If in doubt, contact **KOHLER** service department.    Z_importante.jpg **Important**       * Failure to comply with these instructions can cause damage to the turbocharger and void the warranty. * Modifying the calibration of the turbocharger damages the turbocharger/engine. * Always use the correct gaskets, and fit carefully to avoid blocking holes when mounting. * Refer to the manual of the engine / vehicle, for: the correct type and quantity of oil, the correct tightening of components, instructions and installation. * It is forbidden to use liquid gaskets or sealants, particularly for the oil inlet/outlet. * Avoid dirt / debris while installing the turbocharger. * Before mounting the turbocharger, check that the code of the component is correct for the type of engine, as mounting the wrong turbocharger can damage the turbo / engine and void the warranty. | |

## Balancer device (optional)

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| The balancer device is composed of a special crankshaft that activates 2 additional shafts (balancers).  Rotation of the balancers, which have counterweights that oppose the movement of alternating weights (crankshaft - connecting rods - pistons), reduces vibrations caused by them.    The device is developed under the crankshaft, fixed on the crankcase, closed by the oil sump.  **Tab 2.43**   |  |  | | --- | --- | | **POS.** | **DESCRIPTION** | | 1 | Crankshaft | | 2 | Balancer shaft control gear | | 3 | Balancer shaft support box | | 4 | Conductor balance shaft | | 5 | Conducted balance shaft | | 2.56.jpg **Fig 2.67** |

