

KDI

Kohler Direct Injection

Kohler/Lombardini - Ready for 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.

Main Technical Features - Innovating the Future

Fully optimized to meet market demands, the design was developed using the most advanced technology currently available. Clean combustion achieved with a high-pressure (2000 bar) Common Rail system of the latest generation, combined with an electronically triggered EGR valve that makes circulate the right amount of exhaust gases (which are liquid-cooled by a water/air heat exchanger), enables emission levels to comply with the new regulations while providing exceptional performance - and all without the use of after-treatment systems. The added value of KDI and the technology employed to create it result in "Best Comfort" for the user, thanks to the compact size of the engine, and its performance, sturdiness, low levels of vibration and noise emissions, and low operating and maintenance costs.

The Common Rail system:

Kohler/Lombardini have chosen the most advanced common rail system available on the market. It's specifically designed for extreme durability and resistance to the highly severe conditions of operation that are typical of applications in the industrial and building construction sectors. The high pressure pump operates at 2000 bars. This feature, combined with G3S solenoid-type injectors, enables fuel optimization during injection.

4 valves:

The 4 valves per cylinder system used was designed to house the injector in a perfectly vertical position at the very center of the combustion chamber. This solution optimizes fuel filling, atomization and mixing with oxygen in the chamber.

The intake manifold and the combustion chamber were developed with thorough fluid-dynamic (CFD) analysis for maximum combustion efficiency.

Turbocharger and aftercooler:

The waste-gated turbocharger has been specifically tuned to minimize the turbo-lag response and provide the precise volume of air for an excellent low end torque capability. Specific oil control devices also allows for the required lubrication of the turbine shaft for long term durability. The use of a charge air cooler is required to ensure the correct air inlet temperature for the optimal engine performance whilst achieving emissions compliance.

The turbocharger is equipped with special lubrication and oil retention solutions for unmatched durability and reliability over time.

The EGR System:

The exhaust gas recirculation system, which is the product of a painstaking CFD analysis, consists of two cooling stages that optimize heat exchange without increasing overall size. Also, its position on the hot side effectively prevents the EGR valve from jamming, which ensures maximum reliability.

ECU:

The Common Rail injection system and the electronic control unit required for controlling it are both of the latest generation. They were specifically developed for heavy-duty applications in the industrial and building construction sectors.

The control unit provides total control of engine calibration parameters so that required performance and emission levels can be reached. The CAN-BUS system provides a direct communication interface between the engine and the electronic components associated with the specific application.

User Benefits - Creating the Future Together

The absence of after-treatment systems offers countless advantages for both the manufacturer and the user. In fact, thanks to the advanced injection system (with 2000 bar Common Rail, EGR valve and 4 valves per cylinder), no DPF is required. The immediate resulting advantage is reduced external dimensions. KDI is designed to be compact, yet provides great performance (power of up to 23 kW/liter and torque of up to 120 Nm/liter). Also, since no filter regeneration is necessary, fuel consumption is effectively reduced (by 3-5% over a solution with average 1600 bar pressure and DPF, and more than 10% when compared with a solution employing indirect injection and a stand-alone DPF) and the same is true for the consumption of oil. Oil consumption is also influenced by the special smoothing of the cylinders with latest-generation machinery, which reduces friction and thus optimizes oil consumption and raises maintenance intervals to 500 hours, with a resulting gain of from 250 hours (comparing KDI with current engines that do not comply with final TIER IV regulations) to 350 hours (considering the oil consumption of these engines with DPF). Also, maintenance intervals are not adversely affected by the need to replace the particulate abatement filter (which has an estimated service life of 3000 hours).

The cooling of recirculated exhaust gasses with resulting abatement of NOx is not only due to the location of the EGR valve on the hot side, but is particularly produced by the special path that circulating air takes

through the two cooling stages. Also, the special geometric layout of the intake manifold leads to uniform mixing of air in each cylinder, which equally distributes the NOx abatement obtained in the previous stage.

Precise, meticulous NVH (Noise – Vibration – Harshness) analysis, combined with the bedplate architecture design concept (i.e., crankcase assembly is obtained by joining the crankcase and the bed plate) makes the engine more rigid and thus more solid, for reduced noise and vibration.

The auxiliary power take-offs are designed and located to deliver the highest possible percentage of engine power. They also allow two hydraulic pumps to be installed in tandem. What’s more, the PTO turn ratio (1:1.2) allows the use of smaller hydraulic pumps with the same power.

The Product Range - New Opportunities 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	36.4@2800	55.4@2800	55.4@2600
Max. torque [Nm@RPM]	133.0@1500	225.0@1500	170.0@1500	230.0@1500	300.0@1500

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.

The triumph of “Made in Italy” - Believing in the Future

Designed in Reggio Emilia - the historic home of the Research & Development Centre named after Franco Lombardini - the KDI engine was developed using a multipurpose platform that covered all company processes, from purchasing to the assembly lines, from design to application engineering. 25 specialists, including engineers and designers, designed and perfected the engine in the record time of 24 months.

The major investment made by the Kohler Co. will enable the Reggio Emilia-based company to ensure its future success exploiting its own resources, as the new engines will be produced in Reggio Emilia.

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.

Promoting the Future

Innovation also lies at the heart of the publicity system used to promote the new KDI family.

Advanced design, the use of easily recognizable colors (black and bronze) and social media, along with an international "Press Conference", are helping to renew the image of the two companies (KOHLER/Lombardini), which have been producing engines for over 80 years.

A dedicated website www.kohlernewproject.com allowed people to view the presentation of the new line on October 25, 2011 at the Reggio Emilia factory (the engine production facility).

For the first time ever, a Lombardini event could be followed over the Web, thanks to a live streaming service.

All promotional material on the new engine, including the “product presentation”, will remain available at www.kohlernewproject.com.

Always ready to experiment with innovative products and communication, Kohler has developed a veritable social media strategy that exclusively employs *relationship marketing* to launch the brand in Europe.

The goal is to establish a direct, interactive and emotional contact with its target group, in order to understand and satisfy their needs (<http://www.facebook.com/#!/lombardinigroup>).

KDI will be on display at the following trade fairs:

- GIE (Louisville, 27-29 October, 2011)
- BATIMAT (Paris, 7-12 November, 2011) – Hall 4/Stand D111
- AGRITECHNICA (Hannover, 13-19 November, 2011) Hall 25/Stand J22
- WOC (Las Vegas, 24-27 January, 2012)
- ARA (New Orleans, 6-8 February, 2012)
- HIRE SHOW (Coventry, 8-9 February)
- FIMA (Zaragoza, 14-18 February)
- GOLF (Las Vegas, 29 February – 1 March, 2012)
- INTERMAT (Paris, 16-21 April)
- GALABAU (Nuremberg, 12-15 September)
- EIMA (Bologna, 10-14 November)

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