Different worlds

Engine emission laws mean every manufacturer is renewing its range of earthmoving machines for Europe, Japan and the US. But the faster growth in emerging markets means there are new developments for these countries too. Chris Sleight reports.

If you plan to buy a new earthmover in Europe, Japan or the US in the near future, it is likely to be a newly launched machine with a low emission engine. These machines started to come onto the market in mid-2010 in some cases, although laws mandating them only started to take effect in early 2011.

Each region has different laws — Stage III B in the European Union (EU), Interim Tier 4 in the US and Step 4 in Japan — which are being progressively introduced to different power ranges of diesel engines in the off-highway sector. Today the laws cover engines from 56 to 560 kW, which affects almost every type of earthmoving machine — excavators over about 10 tonnes, wheeled loaders with 1 m³ buckets or bigger, all types of haulers, dozers above about 7 tonnes or a D3 size, and so on.

There are still many ‘old stage’ machines available on the market due to flexibility provisions in the laws which are designed to smooth the transition for manufacturers. However, these will continue to be phased out over this year and the next.

Covering both construction and agricultural machinery, the laws are the continuation of more than a decade of increasingly tight legislation on exhaust emissions. Previous stages have focussed on reducing gaseous pollutants like nitrogen dioxide (NOx), carbon monoxide (CO) and hydrocarbons (HC) but the latest round of laws looks at particulate matter (PM), or soot.

In order to reduce PM emissions, manufacturers have added to existing technologies that control pollutants in the engine itself with after-treatment devices which sit in the exhaust system.

There are two basic approaches here. The more common is for relatively low combustion temperatures in the engine, which keeps down the production of NOx, but makes for higher volumes of PM. This is then dealt with using a diesel oxidation catalyst (DOC) and/or a diesel particulate filter (DPF) in the exhaust pipe. A DOC uses a chemical process to break down PM, whereas a DPF physically traps the particles, which are then burnt-off by the heat of exhaust gasses in a process called regeneration.

The other approach is to run the engine at high temperatures, which prevents the formation of PM, but means lots of NOx is produced. This is then managed in the exhaust system with a process called selective catalytic reduction (SCR), which converts the NOx into nitrogen and water. One perceived downside to this is that a urea solution, marketed as ‘AdBlue’ in some countries, needs to be added regularly to feed the SCR chemical reaction.

New from Hitachi this year is the Zaxis-5 range of excavators, featuring Stage III B engines.
Earthmoving

Among Komatsu’s new launches at Intermat this month is the D65-17 dozer, which features a 153 kW Stage IIIB engine and weighs in at up to 23.8 tonnes. The company says fuel consumption is -5% lower than its Stage IIIA predecessor.

AdBlue is fairly widely available in Europe, as SCR has been used in the on-highway sector for six years or so in reaction to the Euro 4 requirements for road-going trucks.

However, it has not been as widely available elsewhere, and this is one of the reasons the industry has leaned towards DPF and DOC technology. But this may change in 2014, when another step – Stage IV/Tier 4 Final – is introduced, requiring a further reduction in NOx levels. In many cases this will require the use of both the DPF/DOC approach in combination with SCR.

The one exception to this rule so far has been JCB, which says it has achieved the required reductions in both NOx and PM in its own Dieselmax engines without the use of any aftertreatment. The company says this will give it a competitive advantage as JCB director of engine programmes, Allan Tolley explained.

“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 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,” he said.

New Holland has added two new models to its excavator range in the shape of the 21 tonne E215C and 25 tonne E245C. The company is using SCR technology to meet Stage IIIB emissions requirements and it says the machines are +10% more productive than their predecessors.
Bell is updating its Mark 7 generation of articulated dump trucks (ADTs) with low emission engines. It says in a like-for-like test the new 40 ton 8400 Mk 7 out performed a competitor by 6% in terms of production and burnt -13% less fuel.

for the DPF to be continuously cleaned by this heat – ‘passive regeneration.’

However, in some cases, there will need to be a periodic regeneration cycle, where the temperature in the exhaust is artificially raised to burn off the PM – ‘active regeneration’. Most new machines include an indicator in the cab to show the status of the DPF, and this will alert the operator if an active regeneration cycle is about to take place. However, the operator will have the option to over-ride this if, for example, the machine is being used in an environment where this would be hazardous.

Despite regeneration, the very small proportion of metals in fuel will lead to a build-up of non-combustible ash in DPFs. This will have to be cleaned, or the DPF replaced, as part of a major service – usually every 5000 hours. This is a procedure that would normally be handled by a dealer, and some manufacturers are offering exchange programmes through their dealers whereby DPFs can be exchanged at a lower cost than a new unit, much like a remanufactured (reman) parts programme.

In terms of advantages of the new engines, many manufacturers say they are helping to deliver savings in fuel efficiency and improvements in productivity. The new machines do not necessarily burn less fuel, but many can move more material for a given amount of fuel. But this depends on the application of course.

Commenting on Caterpillar's new E-series range of excavators, Mr Iatas said, "As a very general statement, fuel consumption has been improved quite dramatically, but it depends what the operator is doing with the machine. If the operator is not calling on the additional hydraulic power that the E-series has been loaded with – just working in standard mode – in those cases you would see significant fuel consumption reductions.”

This type of comment is common across the industry: Volvo Construction Equipment vice president for product platforms, Alan Berger told IC, “We’re getting positive feedback. We have hours on these Tier 4 machines in the field, which confirm the
Among Terex's new Stage IIIB-compliant machines is the TA30D ADT.

