Tech Now

MOBILE MACHINES - RESPONDING APPROPRIATELY TO STRICT LIMITS

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The European Union's upcoming Stage V regulation sets the world's strictest emission limits for mobile machines. Leading manufacturers illustrate how they are handling the new requirements.

By Nikolaus Fecht

Manufacturers of combine harvesters, dredgers, industrial trucks, cranes and barges must further reduce the pollutant emissions of their products from 2019 onwards. They must invest in research, development and construction to adhere to the emission limits of EU Stage V.

Challenge and opportunity

EU Stage V is a serious challenge for engine manufacturers, as they have to integrate highly developed exhaust gas aftertreatment systems. "However, this will also provide us with an opportunity to support our customers in the best possible way with appropriate solutions and thus gain market share," predicts Dr. Marcus Schwaderlapp, research and development manager at Deutz AG in Cologne. "We began familiarizing ourselves early with the technologies required for EU Stage V." The engine manufacturer promises that their product range with diesel particle filters already complies with Stage V limit values. The engines have almost identical installation space requirements, so that emission level changes do not necessitate expensive changes to customer devices.

Optimal particle combustion

A closed diesel particle filter (DPF) is required to adhere to the particle number limit of EU Stage V. Additional components such as diesel oxidation catalysts are used as required and are offered by Deutz as compact systems that are individually adapted to customer devices. "The DPF in particular requires comprehensive expertise," explains Schwaderlapp and continues: "Deutz has been developing DPF systems for over ten years and is already applying them in serial production. This experience benefits the customer, as the reliable operation of a DPF within a total system requires sound integration expertise and an understanding of the respective application." Different load profiles apply, depending on the device in which the engine is used. Intelligent "heat management" is required to burn the soot particles collected in the DPF. The manufacturer in Cologne has developed a "heat mode", which specifically increases the exhaust temperature and ensures safe machine operation. The underlying model was programmed by the Deutz internal software development team.

Harmonizing emission legislation

"We are proud that our engines meet the world's strictest emission limits for non-road mobile machinery," emphasizes Schwaderlapp. Manufacturers in Europe are currently facing stricter emission regulations than manufacturers in the USA or China. The ever more complex emissions regulation map poses serious challenges to machine and engine manufacturers, as different engine configurations have to be delivered to different target markets. "Globally harmonized emissions legislation would make sense from our point of view," says Schwaderlapp.

The challenge is not only the implementation and introduction in Europe, but also the increased global diversification of emissions legislation. "It has unfortunately not been harmonized thus far, which implies huge efforts by the manufacturers in getting approval for engine systems worldwide," agrees Stefan Rudert, Application Director at MTU Friedrichshafen GmbH, a Rolls-Royce subsidiary, and continues: "For us this

means that we have to introduce a diesel particle filter, as we have thus far managed to get by with a more robust selective catalytic reduction (SCR) system for exhaust gas treatment on Stage IV." However, the Friedrichshafen-based company will be able to comply with the new legislation by the middle of 2018 in order to allow machine manufacturers early implementation with their new devices.

The company is also improving the engine characteristics in order to achieve better productivity and life cycle costs for end users and to reduce the CO2 emissions. This includes torque, performance and dynamics.

A change of stages requires high investment

"Some of the changeover from Stage IIIa to IIIb and IV and then to Stage V took place very rapidly and each change required high amounts of investment. Not all machine manufacturers have managed to change their entire fleet of new machines to currently valid emission levels, i.e. to Stage IV / Tier 4," says Rudert. He now hopes that the Stage V legislation will be more long term, so that the standard will be widely available in the market, the desired positive environmental effect will be achieved and the investments of engine and machine manufacturers and the end customers can be redeemed.

Politics should harmonize the regulations

Rudert indicates that global harmonization and mutual acceptance of the emissions legislation is desirable, particularly in the highly regulated markets in the EU, Nafta region, Korea, Japan and recently also in China. The same also applies in markets with still low but increasing requirements, such as Brazil, Chile and India. Politicians should make additional efforts to coordinate the regulations. New, environmentally friendly technologies can only prevail when they are not associated with costly modifications and regulations for global application. "The new legislation for EU Stage V will ideally enable engine approval all over the world without further modifications or high bureaucratic hurdles," expects Rudert.

"The currently applicable Stage IV for mobile machines already ensures lower pollutant emissions than Stage Euro 6 for passenger cars, as was demonstrated by a study conducted by the Karlsruhe Institute for Technology (KIT)," says Martin Lehner, Chief Executive of Wacker Neuson SE, Munich. The study showed that pollutant emissions during the operation of diesel passenger cars are higher than the limits for construction machinery. The prejudice that emission limits for construction machinery are more tolerant than those for passenger cars is therefore completely wrong.

Different studies have also shown that the contribution made by construction machinery to the total amount of airborne particle pollution is below 10 percent. Lehner therefore doesn't believe that even stricter legislation makes sense, either from the environmental policy perspective or the economic point of view.

A challenge for developers

"In concrete terms, the new stage means that we have to lower the particle emissions by a further 40 percent," emphasizes Lehner. "All machines for European markets in a power category higher than 19 kW will require the installation of diesel particle filters in future. This is a challenge for our developers, as compact machines provide us with little installation space." Machine manufacturers are furthermore not in a position to pass all additional costs on to the customer. Price increases are nevertheless unavoidable. The situation is rendered more difficult by the fact that emission regulations are not globally harmonized. Each manufacturer therefore requires three different versions of each machine type. The product range thus triples. "We have a transition period of only 18 months to change our entire production for all models," complains Lehner.

