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## KDI, The Game Changer

*Right from its introduction to the market, the new KDI range of engines from KOHLER became a technological standard of reference within the 30kW to 100kW power range showcasing its ability to offer a clear, effective, and functional response to a demand that is increasingly oriented towards compact engines. Thanks to the high power density, low fuel consumption and smooth yet uniform delivery of power throughout the RPM range, KDI engines ensure maximum productivity and offer an approach to limiting emissions that is effective yet easy to manage from the technical standpoint whilst requiring limited maintenance.*

### KOHLER DIESEL KDI, an answer for every need

Available in a number of different models and power ratings, compliant with the Tier 4 Final – Stage IV standards (56-100 kW power output range), packed with cutting edge technologies and power delivery equivalent to that of larger displacement engines (100 kW @ 2200 rpm and 500 Nm @ 1400 rpm), the KDI range offers excellent performance features that translate into concrete operational benefits for end users.

From a technological standpoint, the exceptional features of the KDI range are based on the use of high-pressure common rail injection system (2000 bar) of the latest generation combined with G3S solenoid-type injectors aimed at precise fuel metering during the injection process. An electronically controlled EGR valve is included for recirculating the right amount of exhaust gasses that are liquid-cooled by a water/air heat exchanger. The EGR system consists of two cooling stages that make it possible to optimise heat exchange without increasing external dimensions. In addition, the system is installed on the hot side, which prevents the EGR valve from seizing, therefore guaranteeing the maximum reliability. The valve train incorporates an architecture with four valves per cylinder, designed to house the injector in a perfectly vertical position and in the very centre of the combustion chamber. In this way, the cylinder is filled with the exact amount of fuel which is atomised and mixed with air in the best way possible.

GENERAL TECHNICAL DATA				
Model	KDI 1903TCR	KDI 2504TCR	KDI 1903M	KDI 2504m
Thermodynamic cycle	Diesel 4 stroke	Diesel 4 stroke	Diesel 4 stroke	Diesel 4 stroke
Air intake	TCA	TCA	NA	NA
Arrangement	In line 4 cylinder	In line 4 cylinder	In line 4 cylinder	In line 4 cylinder
Swept volume [cm <sup>3</sup> ]	1861	2482	1861	2482
Fuel injection system	DI Common Rail	DI Common Rail	DI Mech Rotary pump	DI Mech Rotary pump
Valves per cylinder	4	4	4	4
Cooling	Liquid	Liquid	Liquid	Liquid
Max Power [kW@rpm]	42@2400	55.4@2400	31@2600	36.4@2600
Peak torque [Nm@rpm]	225@1500	300@1400	133@1400	170@1400
After-treatment device	DOC	DOC	-	-
Emission compliance	Stage IIIB - Tier 4 Final	Stage IIIB - Tier 4 Final	Stage III A	Stage III A

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GENERAL TECHNICAL DATA				
Model	KDI 3404TCR - (55.4kW)	KDI 3404TCR-SCR (75kW)	KDI 3404TCR-SCR (90kW)	KDI 3404TCR-SCR (100kW)
Thermodynamic cycle	Diesel 4 stroke	Diesel 4 stroke	Diesel 4 stroke	Diesel 4 stroke
Air intake	TCA	TCA	TCA	TCA
Arrangement	In line 4 cylinder	In line 4 cylinder	In line 4 cylinder	In line 4 cylinder
Swept volume [cm <sup>3</sup> ]	3359	3359	3359	3359
Fuel injection system	DI Common Rail	DI Common Rail	DI Common Rail	DI Common Rail
Valves per cylinder	4	4	4	4
Cooling	Liquid	Liquid	Liquid	Liquid
Max Power [kW@rpm]	55.4@2200	75@2200	90@2200	100@2200
Peak torque [Nm@rpm]	375@1400	475@1400	480@1400	500@1400
After-treatment device	DCC	SCR	SCR	SCR
Emission compliance	Stage IIIB - Tier 4 Final	Stage IV - Tier 4 Final	Stage IV - Tier 4 Final	Stage IV - Tier 4 Final

