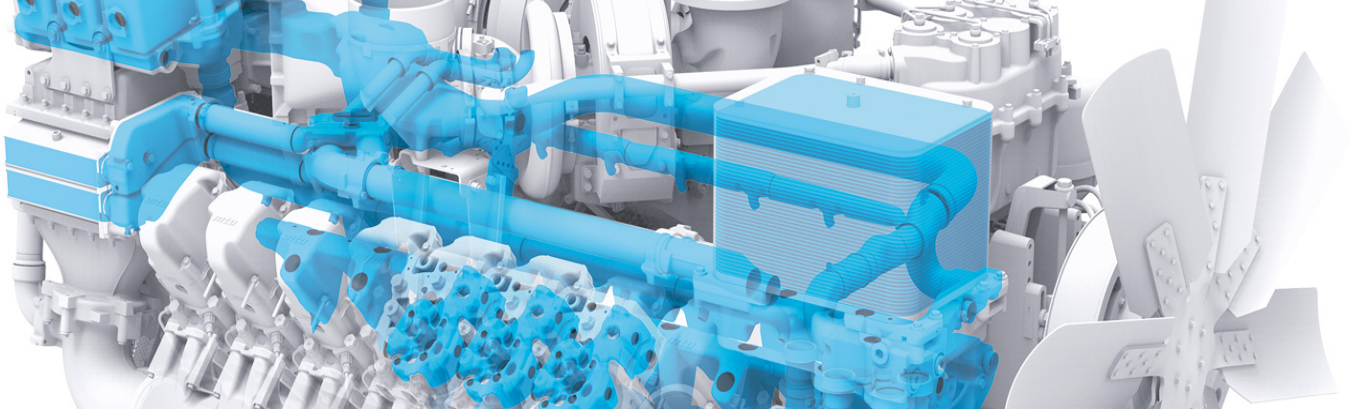


Staying cool

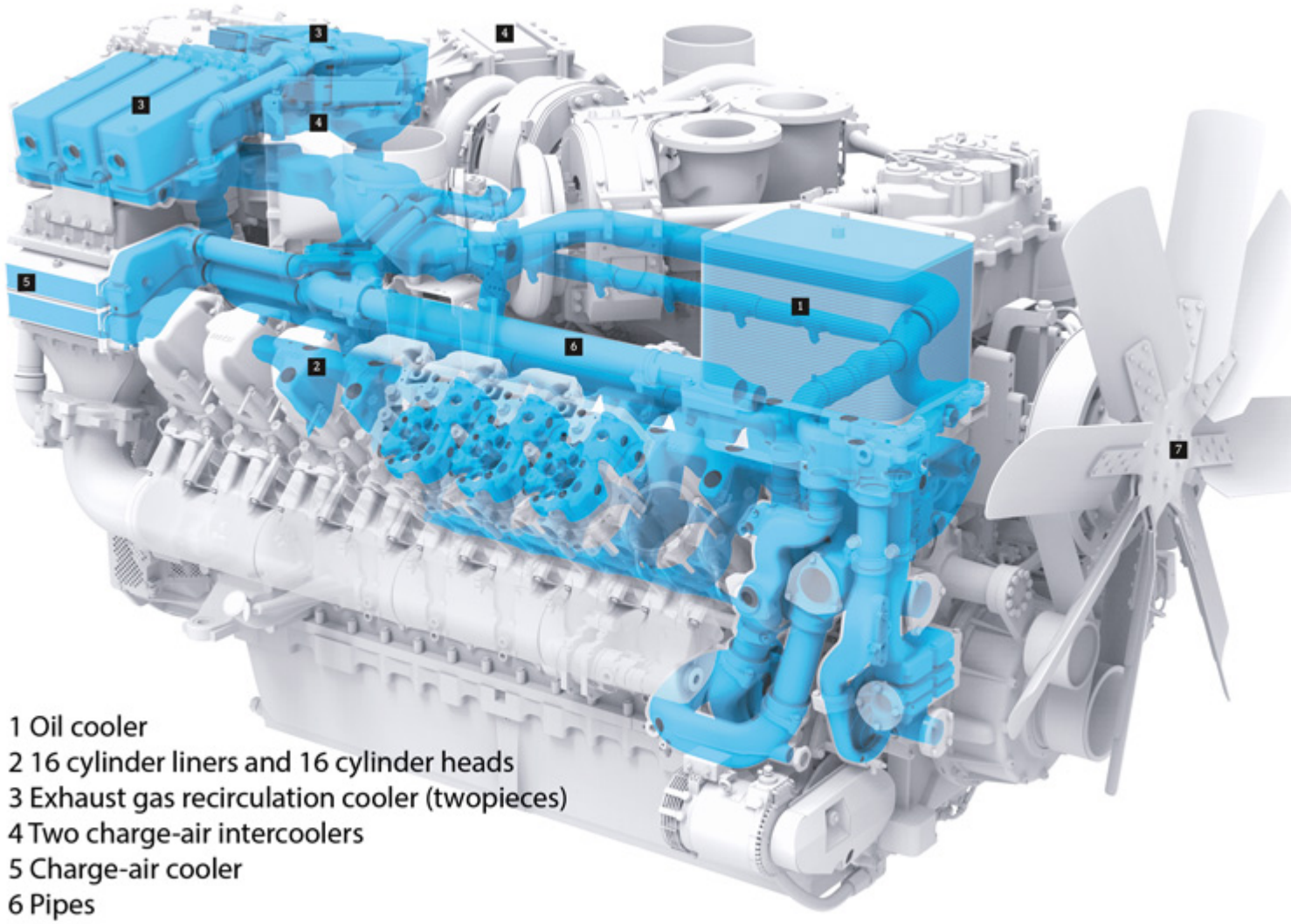
Words: Alina Welsen | Pictures: Adam Wist

