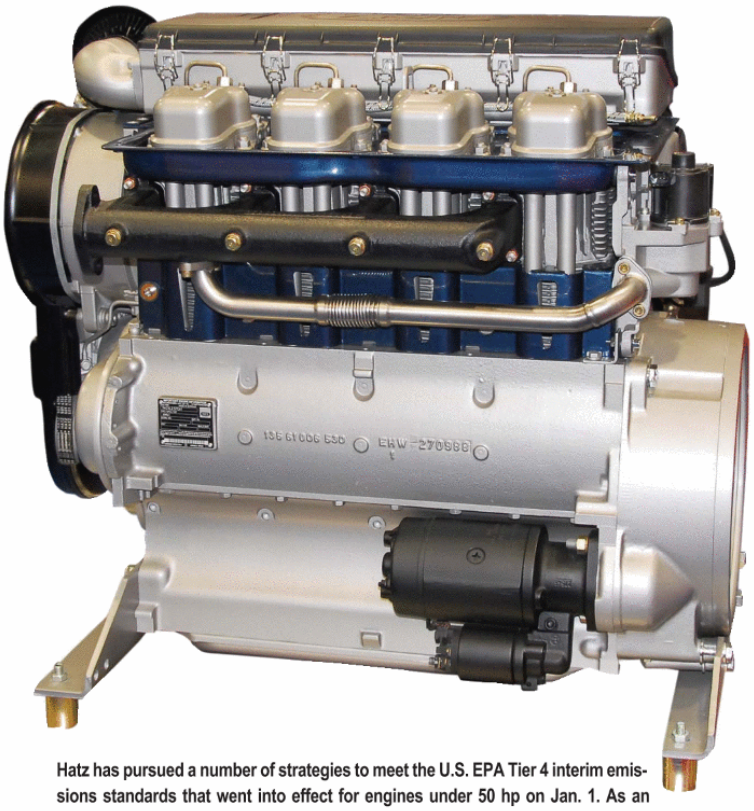
Hatz Takes Varied Approach To Meet Tier 4 Emissions



Hatz has pursued a number of strategies to meet the U.S. EPA Tier 4 interim emissions standards that went into effect for engines under 50 hp on Jan. 1. As an example, the 4M42 engine incorporates an exhaust gas recirculation system, which proved to be a packaging challenge, particularly in the company's Silent Pack engine systems.

BY ROBERTA PRANDI

Hatz Diesel of America, the Waukesha, Wis., subsidiary of German manufacturer Hatz Motorenfabrik, markets a wide range of single-cylinder engines from 2 to 15.6 hp and multicylinder engines up to 72.2 hp. The company, like virtually all diesel engine manufacturers, has been busy addressing issues related to tightening emissions limits and recently announced a development of its four-cylinder range to meet EPA Tier 4 interim standards, which are going into effect for a variety of engine power segments in 2008, including several categories below 75 hp.

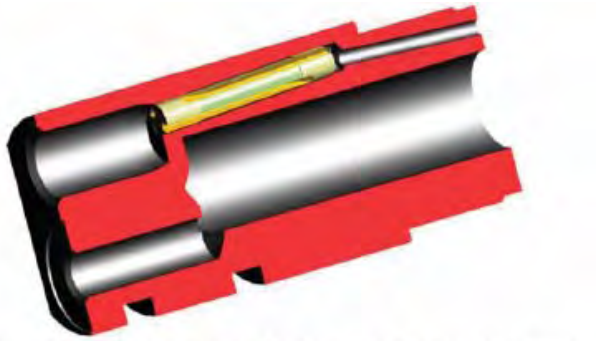
David Priestley, president of Hatz Diesel of America Inc. said that the factory engineers have completed what he called "a remarkable task" in getting the engines certified in time for production after Jan. 1. Priestley also stated that by being able to achieve the emissions levels on all but the four-cylinder engines operating above 50 hp by mechanical methods, they have been able to keep costs for the engine itself and service/maintenance lower.

In order to meet Tier 4 interim, Hatz has opted to incorporate exhaust gas recirculation (EGR) into its L and M series engines. This is the first application of EGR into Hatz engines, and the company noted that the introduction of this technology raised significant technical challenges for its engines with the Silent Pack cover. The Silent Pack module was precisely tailored to the engines' dimensions, and Hatz needed to work on the engine design in order to avoid modifications that would raise packaging difficulties.

The manufacturer was ultimately able to integrate its EGR system with a modification in the cover of only 1.18 in. and to announce it in enough time to enable its customers to accommodate that dimensional change in their design work.