The construction solutions devised by KOHLER Engines have made it possible to lower the fuel consumption of KDI engines by more than 10% compared to other engines within the same category. In addition, with their high torque output idle at (412 Nm @ 1000 rpm) and excellent specific performance (torque and power), KDI engines maximise the productivity of the machines they power and instantly respond to load even at low rpms. With these superior characteristics and perfect integration of the turbocharger and its electronic control system, KDI engines reach a level that is nothing short of exceptional. Also worth mentioning is the narrow profile that minimises the steering radius for better handling, a feature that is particularly useful in agricultural applications.

However, the benefits of the KDI engines do not stop here. Their compact size, as an example, facilitates the installation process and provides excellent versatility in application also thanks to the four power take-offs with two additional PTOs at each side (SAE A and SAE B) that supplement the main and secondary PTOs, designed and positioned to draw the greatest amount of power from the engine.

The best-in-class features of the KDI range are based on excellent power density (30 kW/l) and torque output up to 500 Nm at 1400 RPM with torque density equivalent to 149 Nm/l, which translates into an excellent transient response, high power availability at low engine speeds, and an increase of up to 15% in machine productivity.

Added to this are low operating costs and easy maintenance at intervals of 500 hours thanks to the clean combustion that does not require a DPF. The absence of the DPF means that less space is required in any application and that productivity is enhanced as operation never has to be interrupted to regenerate the filter. What's more, no costly thermal protection is necessary for preventing excessive

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heat loss and the consequent risk of fire. The result is that the machines are compact and easy to handle and the operator enjoys better visibility, which enhances safety and improves productivity.

Driving is exceptionally comfortable, guaranteed by minimum levels of noise and vibration thanks to the use of bedplate architecture (crankcase + bedplate) for the engine block, and the (optional) counter-rotating shafts it contains.

## STAGE V FEVER, the vision of KOHLER Engines

Once again, KOHLER Engines is committed to delivering state of the art solutions to our customers globally by following our inspiring guiding principle “to be on the leading edge of technology and innovation”.

By 2019, the new generation of the KDI Engines platform will see the integration of the Diesel Particle Filter to meet Stage V emission requirements. Our Engineering teams are actively developing a state of the art compact after-treatment solution that will leverage the latest DPF technology and experience. The solution will be based on a passive regeneration approach and will be transparent to OEMs and end users. Passive regeneration is a continuous process that allows the DPF to perform as intended without the need to raise the temperature.

This enables:

- Optimized solutions under all operating conditions
- Easy maintenance
- Long service intervals
- No impact on engine performance or machine productivity

With our Stage V solution, our KDI platform will maintain best in class performance and a low cost of ownership. The new generation of KDI Engines will be unveiled at AGRITECHNICA 2017.

Stay tuned!

## Checkmate! KDI, a winning solution

*The success enjoyed by the KOHLER Engines KDI range is clearly demonstrated by the large number of applications present in the market and the confidence in our products shown by numerous top-tier brands in the world of construction and beyond.*

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The KOHLER Engines KDI range has rapidly made its mark on the market, thanks to the innovative construction technology and the flexibility of the production, features that translate into solid benefits for OEMs and end users alike.

This success is demonstrated by the many OEMs that have chosen KDI engines for their applications, many of which will be exhibiting at BAUMA 2016. These include: Avant Tecno, Bruno Generators, Bugnot Broyeurs, Elentek srl, Fiori Group, Green Power Systems, Haulotte Group, Kramer-Werke, Idrofoglia, Inmesol, JaNo, JCB, MDB srl, MultiOne (CSF), Omac, SDMO Industries, Varisco, Vietz, and Zeck.

We asked a few of these OEMs to describe their experience with KOHLER Engines and to explain why they chose KDI engines and the benefits obtained for their customers.

