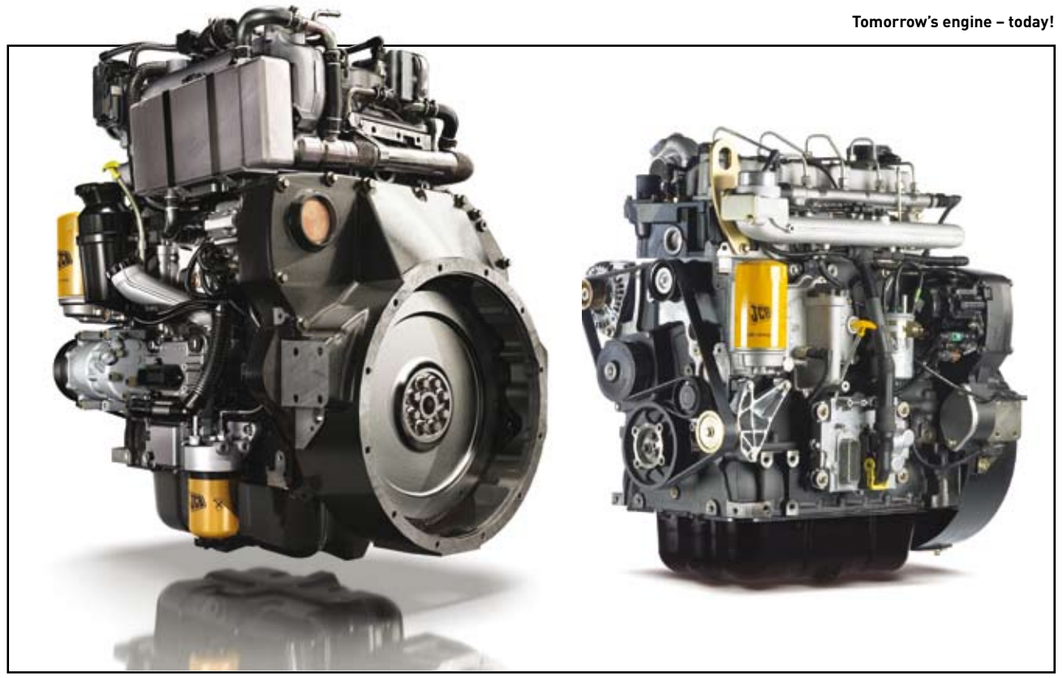
TAKE IT TO THE MAX

HARNESSING ADVANCED TECHNOLOGY AND DRAWING UPON SOME OF THE LATEST INTERNATIONAL THINKING, ONE OF THE NEWEST ENGINE RANGES TO HIT THE OFF-HIGHWAY SCENE IS A SOPHISTICATED SUITE OF POWER SYSTEMS THAT WILL BOOST PERFORMANCE ACROSS A WIDE RANGE OF VEHICLES

JCB EcoMax high-efficiency combustion system



Tomorrow's engine – today!

JCB is a globally recognised name that is synonymous with quality. With a reputation for reliability, the company has a proud history and strong heritage of engineering excellence. The company's major investment in its engine range, which includes the JCB Power Systems purpose-built, multi-million-pound manufacturing plant and assembly line, is the biggest it has ever committed to a single programme; proof if needed of a single-minded dedication to producing the perfect engine.

Working with leading component and equipment suppliers, JCB uses proven technology and puts all its prototypes through an uncompromisingly tough testing process. The company operates on an innovative 'no faults forward' system, whereby an engine cannot proceed to the next manufacturing stage until the previous one has been perfected. It develops its engines from scratch, priding itself on its 'blank sheet of paper' approach – rather than attempting to update inferior models, JCB has created its engines though significant research and development to ensure it is producing the best technology possible.

The company has recently also made a further investment to fulfil incoming industry emissions standards. Part of this considerable investment has been into a new R&D centre. This includes 10 advance test cells and equipment for its low emissions engines. Each of these is capable of carrying out the full EU transient test cycle needed to meet Stage IIIB and Tier 4i legislation and can handle engines of up to 300kW.

