

# KDI

## Kohler Direct Injection

### KDI and the Construction, building the future

In preparation for new regulations on emissions that are soon to take effect (final TIER 4, above 19 kW in the US; Stage IIIB, above 37 kW in the EU), Kohler is presenting a new line of KDI (Kohler Direct Injection) diesel engines.

Innovation is the common thread running through the design of this completely new family of engines, which feature highly advanced technology for clean combustion and limited emissions without the use of after-treatment systems, while simultaneously enabling remarkable performance levels to be reached.

The excellent power and torque in relation to the engines' compact size and the absence of particulate abatement systems (such as DPFs) translate into clear advantages for all OEMs who can now replace their current engines with lower-displacement units and, at the same time, enjoy the benefits of reduced fuel consumption and longer maintenance intervals, since no filter regeneration is required.

### WHAT MAKES KDI THE RIGHT ENGINE FOR THE CONSTRUCTION?

#### Engine torque

#### Construction requests

- Highest possible value
- Excellent back-up
- High figure at low rpm

#### Technical solution

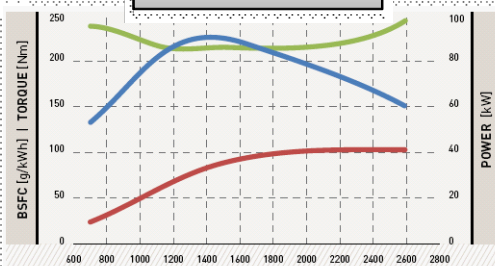
- By combining 4 valves per cylinder, long stroke and vertical injectors combustion and performance were optimised
- In the TCR model performance were enhanced also through a careful turbo matching and 2000 bar injection pressure

#### KDI responses

Model	Max Torque [Nm@rpm]	Low-end Torque [Nm@1000rpm]
KDI 1903M	133@1500	125
KDI 1903TCR	225@1500	190
KDI 2504M	170@1500	165
KDI 2504TM	250@1500	200
KDI 2504TCR	300@1500	260

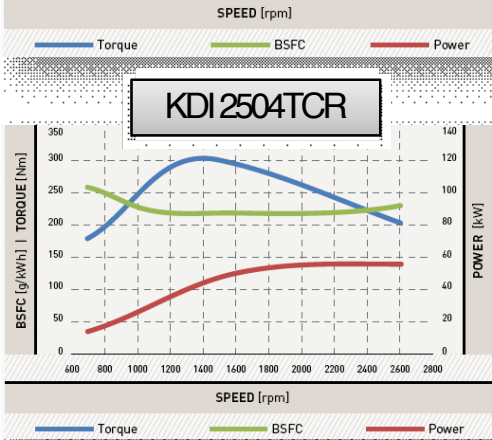
#### Engine torque

#### KDI 1903TCR



Substantial and constant torque back-up in a wide speed range (1000 - 1900 rpm)

Tested on: TELESCOPIC HANDLER



## Auxiliary PTO's performance

### Construction requests

- Options for multiple PTOs
- High torque available
- Limited dimensions of hydraulic pumps

### Our Technical solution

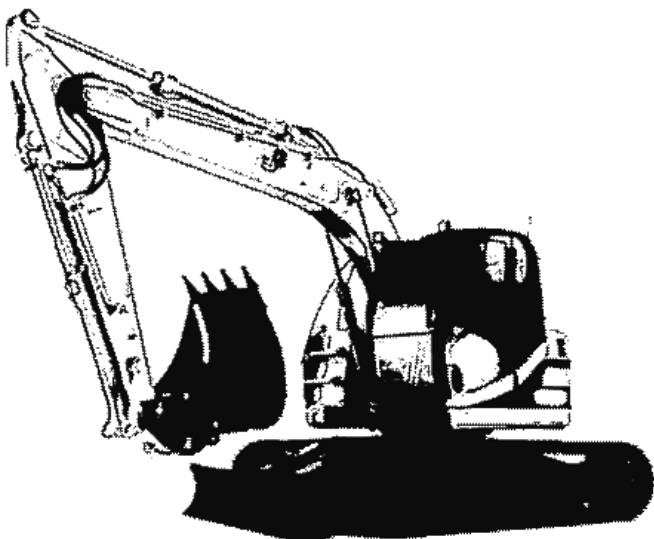
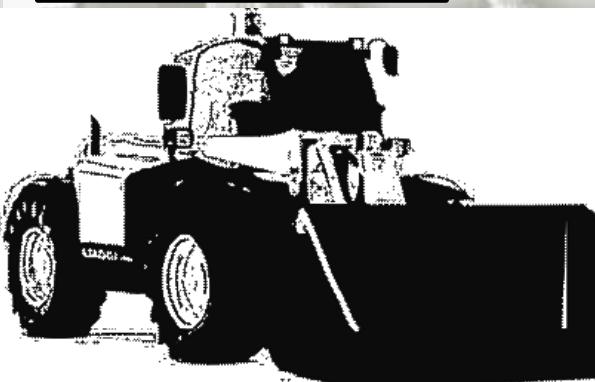
- Design for multiple PTOs
- Robust and efficient mechanical transmission