**Haulotte Group**, a French company that is a world leader in the **manufacture of aerial platforms and telehandlers**, chose the KDI 3404 in the 55 kW calibration for two of its most successful telehandlers, the HTL 4014 and the HTL 4017, designed for markets subject to the Stage IV/Tier 4 Final standards. As explained by **Vincent Mazzoleni**, Telehandlers Business Unit Manager, *"We were looking for an engine that, in addition to using emissions reduction technology that does not involve the use of DPF and SCR, would provide the same torque delivery of the Tier 3 engines we were using previously."*

Why did you choose KDI engines? *"First of all for their compliance with the requirements I mentioned, that is, no particulate filter or SCR and torque values in line with our expectations. Added to these elements were an engineering timeframe that was consistent with our programme and no less important, a competitive cost point."* What benefits have you gained by using KDI engines? *"This choice allowed us to obtain a solid competitive advantage, as we were the first manufacturers of telescopic handlers to introduce on the market machines in the over-10 metre segment equipped with Tier 4 Final engines."* What aspects of your relationship with KOHLER have been the most satisfying? *"Without a doubt the close collaboration between our team of designers and the KOHLER Engines technicians, which enabled us to respect the established engineering times, and the proactive support provided by KOHLER".*

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## Why did HAULOTTE choose KDI?

The KDI 3404 offers a SMART AFTER-TREATMENT System.

The entire range of KDI engines uses only DOC to comply with the current regulations for under 56 kW. This allows manufacturers to produce machines with compact engine compartments, increasing operator visibility and therefore enhancing safety and productivity. With this system, the external dimensions are reduced and the work cycle is not interrupted, consequently increasing productivity. In addition, it is not necessary to shield the machines to prevent excessive heat loss and the consequent risk of fire. In configurations above 56 kW, the KDI 3404 engine complies with Stage IV - Tier 4 Final emissions standards thanks to the use of SCR (Selective Catalyst Reduction) to abate the NOx in the exhaust gasses. The special SCR solution chosen by KOHLER Engines helps to underscore the "best fit" philosophy. The "all in one" SCR system contains the DOC (Diesel Oxidation Catalyst), the MIXING Pipe and the SCR in a single piece of equipment. The extremely compact footprint of the whole system and the possibility to fit it at any angle greatly simplifies its integration with the machine.

**Fiori Group** is an Italian company operating at the international level that designs, develops, and produces off-road vehicles for concrete production. For its DB line of mid-segment concrete mixers with capacity up to 2.5 m<sup>3</sup>, Fiori chose the KDI 2504TCR in the 56 kW calibration. The excellent results obtained led the company to extend the use of KDI engines, in the 90 kW calibration (KDI 3404TCR-SCR), to its high-end solutions with capacity of 4 or 5 m<sup>3</sup>.

*"The characteristics and performance features we were looking for when considering the use of new engines on our products," affirms **Enrico Santini**, Managing Director of Fiori Group, "were focussed primarily on interchangeability with other engine versions in order to be able to use a single platform for the entire world market."*

*Why did you choose KDI engines? "Essentially for the emissions management system employed, which allows the versions with power greater than 56 kW to pass from the Stage IIIB/Tier 4 Interim to the Stage IV/Tier 4 Final and therefore to the subsequent stages in view of 'Stage V Built' by simply taking certain measures as regards the layout."*

*What benefits have you had by using KDI engines? "Alongside an excellent price/performance ratio, the easy interchangeability of other models already used, aimed at markets that have less restrictive emissions regulations."*

*What aspects of your relationship with KOHLER have been the most satisfying? "Without a doubt the collaboration we had in the product engineering phase, which turned out to be a determining factor in the*

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*development of these engines, whose installation on-board operating machines is decidedly challenging, alongside the willingness to produce variants and customisations for any size of supply."*

## **Why did Fiori Group choose KDI?**

The "Stage V Built" philosophy.

The KDI 3404TCR-SCR model is Stage V Ready. The innovative and compact "all in one" SCR system, is in fact designed to accommodate the DPF, currently the only technical solution capable of meeting the requirements for the particle numbering as proposed by the European Commission.