Benefits in performance on the machines. We've also won some design and styling awards.

"In excavators we see customers reporting much better fuel efficiency improvements than we would have predicted. We think we've provided a good value equation in terms of improving operating cost advantages and other improvements."

But fuel efficiency is about much more than the machine – the way an operator uses equipment is possibly the most critical factor in fuel consumption. For example, Caterpillar says its new Tier 4 Interim K-Series wheeled loaders are up to 15% more fuel efficient than their H-series predecessors. However, studies by the company show that an operator who uses a machine aggressively can burn a massive +80% more fuel than on a more moderate truck loading cycle.

Emerging markets

These improvements due to Stage IIIB/Tier 4 Interim engines only apply in Europe, Japan and the US, because it is crucial the machines are fuelled with ultra low sulphur diesel. This fuel, containing 15 parts per million (PPM) of sulphur or less, is only widely available in these countries. If diesel containing more sulphur than this were used, the aftertreatment systems would stop working, back pressure on the engine would increase and the machine would overheat and break down, perhaps with irreparable damage to the engine and exhaust system.

One implication of this is that unmodified second-hand Stage IIIB/Interim Tier 4 machines cannot be used in countries outside the EU, US and Japan. And the modification would not necessarily be straight-forward. "It would definitely require a re-flashing of the engine software. The engine will be expecting signals back from the DPF and other systems, so customers couldn't just take out the DPF and DOC, change the injectors and be up and running," said Mr Loras.

It is an area that many manufacturers say they are looking at, but none have yet put forward a solution.

A further barrier is regulatory issues in countries where there are less stringent regulations as Mr Berger explained. "Not every country's regulations allow you to do something like removing..."
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As well as new excavators, Case's Stage IIIB range includes the 1021 and 1121 wheeled loaders. Like sister company New Holland, Case has opted for SCR technology to meet the new emissions requirements.

Internat will see the launch of new Stage IIIB compliant wheeled loaders and excavators from Hyundai.

an engine's aftertreatment. The engine is known to be at a particular emissions level, and in some countries you can't change that, and then re-declare a new emissions level."

Without both technical and regulatory solutions, owners of Stage IIIB/Interim Tier 4 machines will face a problem when it comes to selling their used machines. They are only likely to find buyers in those developed regions of the world where ultra low sulphur diesel is available. This could lower the residual value of their equipment.

And there are other reasons why there is now a divergence between machines sold in developed and emerging markets. For one, most of the growth and new opportunities for manufacturers are in emerging markets. JCB, for example, says about 80% of the global market for 20 to 24 tonne excavators is in developing countries.

Caterpillar's Mr. Istan agreed, commenting, "I would say 70% or more of our opportunity in tracked excavators is outside highly regulated markets. That means that the highly regulated design is not going to be suitable for that 70% of the customers. They are reluctant on the technology side, they have issues on the fuel cleanliness issue, they don't require the flexibility that customers in Europe want, with machines configured with lots of auxiliary circuits and cab monitors and so on.

"There are some things that are specific to lesser regulated countries. In some regions they will push the machine very hard for certain applications. So heavy-duty front parts are standard in a lot of cases, whereas they would be an option in Europe or North America."

Indeed, a common theme from manufacturers is that machines in emerging markets tend to be pushed harder, with longer working hours, more extreme ambient temperatures and applications that often involve digging hard, virgin ground.

"In India we have a new excavator production facility there, and we optimised the machine for that market. So the 21 tonne excavator for that market has reinforced structure for heavier working conditions; there is a tropical cooling system to cope with the higher ambient temperatures and longer working hours and we also focus on fuel efficiency," said Volvo's Mr. Berger.

Similarly, Caterpillar has developed a 20 tonne machine for emerging markets, as Mr. Istan told IC. "We have the 320GC – GC for general construction – which is a (20 tonne class) 320 with a short undercarriage, lower power and a different boom and stick, specifically aimed at customers in lesser regulated markets, that just require a utility machine. That will happen more and more, where you will see very specific variations and configurations.

"But even within the less regulated countries, we need to make sure we balance carefully the needs of different countries. For example, China is very sensitive on fuel usage, but the Middle East is not."

As a general rule today, fuel consumption is a big issue. JCB is seeking to address this by using its own Dieselmax engines more widely in its own range. It now fits the Dieselmax 444 Engine in five tracked and two wheeled excavator models from 11 to 18 tonnes in Europe and the US. In other regions, its 20 to 24 tonne excavators feature a Stage II 4.8 litre JCB Dieselmax engine rated at 128 kW, which the company says improves fuel efficiency by a massive 24% compared to the predecessor.

In cash terms, JCB estimates that a Chinese customer using a 20 tonne JS200 for 3500 hours per year would save in the region of UK£ 10000 (US$ 16000) per year in fuel costs as a result of this.

Two agendas
On the one hand, the divergence between machines for developed and developing markets has a downside – that manufacturers have to produce multiple models and that owners are more limited in their options to buy and sell used machines. But the positive is that instead of a one size fits all approach, equipment is being developed that is better suited to the environment where it will be used.

In Europe, Japan and the US this means a greater environmental focus and often more multi-purpose machines with more features and options available. In emerging markets the emphasis is often on extreme durability and the ability to work long hours in harsh conditions.

Last year saw Shantui launch its largest ever dozer in the shape of the 62.5 tonne SD52-5.