To support and complement the investment in new technology, JCB Power Systems has also expanded its research and development team by 40%. By adding this new layer of expertise to its already-strong team, the company is emphasising its commitment to future projects and strengthening its impressive credentials as a world leader in the industry.

Deceptively simple

Aimed specifically at mid-range off-highway equipment, JCB's DieselMax engine range is a deceptively simple design that offers a powerfully dependable performance. Designed from scratch to deliver exceptional functionality, it combines high power and high torque at low revs with low emissions and low noise. In developing the design, the company was careful to consider future exhaust emissions legislation as well as the needs of its customers. The result is a product that delivers performance, reliability and in-field serviceability.

Initially developed in 2004, the DieselMax engine became famous when it powered the JCB DieselMax car to break the world diesel landspeed record, reaching 350mph on the Bonneville Salt Flats (see box, overleaf). Since then, it has undergone continual developments and there are now around 150,000 DieselMax engines operating worldwide.

The engines were built to comply with Tier 2/Stage II, Tier 3/Stage III and finally Tier 4/Stage IV requirements. The advanced combustion systems will therefore only need minimal installation changes over the next decade, making the engine a wise and cost-effective investment.

The engine offers a series of ratings from 55.3-120kW (74-161hp), to tackle all types of mid-range application, and is available as a 4.4- or 4.8-litre unit. With increased power at lower engine speeds (compared with similar-sized engines), it also offers the opportunity to power hydraulic pumps and other devices from the side of the engine.

All JCB DieselMax engines are designed to be robust beyond compare, offering strength and durability to easily withstand extreme conditions and workloads. The block, bedplate and cylinder head have been designed as hardwearing structures with great reserves of strength, with added strength provided by heavy-duty geartrains and cast-iron housings. Huge workloads are taken in their stride too, due to the large crankshaft dimensions.

Extreme efficiency

Reliability is a must for any company choosing to make an investment in an engine. JCB pays particular attention to the longevity of its systems, using parts and components with proven durability and introducing processes to increase the system's overall reliability.

Robust structures keep the moving parts flowing smoothly throughout the engine's life, while superior sealing technologies prevent any fluid leaks. An auto-tensioned vee belt offers service-free reliability, and optimum efficiency can be achieved by gaining high outputs when operating at the lower ratings. Low-pressure fuel systems are design to protect the core engine, and its components, from operating life issues – these have been tested in some of the toughest operating territories in the world.

Noise and vibration reduction was another key focus when designing the DieselMax series. All types are low noise – 89dB(A) at 1m max – with a built-in rigid bedplate to keep noise and vibration to a minimum, and a rear geartrain to act as a further noise inhibitor. There is no metal-to-metal contact between engine and covers and a laminar steel oilpan has a cushioning effect to diminish sound. All of this has the desirable effect of making the vehicle more comfortable to operate.

High torques at low revs also help to power the engines more effectively. The advanced combustion system offers an efficient burn with low emissions, while four valves per cylinder offer improved breathing. Meanwhile, carefully matched fuel and turbo systems give an improved performance throughout the speed and load range.

Clean machines

The latest generation of the JCB DieselMax engine suite is due to go into

production in 2012 following a rigorous round of in-field testing. The EcoMax T4 4.4-litre engine is destined to become the cleanest engine in the off-highway sector, and has been designed to comply with incoming emissions legislation.

Representing an £80million investment from JCB, the engine boasts a revolutionary solution which eliminates the need for any exhaust aftertreatment, delivering notable cost savings for users.

Alan Tolley, JCB's Director of Engine Programmes, says: "Meeting Tier 4 emissions legislation is a massive challenge but also a huge opportunity for innovation; an opportunity to come up with a solution that has real advantages for our customers. We believe the result is not only the off-highway sector's cleanest engine, but a first for our industry.

"The expectation for the first part of Tier 4i/Stage IIIB legislation was that to achieve these really low particulate levels you needed to fit a Diesel Particulate Filter (DPF). But when you look at that technology for our particular part of the market, namely mid-range construction equipment, we see there are some real disadvantages with that solution, in particular increased fuel consumption through increased backpressure to the engine. Also, in many applications load cycles are light and the DPF doesn't self-regenerate so you have to force it to do so and it needs fuel to do it."