In the KOHLER Engines engineering layout, the "all in one" module will simply have to be replaced with a new module of exactly the same size as the previous one. This solution means that customers will not have to make any changes to their application.

The DPF adopted will be small and its use will benefit the already clean combustion thanks to the current injection system. This will consequently have a lower number of regenerations than any other DPF while maintaining high levels of productivity.

A brand known throughout the world for its wide range of pumps used in construction, civil engineering, and fire-fighting, the Italian company **Varisco Pompe** chose the new KDIs to equip their two families of motor pumps Super J and Albatross, which currently use the entire range of KDI engines with 1.9L and 2.5L displacement in both the mechanical and common rail versions with calibrations and delivery curves customised for this type of use. *"For these two product lines, and in particular the line of silenced canopy pumps,"* states **Massimo Scapolo**, Vice President Sales & Marketing of Varisco Pompe, *"we were looking for engines featuring technologically advanced architecture and high performance but that would also offer power delivery suitable for our needs, and naturally water-cooled engines, given our installation requirements."*

Why did you choose KDI engines? *"After seeing on paper the requisites we needed in terms of efficiency and consumption as well as the design layout, in particular the absence of the DPF, we conducted a series of tests to check their behaviour in the field. The results were more than positive, confirming that we had made a good choice. Also the extensive KOHLER service network carried a lot of weight in our final decision."* What benefits have you had by using KDI engines? *"Without a doubt, excellent performance under the operating conditions typical of our products, with clearly advantageous fuel consumption compared to the solutions we had used in the past, as well as great versatility in the operating powers we chose."*

What aspects of your relationship with KOHLER have been the most satisfying? *"The outstanding availability of the technical staff, both during the product engineering phase and in the calibration of the delivery curves most suitable to our specific uses."*

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## Why did VARISCO choose KDI?

KDI engines show fuel consumption rates much lower than engines in the same segment, with performance features equivalent to those of larger displacement engines thanks to an advanced injection system (common rail 2000 bar, EGR valve, and four valves per cylinder) and the absence of a DPF.

Thanks to the high torque output at idle, machine productivity is maximised and the engine immediately responds to load even at low speeds. This means productivity increased by 15% compared to the engines of the competition.

**JCB**, a world leader in the production of construction machinery and equipment, chose Kohler KDI engines for their many lines of compact machines, including Mini and Midi Excavators, Skid Steer Loaders, Telescopic Handlers, and Teletruk. The engines fitted on these machines are branded JCB Diesel by Kohler, underscoring the strong partnership established between the two companies in this operation.

The Kohler KDI engines chosen by JCB – the KDI 1903TCR, KDI 2504M and KDI 2504TCR models – use a common rail injection system at 2000 bar, exhaust gas recirculation (EGR), four valves per cylinder, and a diesel oxidation catalyst (DOC) inside the exhaust system.

Why did you choose KDI engines? "The decision to collaborate with Kohler Engines to use their engines for our compact JCB machines," explains Alan Tolley, JCB's Director of Engine Programmes, "was guided by the synergy between the technologies used by both JCB and Kohler to reach the thresholds established by the regulations. These compact engines meet the strict EU Stage IIIB and EPA Tier 4 Final standards for exhaust gas emissions without using a DPF. This is perfectly in line with JCB's wide-ranging engine strategy."

What do you appreciate most about your relationship with Kohler? "First of all, the shared design philosophy adhered to by both companies to comply with the limits established by the current emissions regulations. These characteristics make it an ideal solution for the JCB lines of machines."

## Why did JCB choose KDI?

KDI engines offer "best in class performance":

- ✓ Specific Power: 30kW/l
- ✓ Specific Torque: 150 Nm/l
- ✓ Torque at idle: 410Nm@1000rpm
- ✓ Torque reserve: up to 50%

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## ✓ Excellent transient response

These characteristics enable OEMs in their designs to replace larger displacement engines with a model with considerably smaller external dimensions and consequently to reduce fuel consumption without necessarily having to redesign the application. In the case of new machines, the manufacturer can design smaller engine compartments, which increases operator visibility and thus enhances productivity and safety.