Tags/Keywords

Flame temperatures of over 2,000°C that occur during the combustion of diesel fuel stress cylinder heads, pistons and other engine components to their limits. Therefore, excess heat has to be quickly and reliably dissipated via the cooling system. This is a job for which water appears predestined – with the help of some added extras.

For years on end, it does its job unnoticed, covering hundreds of kilometers a day. Only rarely is it paid any attention even though it is essential to engine survival. What we are talking about is engine coolant, a mixture of water, corrosion inhibitor and, if required, antifreeze. It is a multitalented master of many skills that makes sure engine components do not overheat. But it also plays an important role in combustion. It cools the charge air delivered by the turbo to the combustion chamber from a temperature of 250°C down to 50°C. That not only increases power output, it also helps to reduce nitrogen oxide emissions.

Circulating through the engine at 10kph
It is early morning. The sun is just rising above the horizon, and the working day for the 2,240kW (3,000hp) haul truck is about to start. The driver turns the ignition key and the 16-cylinder Series 4000 engine starts up instantly with a throaty rumble. Time for the coolant to get to work. A coolant pump starts circulating roughly 250l of liquid at a pressure of 1.5bar. Inside the closed circulation system, the water-based mixture flows along the 9cm diameter cast-iron pipes. First of all it passes through the oil cooler, around the cylinder liner and into the cylinder head. It continues via other components subject to high thermal stresses, such as the turbocharger and, on vehicles that are required to meet the American EPA Tier 4 emission limits, the exhaust gas recirculation cooler. “The engine coolant reaches temperatures of 105°C, and in military engines maximum temperatures as high as 130°C are possible because it is pumped around the cooling system at a pressure of 4bar,” explains Ralf Speetzen, hydraulic and combustion simulation team leader at MTU. “The primary aim is to ensure the coolant doesn't boil, because that would overheat the components and damage the corrosion inhibitor and anti-freeze.” To prevent that happening, the water-based mixture has to be cooled down again – which is the job of the radiator. The coolant negotiates numerous copper-finned passages to make its way through the radiator. Measuring more than two meters by three, it sits at the front end of the haul truck. Unlike a car radiator, which most of the time can make use of the airflow from the movement of the vehicle, a haul truck radiator needs a fan two meters across to provide a flow of cooling air to remove the heat. Finally, having been cooled to between 60°C and 30°C, the coolant exits the radiator and flows back to the pump. And so the next circuit starts.



1 Oil cooler
2 16 cylinder liners and 16 cylinder heads
3 Exhaust gas recirculation cooler (twopieces)
4 Two charge-air intercoolers
5 Charge-air cooler
6 Pipes
7 Fanwheel

Sea water instead of air

Marine engines are a peculiarity. Many of them use sea water to cool the engine coolant. An additional pump draws the water from about a meter below the surface and delivers it directly to the engine cooler. There it absorbs the heat from the coolant and is then discharged back into the sea or lake. “Salts or contaminants in the water are dangerous. Salts form deposits at temperatures upwards of 48°C, which then attack the components. Dirt in the water can clog up the pump or the pipes. Both of those scenarios have an adverse effect on heat transfer,” explains Helmut Rall, MTU cooling systems expert. “To stop that happening, all components that come into contact with sea water are made of highly resistant bronze. In addition, the pump is as large as possible but as small as necessary to utilize the limited space available most efficiently.”

Sea-water cooling is not suitable for everybody, however. “For ships that travel through polluted waters, cooling via the outer skin of the hull is the most sensible choice. On inland waterway vessels or tugs, for example, the coolant pipes run along the inside of the hull. In that way, the sides of the hull act like a giant engine cooler,” Speetzen explains.

Water – just made for cooling

Water in its various forms and compositions is and remains the number-one coolant. More than any other fluid, it is capable of absorbing large quantities of heat before becoming too hot itself. What is more, it is cost-neutral and universally available, and produces no emissions – so it is a master of all trades with many positive characteristics.

Contact
Helmut Rall

Tel.: +49 7541 90-3522
Email Alina.Welsen@rrpowersystems.com