

The Spirit to Take On Environmental Measures

Diesel Engine Technology for a New Generation of Construction Equipment:
The Development of "ecot3"



Construction equipment diesel engines, for which emissions regulations are tightening

By pursuing original technology in keeping with its position as one of the top manufacturers in the domestic market, Komatsu is independently developing key components that are indispensable for construction equipment. The diesel engine, the heart of the machine, is symbolic of such components. As with other internal combustion engines, these diesel engines used in construction equipment are currently confronting the major issue of how to respond to global environmental issues.

Diesel engines, while enjoying the significant merits of high combustion efficiency and low amounts of CO₂ emissions, have also been characterized by the demerits of emitting high amounts of NO_x (nitrogen oxide) and particulate matter (soot and other airborne particles). To overcome these shortcomings, emissions regulations governing diesel engines for construction equipment have been tightened in recent years. With the

launch of stricter regulations in 1996 in the U.S. marking the start of this trend, the U.S., Europe, and Japan have introduced emissions regulations with indicators for both NO_x and particulate matter. Since that time, the regulations have become progressively stricter in five-year intervals, and here in 2006 the U.S. and Europe's Tier III emissions regulations entered into force.

Bringing together Komatsu's leading-edge technologies: The latest-model diesel engine ecot3

Komatsu considers compliance with such emissions regulations of various countries to be critical issues yet at the same time views them as business opportunities. In the 1970's the company began promoting research in order to differentiate itself from the competition. In addition, Komatsu has consistently developed the latest technology one step ahead of regulatory requirements.

In 1998, the company entered into an alliance with Cummins, one of the U.S.' "Big Three" engine manufacturers, establishing

Industrial Power Alliance, Ltd. (IPA). Assembling engineers for construction equipment diesel engines, IPA boasts a world-leading system for research and development.

In order to comply with the Tier III emissions regulations entering into force in 2006, Komatsu has developed leading-edge engine technology known as "ecot3." Diesel engines utilizing the ecot3 technology have already made their debut in construction sites around the globe and are already delivering solid performances in the field.

Severe usage conditions unique to construction equipment that constituted a significant obstacle

Mobility, fuel efficiency, durability, reliability—the issue becomes how to meet these requirements, even those that conflict with each other, yet still comply with emissions regulations. The Tier III emissions regulations constituted a formidable challenge, even for Komatsu engineers. Tier III emissions levels are at about a third of the 1996 Tier I regulations, meaning that a high standard for



A diesel engine for construction equipment requires a number of original technologies. Our engineers are all proud to be involved in the development of these engines.

IPA Managing Director
Tohru Okazaki



I invested some three years in finding the best way to bring conflicting elements together to coexist and then determine how to fine-tune the design.

IPA Engine Development Group
Hatsuo Andou



For Komatsu, having such strengths in technology, emissions regulations are just a further push in the same direction. If we worried that it would lead to a step back for us, there would be no technological progress at all.

IPA Control Development Group
Takashi Sakasai

emissions had to be met.

One of the technologies noticed by the engineers that held the key to a breakthrough was the EGR system, which reduces NOx emissions. EGR is not a new technology and is already widely introduced in the world of on-road trucks. However, mounting that onto a diesel engine for construction equipment makes it a matter of an entirely different dimension. Its development started with a revision of an EGR for truck engines. However, the engineers soon found themselves up against a formidable obstacle.

Construction equipment operates in environments so severe that they have no comparison with those in which on-road trucks operate. The environmental conditions set for the development of the ecot3 included a temperature range from 50°C to -50°C and altitudes in excess of 4,000 m. In addition to that, the engine had to be able to withstand enormous amounts of dust, dirt, and sand. Furthermore, grades and types of water, engine oil, and diesel fuel for diesel engines used in construction equipment vary according to the environment in which the engine is being used.

Current emissions regulations are limited to Japan, the U.S., and Europe, but Komatsu has taken the stance that it will provide only construction equipment that meets these regulations, even in other areas of the globe. This means that these stringent conditions must be cleared for the various environmental contexts existing around the globe.

The conditions put upon the EGR were equally severe. Thus "improvements" to the existing model or other kinds of tweaking processes would not even begin to enable the company to achieve success. The engineers went back to zero and began to craft an EGR specifically designed for construction equipment diesel engines with their own hands.

Drawing blueprints and creating an experimental model to put it into concrete form, they ran tests to evaluate their experimental production and used the results as further feedback into the process. The development

of the EGR moved forward incrementally as the engineers repeated this cyclical process. Expressions such as "taking on state-of-the-art technology" may have a nice ring to them, but actually being on the front line involves only patient and unceasing trial and error. Using the analysis data resulting from the evaluation tests, the engineers bounced ideas and opinions off each other until late into the night. The engineers paid the most careful attention possible to everything from the quality of the material to the shape of each part of the engine, and in the case of one crucial part, the EGR valve, the engineers adopted a completely original design never used in an EGR before.

An original "Heavy Duty Cooled EGR" born from days and weeks of patient trial and error

In this way the days passed, and the prototype for the ecot3 was finally completed some five years after development started. The EGR mounted in the new engine was dubbed the "Heavy Duty Cooled EGR" in order to draw a clear line to existing technology. The words "Heavy Duty" also refer to the great personal investment of the many engineers who were involved in its development.

Yet why is it that Komatsu places such great importance on originality that it will go even to these lengths? Manufacturing crucial components within Komatsu is one major way in which it differentiates itself from other companies. There is also the major benefit of reducing the time required for development. Supporting that is the pride of Komatsu's engineering team, which creates the best construction equipment on the globe with their own hands.

In 2011 Tier IV emissions regulations will enter into force, with emissions to be reduced to a level about one-twentieth of that of the 1996 levels. Komatsu's engineers already have their eyes on 2011, and the wave of breakthroughs for the next generation of technology is already underway.



Tier III-compliant engine which incorporates Komatsu's advanced engine technology



I chose this job because I've always liked construction equipment ever since I was a little boy. I have been involved in this project since immediately after I joined the company, so I'm extremely fond of this engine.

IPA Combustion & Fuel System Group
Yoshiaki Kanzaki

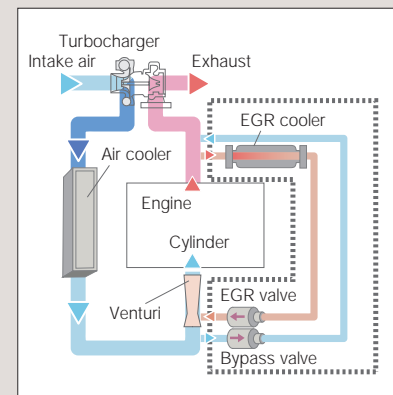


To ensure quality, evaluation tests constitute an absolutely essential process. In these tests we had to be particularly attentive to the fact that, among other things, regulation values and conditions in Japan, the U.S., and Europe are slightly different.

IPA Testing Group
Akira Kusakabe

Heavy Duty Cooled EGR

EGR (exhaust gas recirculation) is a system by which part of the exhaust gas that has already been combusted and whose oxygen content is low is rechanneled into the engine's cylinders. As a result, the binding of nitrogen and oxygen during combustion is kept under control, leading to lower amounts of NOx emissions. Komatsu's Heavy Duty Cooled EGR makes use of an original design to meet the unique quality requirements found in construction equipment while responding fully to the severity of the usage conditions.



Engine air induction system. Red line indicates EGR. By mounting originally-developed valves and the like, Komatsu has increased Quality and Reliability even further.