Driver lowers fuel consumption

One response by the Munich company to exhaust gas regulations are emission-free products with electric drives. They offer special operator and environmental protection without sacrifices in performance. The series includes a battery-driven rammer, a mini dredger with "dual power" option (use of an electro-hydraulic, external power aggregate) as well as a battery-driven wheel loader. However, the exhaust emissions can also be lowered in another way. "The productivity of a machine can be increased by up to 700 percent and the fuel efficiency can be increased by up to 200 percent, depending on the experience of the driver," reports Lehner.

Specialists in exhaust gas cleaning include HJS Emission Technology GmbH & Co. KG in Menden. "Compared to the currently valid EU Stage IV, Stage V mainly defines a limit value for the number of particles emitted by engines in the power category from 19 to 560 kW," explains Dr. Markus Müller, member of the management team responsible for development, production and sales. EU Stage V requires a combination

of diesel particle filters and SCR catalysts. Both technologies have been used in non-road mobile machinery since the introduction of exhaust gas aftertreatment.

High system competence needed

However, the combination of both technologies implies increased technical complexity. Low limit values can only be achieved when the manufacturer optimally matches the engine to the exhaust gas aftertreatment. Manufacturers are furthermore required to integrate ever more complex systems into their vehicles and machines. According to Müller, this is further compounded by the fact that end customers expect low-maintenance systems. “We are manufacturers of solutions for exhaust gas aftertreatment and must therefore have sufficiently high systems competence to manage the varied requirements of different applications,” explains Müller.

Balance between variety and standard

HJS customers are supposedly currently demanding products with maximum performance and minimum installation space. This is compounded by the fact that these systems must be developed over progressively shorter development periods. The low-cost requirements are also in conflict with the balance between application variety and standardization.

The technical requirement for manufacturers like HJS is to develop SCR systems that work efficiently at low exhaust gas temperatures while avoiding AdBlue crystallization. AdBlue is a watery urea solution that reduces the nitrogen oxide output of diesel engines. Engine-oriented concepts for exhaust gas treatment are also required. It might even be necessary to integrate an SCR coating on the diesel particle filter as a function of the operating profile of the machine. “After more than 25 years of experience in diesel exhaust gas aftertreatment, HJS has a technology portfolio that allows integrated support of our customers on their way to EU Stage V,” says Müller.

Stable framework conditions are key

Müller demands consistent framework conditions for the regulations issued by the European Union. He regards this as an important requirement for the sustainable management and strategic alignment of a company. “Stable framework conditions are an essential foundation for innovation and future-oriented investments,” summarizes Müller.

John Deere GmbH & Co. KG in Mannheim has a relaxed attitude towards the new EU Stage V. “We are currently at Stage IV and use all common components for exhaust gas aftertreatment in our products,” says Dr. Axel Kunz, Manager Advanced Energy Management at the Mannheim-based company. “All machines are type approved according to Stage IV. However, we know from existing measurements that we are already able to comply with the only new criterion for the particle number,” explains Kunz. This reduces the effort required by John Deere to meet the new emission limits mainly to repeating the type approval test on largely identical engines and components for exhaust gas aftertreatment according to EU Stage V. Those tests will then also form part of the vehicle type approval test, which has to be renewed.

Separate shipment regulations make logistics difficult

However, the implementation of the separate shipment regulations, which are also included in the new EU regulation (2016/1628), is expected to take more effort. The legislator uses these regulations to specify logistic requirements for engines that are to be delivered without an exhaust aftertreatment system. “These regulations stipulate that the engine and exhaust gas aftertreatment components must be temporarily marked when they are separately delivered to the vehicle manufacturer. This is intended to support the predetermined matching of specific components in each individual vehicle,” explains Kunz. This requires a considerable change in the current organizational procedure for purchasing and logistics by engine suppliers and vehicle manufacturers. This regulation comes into force before the new emission regulations and must be implemented by all manufacturers without a transition period by the scheduled date.

Measuring real driving emissions

This rule requires the engine suppliers to take several measurements of the gaseous emissions during the product life cycle of the vehicle while it is in operation by the farmer. The data will be centrally collected for the whole EU and will be publicly accessible. This new requirement is likely to make agricultural machines more expensive, as the costs of the measurements would be passed on. A similar requirement has been specified for Euro 6 trucks only. It could also be used in public, given the current discussions around diesel engines. Manufacturers could point out how exemplary users monitor real driving emissions of non-road mobile machinery to ensure life-long compliance with the limit values.

A look at new regulations

For approximately 20 years, manufacturers such as John Deere have observed that emission regulations strongly affect the technical development of agricultural machines. In the past, the company had to spend a large part of its financial resources on implementing these specifications. “It was good that the European Commission announced, after some time, on which date the scheduled emission regulations will come into force and that it published the emission limits early enough,” says Kunz.

It seems that this long-term strategy has been abandoned for Stage V. Kunz states that the second stage of consultation before drafting and passing the content of EU 2016/1628 certainly did not make it clear to every observer that Stage V is more than a singular step. Article 59, for example, includes inspection deadlines for in-service monitoring data and specifications that adapt or extend the emission limit values. According to Kunz, such specifications are usually applied to prepare for new regulations: “I would prefer a clear specification of the EU strategy, which certainly already exists, in order to facilitate better planning. It would be even better to suspend these activities for a clearly communicated period or to stop them completely.”

Further Information

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