JCB therefore decided to meet the Tier 4i emissions standards without a DPF but also without any exhaust aftertreatment. The massive R&D investment has paid off, with efforts successfully focusing on developing a high-efficiency combustion system. This basically involves not creating the pollutants at all, rather than trying to deal with them at a later stage. Using this approach, the company was also able to achieve extremely low fuel consumption levels.

"The solution we have come up with gives considerable advantages for our customers for packaging and integration," Tolley adds. "There is little spare room in an engine compartment, so we had a lot of discussion about how to optimise the machines, their design and functionality. The risk with Tier 4 is that you have to compromise those elements in order to package everything – we weren't willing to do that, which drove us to pursue a different technology solution. One of the advantages we have as a company that makes both machines and engines is that we can come up with a final machine product that is better optimised."

The world's fastest diesel

The JCB DieselMax shot to fame when it was used to set the landspeed record for diesel-powered cars in 2006. The attempt at the record was initiated by JCB chairman Sir Anthony Bamford, who wanted to showcase the extreme performance capability of the JCB engine, more often used to power off-highway equipment for construction, agricultural, industrial and power-generation applications.

The record-breaking JCB444-LSR engine displaces 5-litres, weighs 382kg (dry), and produces 750bhp at 3,800rpm and in excess of 1,500Nm of torque at 2,500 rpm. Two engines were used to set the new record at Bonneville Salt Flats, Utah, USA, with a total power output of 1,500bhp. The engine proved its merit by powering a magnificent 350.092mph (563.418kph), a landspeed record for diesel-powered cars.

Reduced costs and fuel consumption

Customers can look forward to reduced costs throughout ownership, as well as increased reliability and lower fuel consumption (tests demonstrate that the Tier 4 engines operate on around 5-10% lower fuel consumption than their predecessors). There is no need to fit a costly exhaust aftertreatment system, while there has been no requirement to increase the cooling pack size or to reduce service intervals from their standard 500 hours. The engine design is also future-proofed as the structural architecture, the componentry and systems will remain the same for Stage IV/Tier 4 Final regulations in the future.

JCB Power Systems worked alongside research and development specialists Ricardo to achieve these groundbreaking results. Using CFD, FEA and a specially designed combustion bowl, they perfected the combustion process. Fuel distribution and atomisation has been optimised by raising injection pressures to 2,000 bar and bringing in nozzle-hole geometry. JCB has also incorporated variable geometry turbochargers on all but the lowest powered 55kW DieselMax engine, which falls under a slightly different emissions regulation.

In a further intelligent development, the company used cooled Exhaust Gas Recirculation (EGR) to clean up the exhaust gases before they are passed from the engine, removing the need for any exhaust aftertreatment components to meet new emissions levels.

JCB also worked in tandem with fuel system and electronics specialist Delphi to develop a new electronic control system with a form of learning capacity. This will enable the engine to stay within its intended parameters, even as the components settle.

JCB engines are renowned for reliability and performance, and have a formidable reputation that reaches right across the globe. Engines can be found in equipment across a wide range of industries, including concrete pumps, auxiliary cranes, aircraft ground support equipment, construction and materials handling machinery, drilling rigs, forklift trucks, fruit and vegetable harvesting equipment, vibration compaction equipment, compressors and irrigation pumps. **iVT**

Model	Emissions level	Output
DieselMax 4.4-litre	Stage 2	47-100kW
DieselMax 4.8-litre	Stage 2	117kW
DieselMax 4.4-litre	Tier 2	63-93kW
DieselMax 4.4-litre	Stage IIIA	56-74kW
DieselMax 4.8-litre	Stage IIIA	100-120kW
DieselMax 4.4-litre	Tier 3	63-120kW
EcoMax 4.4-litre	Tier 4i	55-93kW
EcoMax 4.8-litre	Tier 4i	108-129kW

TABLE 1: **JCB Power Systems products and ratings**

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