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MASSIVE INVESTMENT RESULTS IN INDUSTRY'S CLEANEST ENGINE

JCB has made one of the biggest investments in its history to develop the off-highway sector's cleanest engine in readiness for incoming emissions legislation.

The company has invested around £80 million in researching and developing a new combustion system for the new JCB Ecomax T4 4.4 litre engine - the latest generation of JCB Dieselmox engine. The investment has delivered an industry-first solution which eliminates the need for any exhaust after-treatment and delivers cost savings for mid-range customers.

The engine is now undergoing full in-field testing before going into production in 2012 to meet Tier 4 interim/Stage 3B legislation.

The keys benefits of the innovation are:

- Reduced fuel consumption
- Reduced cost of ownership
- Better reliability
- Better packaging and no compromise of machine design

Alan Tolley, JCB's Director of Engine Programmes, said: "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 4 interim/Stage 3B legislation was that to achieve these really low particulate levels you needed to fit a Diesel Particulate Filter (DPF).

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“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 back pressure 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.

“Our strategy therefore has been to meet Tier 4 interim emission standards without a DPF but also to achieve this without any exhaust after-treatment. We have focussed our research and development efforts on a high efficiency combustion system; in other words we have made sure we don't create the pollutants to start with rather than try and deal with them later. This approach also gives us very low fuel consumption levels.

“The solution we have come up with gives significant advantages for our customers for packaging and integration. On machines there is not much spare room in the engine compartment and we had a lot of discussion about how to optimise the machines, their design and functionality. The risk with something like Tier 4 is that in order to package everything you have to compromise those elements and we were not willing to do that which is what drove us to pursue a different technology solution.

“One of the advantages we have as a company that makes machines and engines is that we can come up with a final machine product which is better optimised.

“The real end user benefits come in the shape of reduced cost of ownership and reduced fuel consumption and better reliability. We see DPFs as a significant reliability risk; that has certainly been the experience in the automotive sector. We knew the emissions limits were very challenging but we always had the belief and objective of achieving it without putting the onerous burden on our customers.”

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Better by design

Since its launch in 2004 the JCB Dieselmix engine, which powered the JCB Dieselmix car to a world diesel landspeed record of 350mph on the Salts Flats in Bonneville, USA, in 2006, has undergone continual development. More than 100,000 engines are now working in the field globally, recording class-leading levels of performance and reliability. The latest developments will see the Dieselmix engines cleanly past the Stage IIIB/Tier 4 Interim legislation that will come into effect for engines of this size in 2012.

As many engines within the 129kW (75-175hp) range are used in plant and equipment that is operated under variable light loads, there can be concerns about Diesel Particulate Filter (DPF) regeneration, with the engine management system having to force the regeneration process by burning additional fuel. This is not only inefficient but can result in additional service requirements, substantial cost increases and the risk of damage to the DPF if a contractor uses a high sulphur fuel.

To achieve the next round of emissions regulations, JCB Power Systems has worked closely with research and development specialist Ricardo, using computational fluid dynamics, finite element analysis and a Ricardo designed combustion bowl to perfect the combustion process.

With second generation common rail fuel injection technology, injection pressures have been raised to 2,000 bar and nozzle hole geometry has been refined to provide highly effective atomisation and distribution of the fuel within the cylinder. JCB has incorporated variable geometry turbochargers on all but the lowest powered 55kW Dieselmix engine, which falls under a slightly different emission regulation. Cooled Exhaust Gas Recirculation (EGR) is also used to clean up the exhaust gases before they are passed from the engine. This means that there is no requirement for any exhaust after-treatment components to meet these emissions levels on the 4.4 litre JCB Ecomax T4 engine.

The company has worked with fuel system and electronics specialist Delphi to develop an electronic control system with a form of learning capacity, that will ensure that the engine stays within its intended parameters even as the components settle throughout their design life.

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Benefit to the Customer

As well as there being no need to fit a costly exhaust after-treatment system, there has been no requirement to increase the cooling pack size or to reduce service intervals from their standard 500 hours. In addition, under test conditions, the engines have been achieving a 5-10 per cent fuel consumption improvement compared to the previous generation.

The engine design is also future-proofed, as the structural architecture, the componentry and systems will remain the same for Stage 4/Tier 4 Final regulations in the future, at which time exhaust after-treatment for NOx reduction may be unavoidable.

Investment In The Future

JCB has invested heavily in its Power Systems business in Derbyshire, UK, to meet the requirements of its customers and legislators. The original 4.4 litre Dieselmex 444 engine has been joined by a 4.8 litre Dieselmex 448 version, while power ratings have been extended at both ends of the scale. The latest investment sees the opening of one of the most sophisticated engine test cells currently in operation in the UK. JCB Power Systems has built 10 test cells, and will initially operate six cells. Each cell is capable of carrying out the full EU transient test cycle that is required to meet Stage IIIB and Tier 4 Interim legislation and the cells can handle engines with up to 300kW of power output, leaving room for further expansion in the future.

To meet this increase in workload, JCB Power Systems has increased its research and development team by 40 per cent, investing further in the JCB Dieselmex range.

This continual investment in technology, research and development of the JCB Dieselmex engine line will ensure that JCB stays at the forefront of diesel engine technology. JCB Power Systems will continue to provide customers around the world with low fuel consumption emissions compliant powertrains, without unnecessary expense or complex exhaust after-treatment.

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