### KDI responses

- The engine layout features 3 PTOs
- High resistance gear train allows up to 100 Nm as torque take-off
- Engine-to-PTO speed ratio of 1 : 1.2 makes it possible to mount smaller hydraulic pumps for a given power request

## Auxiliary PTO's performance

Tested on: Loading Shovel



## Maintainance intervals

### Construction requests

➤ Extended maintainance intervals (actual benchmark, 37-56kW, for NON Tier 4 Final/STAGE IIIB engines is 500 hrs)

### Our Technical solution

➤ NO DPF required (a particulate filter usually shortens oil change intervals)  
➤ Cylinder liner designed to reduce bore distortion and minimize oil consumption and contamination from diesel fuel  
➤ Honing of cylinder liners realised on latest generation machine tools for the same purpose  
➤ Low oil temperatures as a result of a highly efficient engine cooling definitely limit oil thermal degrading

### KDI responses

➤ Standard oil change interval is 500 hrs, extended up to 750 hrs for specific applications and load profiles (250 hrs more compared to actual TER 3/Stage IIIA engines, up to 350 hrs more compared to the same engines with DPF)  
➤ The absence of a DPF obviously eliminates the need for its replacement, usually every 3.000 hrs

## Fuel economy

### Construction requests

➤ Low fuel consumption (this feature is particularly appreciated for construction machines purchased by rental companies)

### Our Technical solution

➤ NO DPF  
➤ Direct Injection  
➤ 4 valves per cylinder  
➤ Special design of piston rings to minimize friction

### KDI responses

➤ The selected technology without any regeneration process achieves a fuel saving of:  
➤ 5%, comparing the KDI's with electronically injected engines at 1600 bar and DPF  
➤ 10%, comparing the KDI's with mechanical indirect injection engines with stand-alone DPF

## Compact layout

### Construction requests

➤ Minimal overall dimensions (possibility for the OEM to easily replace existing engines, without re-designing or modifying the engine compartment)



### Our Technical solution

- NO bulky DPF
- The KDI engines were designed to stay within the overall dimensions of the main competing models in the range 37-56kW

### KDI responses

Model	Height [mm]	Length [mm]	Width [mm]
KDI 1903M	667.5	598.3	452.5
KDI 1903TCR	715.8	598.3	520.7
KDI 2504M	667.5	704.3	452.5
KDI 2504TM	715.8	704.3	520.7
KDI 2504TCR	718.8	704.3	520.7

## Compact layout

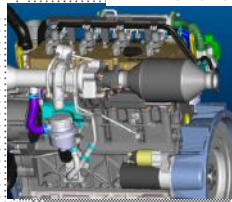
The KDI's do not need any DPF, but only a small size DOC that has the sole constraint of 500 mm as max distance from the exhaust manifold.

Two mounting options are available for connection to the turbocharger:

- Downwards (with a 90° elbow)



- Stra



Tested on: SKID STEER LOADER



## Robustness

### Construction requests

- Long lasting performance
- Robust and reliable structure

### Our Technical solution

- Engine block with bedplate
- Oversized bearings design
- Particularly efficient engine cooling

### KDI responses

➤ The KDI timing system is made by a high strength gear train that does not need any maintenance nor replacement

➤ The KDI engines were tested both at the design stage (simulation) and on the testbeds (development) in conditions that were definitely more severe than in any

### The Range, a new opportunity for the future

The KDI product range is an important opportunity for the future. Two targets have been reached by the development of this new family of engines:

- compliance with emission requirements taking effect in January 2013 (final TIER 4 ; Stage IIIB)
- Extension of the diesel engine line to include power ratings of up to 100 kW

The three models with direct injection, each with a different displacement (1.9L – 2.5L – 3.4L), are available in two different configurations:

- Mechanical injection: compliance with Tier 3/STAGE IIIA emission requirements
- Common Rail injection: compliance with Tier 4/STAGE IIIB emission requirements

Main technical specs	Engine Model				
	KDI 1903M	KDI 1903TCR	KDI 2504M	KDI 2504TM	KDI 2504 TCR
No. of cylinders	3	3	4	4	4
Stroke (mm)	102	102	102	102	102
Bore (mm)	88	88	88	88	88
Displacement [cc]	1861	1861	2482	2482	2482
Power[kW@RPM]	31.0@2800	42.0@2600	<a href="#">36.4@2800</a>	<a href="#">55.4@2800</a>	55.4@2600
Max. torque [Nm@RPM]	133.0@1500	225.0@1500	<a href="#">170.0@1500</a>	230.0@1500	<a href="#">300.0@1500</a>

Main technical specs	Engine Model			
	KDI 3404M	KDI 3404TM	KDI 3404TCR	KDI 3404TCR-SCR
No. of cylinders	4	4	4	4
Stroke (mm)	116	116	116	116
Bore (mm)	96	96	96	96
Displacement [cc]	3357	3357	3357	3357
Power[kW@RPM]	53.0@2600	80.0@2600	<a href="#">55.4@2600</a>	100.0@2400
Max. torque [Nm@RPM]	250.0@1500	400.0@1500	<a href="#">385.0@1400</a>	480.0@1500

Only target data is supplied for the 3.4L model, since the unit is still in the design stage.