In addition, the excellent performance at low rpms increases productivity and contributes to reducing fuel consumption by up to 10% compared to the engines of the competition.

Operating in the market since 1966, the French company **SDMO** is now one of the major world manufacturers of generating sets with power ranging from 1 to 3300 kVA, from small portable models to large industrial and cogeneration units. The company uses the KDI models 1903M, 2504M, 2504TM and 3404TM for its range of industrial gensets from 20 to 60 kVA (Models: K22, K27, K33, K44 and soon K66, as well as for the R22, R33 and R44 models designed for the rental market). *"We were looking for an engine solution that could satisfy the requirements of size, durability, efficient response under load, and low consumption that are essential for our applications,"* underlines **Philippe Forest**, Communication Manager of SDMO.

Why did you choose KDI engines? *"What oriented us towards the KOHLER Engines KDI range was mainly their innovative design layout and outstanding reliability, naturally along with the ability of KOHLER engines to satisfy the typical needs of our applications in terms of engineering, operating economy, and service life."*

What benefits have you had by using KDI engines? *"As regards the gensets in our industrial range, the characteristics of the KDIs allowed us to produce soundproofed 22 and 27 kVA cabinet models in a particularly compact size, thanks to which the number of units that can be housed in a standard 40-foot container is almost doubled, considerably reducing transport costs."*

What aspects of your relationship with KOHLER have been the most satisfying? *"Without a doubt the outstanding availability demonstrated by KOHLER Engines in the phase of product development and engineering, as well as the prompt technical support provided by the company."*

## Why did SDMO choose KDI?

KOHLER Engines offers a complete range for the low- and medium-power generator sector, covering a range of 20 to 60 KVA at 50 HZ (1500 rpm) and 20 to 70 KVA at 60 HZ (1800 rpm), respectively.

The main feature of the new Power Unit range offered by KOHLER Engines is the highly innovative layout, the result of a design philosophy that makes it unique on the market and offers end users

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significant benefits in terms of operation. It also provides important benefits for OEMs in terms of manufacturing and logistics, in that the generator dimensions, for the same power output, can be reduced by 15% to 30% compared to the typical dimensions (with significant effects on both production and transport costs, thanks to the fact that a larger number of units can be transported in the same size space).

In addition, more efficient combustion decreases the heat released by the engine, with a consequent reduction in cooling requirements. This allows the radiator and fan size to be reduced, so that the engine can be installed in even smaller units.

Since 1991 the Finnish company **Avant Tecno** has designed and produced multi-functional loaders designed to operate in the most diverse contexts thanks to the possibility to use a series of more than 100 different attachments. For one of their most successful models, the Avant 760i, the company chose to use the KDI 1903TCR, an engine that complies with the Stage IV/Tier 4 Final standards, thus allowing the machine to be sold on both the American market and the Northern European market, the main commercial outlet of Avant Tecno. *"We were looking for an engine that complied with the Tier 4 final standard,"* explains **Jani Käkelä**, owner of Avant Tecno, *"but at the same time it had to be compact to facilitate its installation on the machine and above all it had to offer performance features that would allow our machine to be operated easily with loads up to 2.5 tons."* Why did you choose KDI engines? *"The KDI engine was the right compromise between all our needs. It's compact, because it has an injection system that enables a relatively small displacement engine (1.9 litres) to reach a power of 42 kW and does not need a DPF in order to meet the Tier 4 Final standards, but it also has a design tailored to the needs of OEMs. The positioning of the PTOs, for example, makes it possible to draw power from different points, thus achieving optimal machine-engine integration. Also, the high torque at low rpms reduces fuel consumption and lessens acoustic emissions, a consideration that turned out to be crucial for us since our machines are used on construction sites for public works maintenance in cities like Helsinki, so the reduced noise is a feature that is highly appreciated by our customers."* What benefits have you had by using KDI engines? *"Certainly the low fuel consumption as well as, I mentioned, the reduced noise. But I think that those who operate our machines also greatly appreciate the ready response to load variations."* What aspects of your relationship with KOHLER have been the most satisfying? *"Working with KOHLER Engines was certainly important during the machine design phase, especially in the engineering phase of the engine inside a machine that was already in our product portfolio. The technical office in Reggio Emilia worked with us directly, approving each step of the development of the control unit so as to guarantee that the engine would respond to the particular needs of its use."*

## Why did AVANT TECNO choose KDI?

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The KDI range of engines has become the benchmark in its category thanks to the reduced noise and vibrations and the absence of visible exhaust smoke.