Beyond that, the significant reduction of NO_X and particulate matter emissions required by Tier 4 interim remained a significant challenge. Erich Eder, head of technical departments at Hatz Motorenfabrik, explained that EGR helps in reducing NO_X emissions, "but at the same time, particulate matter emissions increase — while the legislation says that they have to sink by 25%, from 0.4 to 0.3 g/kWh. Combined emissions of NO_X + HC have to be reduced by 37%, from 7.5 to 4.7 g/kWh, and this result was to be achieved only with exhaust gas recirculation. But in practice this means that particulate matter increases in inverse proportion.

A schematic of the EGR system being used on Hatz's L and M Series diesel engines.



Hatz worked with Stanadyne to develop the Rate Shaping Nozzle, which is being used in the 1B and Supra Series engines. The RSN injection system is also being adapted to the company's 2G40 and L/M42 engines.

"Thus, we had to obtain a reduction in particulate emission on the engine without EGR from 0.2 to 0.1 g/kWh, so that the engine with EGR could remain in the 0.3 limit. We obtained this by adding an electronically controlled EGR valve that manages the quantity of exhaust gases in the recirculation loop. At higher loads, the combustion is only able to withstand a limited EGR, about 5%, but at partial loads a higher recirculation is necessary: from 35 to 40%."

Peter Prinz-Hufnagel, responsible for engine development, combustion and exhaust emissions divisions at Hatz, explained another feature adopted to achieve lower NO_X values in the 1B and Supra Engine Series and in the 2G40 and L/M42 versions — the Rate Shaping (RSN) injection nozzle. "In former times, standard injection nozzles with a relatively large sac hole had the disadvantage that a small residue of fuel remained in the sac hole after injection and this was blown out again in unburned form," Prinz-Hufnagel said. "The following historic development stage was a tapered sac hole from which today's state-of-the-art technology, the Valve Covered Orifice (VCO) injection nozzle was developed. Here, the injection holes branch off in the area of the nozzle seating, and are thus covered by the needle, which prevents any evaporation of fuel out of the small sac hole.

"Therefore, the VCO injection nozzle also has some concrete benefits as regards the emission of undesirable hydrocarbons (HCs), but one disadvantage being the fixed injection characteristics." Prinz-Hufnagel continued, adding that nozzle manufacturer Stanadyne researched new ways of further reducing NO_X emissions while at the same time abating the knocking that is typical for diesel engines. "The RSN nozzle enables a higher needle stroke and at the same time operates in two stages. Initially, the nozzle lifts only slightly and there is only a small quantity of fuel injected. It is only when the pressure increases that the needle stroke is increased and normal injection (full injection) ensues."

According to Prinz-Hufnagel, the new nozzle offers definite advantages, such as a perceptible reduction in noise when idling and a reduction in the proportion of NO_X. At the same time, better emissions values are achieved at full load. Hatz has introduced the RSN nozzle throughout the 1B and Supra Series, and it is currently under preparation for the introduction of the 2G40 and L/M42 engines.

Prinz-Hufnagel also explained the basic strategies Hatz is pursuing in regard to possible aftertreatment solutions. Considering diesel particulate filters, he commented that "diesel particulate filters for passenger cars and on-highway vehicles are now mass produced. Unfortunately, this economy of scale is not achievable with industrial engines because of such different characteristics in the various applications and geometries to take into consideration.

"In a car, basically the whole bottom under the chassis is available. In industrial machines, space is very tight and when the DPF is in the open, safety concerns also arise because of the high operating temperatures. Industrial vehicles also do not have the same service schedules as passenger cars or trucks have. Maintenance is often performed only when the machine is off-duty. Besides, among the different applications there are differences in the fuels that are being utilized and especially in lube oils, which have a relevant impact on the aftertreatment system."

Thus, the diesel particulate filter will be a must for off-highway machines, but also a challenge to integrate into engine and equipment systems. Prinz-Hufnagel admitted that with every new emissions regulation, "you move away from the ideal engine." As an example he cited Hatz's L/M40 engine, which had an optimal fuel consumption of 205 g/kWh in the early 1990s. Now because of the need to lower combustion temperatures to reduce NO_X emissions, the fuel consumption of the fourth-generation L/M42 is around 220 to 225 g/kWh.

In addressing future emissions regulations, Hatz is basically dividing its engine range into two parts and will deal with each part in a different way. All engines under 25 hp will stay with mechanical engine controls. Engines above 25 hp will adopt some electronics and probably some level of EGR. The company intends to provide the best economic solution for its customers and to avoid more expensive emissions reduction methods whenever possible. **dp**