Production of the 1.9L and 2.5L models will begin in the fourth quarter of 2012. Production of the 3.4L model is scheduled to begin by the end of 2014.

### About the Global Power Group

Within the Kohler Global Power Group, Kohler Engines and its affiliate Lombardini Srl manufacture gasoline engines (with power ratings of up to 30 kW) and diesel engines (with power ratings of up to 50 kW) that are marketed worldwide under the Kohler and Lombardini brand names.

Kohler Power Systems, SDMO Industries and KOHLER Rental are also part of the Kohler Global Power Group. The first two companies produce generators (for marine, residential, industrial and

portable use) sold around the world under the KOHLER and SDMO brand names. KOHLER Rental, the group's rental business, provides temporary power generators, climate control systems and high level restrooms to the industrial, commercial, disaster recovery and events sectors throughout the U.S. Founded in 1873 in Kohler, Wisconsin USA, Kohler Co. is one of the oldest and largest privately-held companies in the United States. Besides producing engines and generation systems, Kohler is also a world leader in other areas such as plumbing, faucets, ceramics, furnishings, hotel facilities that have won numerous awards, and world-class golf courses.

### About Lombardini and KOHLER

Located in Wisconsin and one of the largest private companies in the United States, Kohler engages in a wide gamut of business activities, from gasoline engines to power generators, from kitchen and bathroom products, to interiors, hospitality, and to golf courses. Lombardini joined the energy division called Global Power Group in 2007. The company is the world's third largest producer of diesel engines up to 50 kW and the leader in its market segment, which has contributed significantly to the growth of the Group. Synergies and integrations have distinguished this mutually beneficial association. Kohler produces and distributes single and two-cylinder gasoline engines with power ratings of up to 30 kW worldwide. On the U.S. market, it is one of the best known names for engines used in numerous applications, especially in the Lawn and Garden sector. Lombardini produces and distributes a line of single and multi-cylinder diesel engines with power ratings of to 50 Kw for equipping machines in a number of sectors (agricultural, industrial, electrical, building construction, automotive and marine).

The strong presence of each company in its respective market (Kohler in the United States and Lombardini in Europe, with four branch business offices in France, Spain, Germany and the UK) combined with the companies' interest in developing markets, are laying the groundwork for the widespread distribution of the product at an international level.

### KDI, "Diesel of the Year" 2012

#### THE KOHLER KDI2504TCR: DIESEL ENGINE OF THE YEAR

The **Kohler KDI 2504TCR** has earned the Diesel of the Year award for 2012 because it succeeded in overcoming the obstacle of the Tier 4 Final/Stage IIIB standard in a totally original way. On a market monopolized by particle filters, the Kohler group came up with a solution that offers low maintenance costs and superior reliability.

Like all engines in the KDI line, the **Kohler KDI 2504TCR** is designed to meet the needs of the final user, who is thus freed from problems associated with the maintenance and inspection of post-treatment systems.

The absence of a particle filter is also a distinct added value for all OEMs that build compact machines, as they can now count on a unit with high power density.

The **Kohler KDI 2504TCR** is revolutionizing the image and the product line of the Kohler/Lombardini Group. Debuting are the common rail system, which had been relegated to automotive units up until now, the EGR system, and direct injection.

With its 55 Kw of power and 300 Nm of maximum torque, the Kohler KDI2504TCR is the *best in class* in the segment of 2.5 liter, 4-cylinder industrial engines.

The DIESEL OF THE YEAR® award is given to the year's most technically innovative diesel engine. The award was introduced in 1986 by DIESEL magazine - the magazine of reference in the world of OEMs. DIESEL explores a full range of subjects associated with the development, production and operation of diesel engines in all industrial and automotive applications. DIESEL magazine devotes an in-depth technical discussion to the winning engine. The winning engine can also use the DIESEL OF THE YEAR® logo in its communication. Participation in the DIESEL OF THE YEAR® award is absolutely free-of-charge.

#### Winners:

2012 Kohler KDI2504TCR

2011 JCB Ecomax

2010 Deutz Tcd 2.9 L4  
2009 Perkins 1206E-E70TTA  
2008 Fpt F 32  
2007 Cummins B3.3  
2006 John Deere PowerTech Plus 6090

Contact : Nino De Giglio  
Lombardini srl  
Via Cav. del Lavoro A.Lombardini, 2  
42124 Reggio Emilia