Mining

MTU and Codelco Norte test technologies for Tier 4 mining engines

Who: Codelco Norte, a division of the largest copper producing company in the world

What: Field testing of peak cylinder pressure on a Tier 4 interim/final MTU Series 4000 pre-trial mining engine

Why: Performance tests of future engine technologies six years ahead of stricter emissions legislation standards

Where: Chuquicamata copper mine, Chile, South America

From 2015, diesel engines in the mining sector in North America will have to meet stringent emissions limits. In order to meet future EPA Tier 4 requirements, MTU conducted pre-trials with a Series 4000 mining engine in the field. Powering one of the world's biggest mining trucks, the engine operated 24/7 in the Chilean copper mines of Chuquicamata over a period of more than six months. During this time, MTU tested the engine under the most demanding circumstances.

Located 3,200 meters (10,500 ft) above sea level and in the middle of the Atacama desert, the air in the copper mine of Chuquicamata is thin, dusty, hot during the day and chillingly cold at night. A windy road leads out of the almost one kilometer deep, 4.5 kilometer long and 3.5 kilometer wide pit. Fully laden, it takes the dump trucks up to 45 minutes to get to the top of the mine. Transporting up to 440 short tons of copper ore per load, the heavy duty trucks take the trip 24 hours a day, seven days a week. A demanding task for the machines and the people running them – and the reason MTU approached the mine's operator Codelco Norte regarding the installation of a pre-trial unit to run tests regarding emission reduction technologies for mining engines: "If the technologies prove successful with the engines here, they will do so practically anywhere in the world," says Norbert Eisenblätter, Senior Manager Global Application Engineering Surface Mining at MTU Friedrichshafen.

Higher combustion pressures for EPA Tier 4

Diesel engine development is dominated by increasingly restrictive exhaust regulations. From 2015, engines employed in the North American mining sector will have to meet the strict emissions regulations of the Environmental Protection Agency (EPA) Tier 4 standard. Future motorizations are only allowed a fraction of today's emission levels. Implementing appropriate technologies is especially challenging in mining applications, where components are strained to the limit. "In order to keep fuel consumption at current levels despite the massive reduction in emissions, we had to increase peak cylinder

Wilson Brevis, Maintenance Manager, Codelco Norte

"The technology, reliability, safety and power density as well as high performance levels of the MTU engines contributed significantly to our fleet's productivity and profitability."

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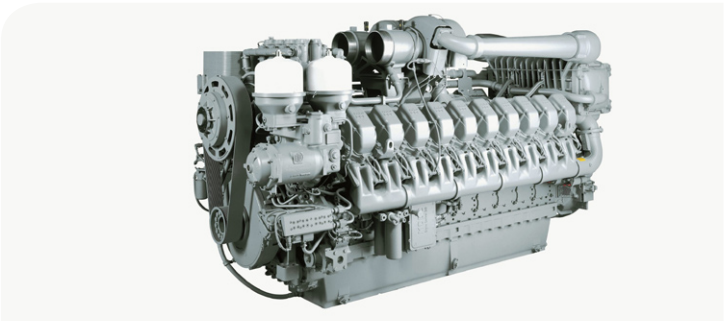

For more than six months, the field testing of peak cylinder pressure on a MTU Series 4000 pre-trial unit for Tier 4 interim/final took place in the Chuquicamata copper mine, northern Chile.
Pictured: 20V 4000 C22

pressures drastically," explains Dr. Ingo Wintruff, MTU project manager for the development of the new Series 4000 generation and head of application engineering of the Tognum business unit Engines. "The high cylinder pressures present a serious challenge for powerpack, pistons and cylinder heads, particularly in demanding mining applications. So to better assess the engine's performance, we decided to run test under actual field conditions at an early stage."

Pre-trial in the world's largest copper mine
For testing grounds, the world's largest copper mine was chosen – Chuquicamata in northern Chile. The supplier of engines and propulsion systems has been working with the mine's operator for many years: Codelco Norte started using MTU engines in 2003 and had them regularly checked by the local MTU distributor right from the outset. Today, 16- and 20-cylinder models of the Series 4000 engines drive a large portion of the mining vehicles in Chuquicamata and the nearby Radomiro Tomic mine. Wilson Brevis, Maintenance Manager at Codelco Norte comments: "We've been using MTU engines in our mining trucks for more than a decade. The technology, reliability, safety and power density as well as high performance levels contributed significantly to our fleet's productivity and profitability."

The robust, fuel efficient 4000 engines have proven themselves in daily operations for years. When MTU was looking for a suitable location to test the emission reduction technologies under actual field conditions, Chuquicamata was the natural choice. "With its vast dimensions, its unique load profile and the prevailing environmental conditions, Chuquicamata offers the opportunity to put engines and associated technologies to the ultimate test," explains Dr. Wintruff.

3,000 hours under field conditions
In 2009, the pre-trial unit was installed in one of the world's largest mining trucks, a Liebherr model T 282 B. Tests were concluded without any difficulties. "It is in our interest to observe first-hand how future technologies perform under real-life conditions," says Brevis. "We see the trials and the possibility of participating in technical developments as a chance to invest in the future of the mine." During the test phase, the engine was thoroughly tested and, after 3,000 hours of daily operation, shipped back for examination to Friedrichshafen. Here, MTU engineers documented and analyzed all the collected data. These insights were not only relevant for engines used in mining vehicles, but also for vehicles with similar requirement profile. From mid-2011 for example, MTU will launch the new Tier 4i Series 4000 models to be used in pump drives of the oil and gas industry. "By the time Tier 4 becomes final for the mining industry, the same technology will have been in production use for three years," comments Eisenblätter. Thus, the know-how comes full circle, and the development of the Series 4000 as a whole benefits from the tests in Chuquicamata.

Proven technologies for mining engines
Continual development has long been the key to the success of the Series 4000 engines. With more than 26,000 units sold since its launch in 1996, this particular engine series is amongst the most popular MTU products and used for power generation as well as in marine, oil and gas, rail and mining applications. In order to meet the increasing demands resulting from emission legislation and customer requests, the series has steadily evolved: The current engine series meet EPA Tier 2 emission legislations by integrating MTU-developed technologies such as common rail fuel injection, electronic engine management and the MTU turbo charger.

EPA Tier 4 final
In order to meet future emission standards, additional engine internal measures will become inevitable. Thus, future generations of EPA Tier 4 final mining engines will feature cooled exhaust gas recirculation (EGR), a two-stage turbocharging system and an improved common rail fuel injection with increased injection pressure as well as a new combustion process with modified valve timing (Miller process). The objective: Avoiding the components used for the aftertreatment of exhaust gases.

For coming engine generations, the key to success will be the perfect integration of all these technologies. "Pre-trials such as the one conducted in Chuquicamata will remain crucial when it comes to optimizing emission strategies," summarizes Brevis. "We're happy to cooperate with such a renowned engine manufacturer and be part of the development of next generation technologies that will advance the mining business."

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MTU is the brand name under which the Tognum Group markets engines and propulsion systems for ships, for heavy land, rail and defense vehicles and for the oil and gas industry. They are based on diesel engines with up to 9,100 kW and gas turbines up to 45,000 kW power output. The company also develops and produces bespoke electronic monitoring and control systems for the engines and propulsion systems.

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