The bedplate architecture (crankcase + bedplate) used for the engine block and the counter-rotating shafts contained within it also guarantee the lowest levels of vibration and noise.

Application versatility is guaranteed by the presence of two auxiliary power take-offs (PTO) on each side (SAE A and SAE B) designed to draw the greatest amount of power from the engine and enable perfect integration with the machine's hydraulic system, also reducing the implementation space needed for the application.

A company belonging to the Solano group, **Inmesol** of Spain has operated since 1989 in the sector of power generation with five product ranges – Portable, Industrial, Stand-by, Rental, and Heavy-duty generator sets and tower light – designed for a wide range of applications. For the rental segment, Inmesol uses the KDI 1903M, 2504M, 2504TM, and 3404TM models, an application in which KOHLER engines are especially appreciated for both their performance features and competitiveness compared to other solutions available in the market. *"The expectations our customers have in regard to Inmesol products," mentions **Antonio Marmol**, Inmesol Rental Product Manager, "and consequently the guidelines that we follow in designing our generators, are focussed mainly on reliability, low fuel consumption, and efficient after-sales service, all within a product having the best price/quality ratio possible." Why did you choose KDI engines? "The presence of KOHLER Stage 3A engines in our generators has given a strong impetus to our sales, becoming a real added value that is rewarded by the market. Consequently, this has led us to consolidate and expand our business relationship." What benefits have you had by using KDI engines? "We have found KDI engines to be a sturdy and reliable solution, easy to install and with a simple and linear architecture despite their high level of technology and full compliance with Stage IIIA." What aspects of your relationship with KOHLER have been the most satisfying? "The effectiveness of the technical support, the comprehensive documentation, and the efficient after-sales service are without a doubt the most positive aspects of our relationship with KOHLER."*

## Why did INMESOL choose KDI?

The KDI Power Unit range of engines developed by KOHLER Engines for the power generation market represents a ready-to-use, versatile, and high-efficiency solution for both end users and OEMs.

The KDI Power Unit is a "plug & play" solution that represents an effective response for generator manufacturers seeking a complete, high-performance drive system that can be easily implemented in their product range thanks to the availability of a package of standard components and accessories.

The specific concept of the engines in the KOHLER Engines Power Unit range, along with features such as the more rigid engine block and optimised internal components, also made it possible to significantly reduce the operating noise. This is another important advantage for manufacturers, who can therefore limit the use of soundproofing materials to the benefit of the overall dimensions, and for end users, who can rely on more quiet operation.

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The outstanding reliability of the KOHLER Engines KDI series, designed for a service life of up to 10,000 hours and with operating intervals that can reach 1000 hours, makes the Power Unit range of engines an exceptionally high-performance solution with low operating costs.

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KOHLER Engines, a world leader in the production of diesel and petrol engines, offers a complete range of products up to 100 kW.

With headquarters in KOHLER, WI (USA), KOHLER Engines offers a global presence with its 4 Regional Headquarters (KOHLER – USA, Reggio Emilia – Italy, Shanghai – China, Aurangabad – India); 7 production plants (Reggio Emilia – Italy, Rieti – Italy, Martin – Slovakia, Aurangabad – India, KOHLER – USA, Hattiesburg - USA, Chongqing, Yinxiang – China); 5 commercial branches (Lyons – France, Barcelona – Spain, Oxford – UK, Frankfurt – Germany, Singapore) and more than 1700 points of service including distributors, sales and service centres for engines and spare parts present throughout the world.