High-concentration space travel

Ready for take-off on the Soyuz launch pad

On October 21, 2011, a Russian Soyuz-ST carrier rocket launched its first satellite from the Galileo satellite network into orbit from the Kourou Space Center in French Guiana. The necessary thrust was provided by an Evonik specialty: PROPULSE™, a highly concentrated hydrogen peroxide.

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Countdown, the excitement is building, first-night fever, extreme concentration in the control center. Yet it is not only there that concentration is key. At 82.5 percent, the hydrogen peroxide (H_2O_2) on board the rocket is also "highly concentrated". It drives the turbo pumps that force the actual fuels—kerosene and liquid oxygen—into the combustion chambers. As the rocket lifts off, several tons of H_2O_2 will be used up in the space of a few minutes. In the initial launch of a Russian-built Soyuz rocket in French Guiana, highly concentrated hydrogen peroxide developed by Evonik is also being used in the fuel technology of a space rocket for the first time.

The new space center in Kourou was built as a cooperation between Western European countries and Russia under the leadership of the European Space Agency (ESA). Backing this ambitious project is a multinational cooperation that would scarcely have been conceivable some years ago. After the dissolution of the Soviet Union, Russian's space agency Roscosmos began seeking closer contact to ESA. The cooperation is now entering a new era. Once ESA and Roscosmos had agreed to collaborate on Soyuz launches in French Guiana, the Russian company TsENKI, a service provider for space launches and supplier of rocket fuel components, started scouring the global market for capable, reliable partners. "We first made contact back in June 2005," recounts Dr. Stefan Leininger, Head of the Specialty Chemicals Active Oxygens (H_2O_2) segment at Evonik. "We sent TsENKI samples of our hydrogen peroxide PROPULSE™ 825. Extensive testing of the H_2O_2 ensued, along with laboratory tests of catalysts, and the very first rocket test was a success."

Production and use of the highly concentrated substance are not the only steps in which expert know-how is essential, however. Highly concentrated peroxide has a tendency to decompose when warmed or in the presence of heavy metals, so it needs to be suppressed during transportation and storage—firstly for safety, and secondly in order to ensure a consistent and reliable supply of the desired quality to the customer. Apart from this, rockets require especially pure hydrogen peroxide, because any impurities would deactivate the catalyst.

The sky's the limit! The highly concentrated hydrogen peroxide - 82.5 percent - drives the turbo pumps that force the actual fuels – kerosene and liquid oxygen – into the combustion chambers.

Evonik has developed specific, specially approved containers for the transportation of highly concentrated H_2O_2. The inner walls of these thermal containers are first pickled using a complex procedure, after which a protective passivation layer is applied and treated with hydrogen peroxide. Pressure relief systems as well as temperature and GPS monitoring are also used. Packed securely in this way, the hydrogen peroxide is transported by rail from the production facility in Rheinfelden (Germany) to the port of shipment on the North Sea and then across the Atlantic to French Guiana in South America.

Hydrogen peroxide is fairly unremarkable in appearance. It is a clear liquid that looks like water. Normal commercial concentrations are usually between 30 and 70 percent. Special expertise is required for higher concentrations. “Evonik has decades of experience in manufacturing hydrogen peroxide using a process it developed itself and we have the technical ability to concentrate this aqueous solution up to 98 percent,” says Leininger. It is precisely such high concentrations of hydrogen peroxide that are needed to power space rockets.

Production facilities already exist in Germany, Belgium, Austria, the United States, Canada, Brazil, Korea, Indonesia, New Zealand, and South Africa.

So what happens when a rocket is launched? In a standard liquid-fueled rocket engine, the liquid fuel and the oxidant are stored in separate containers. Both of these need to be fed to the rocket engine under high pressure to produce the necessary thrust. "The liquid H_2O_2decomposes over a heavy-metal catalyst, generating a lot of heat," Stefan Leininger explains. "This produces gaseous oxygen and steam, which together drive the turbo pumps, which in turn supply kerosene and liquid oxygen as the oxidant to the rocket engines through impellers at 20,000 to 30,000 rpm."

Hydrogen peroxide has been an integral part of Evonik's portfolio for decades. It is one of the oldest products made by the Group and—though this may sound paradoxical—also one of its most innovative. This is because even though the substance has been known since its discovery in 1818 by Louis-Jacques Thénard, the French chemist who first synthesized it, new applications are still being developed. "One of these is space travel, in which alternative propulsion systems are becoming increasingly important," says Stefan Leininger. "Now we are joined for the first time in this market."

Evonik has annual production capacity of approximately 600,000 tons of hydrogen peroxide and is building a new facility for a further 230,000 tons per year in Jilin (China). There, the H_2O_2 will be used as an environmentally friendly oxidant for the direct chemical synthesis of propylene oxide. Production facilities already exist in Germany, Belgium, Austria, the United States, Canada, Brazil, Korea, Indonesia, New Zealand, and South Africa. H_2O_2 is employed for a very wide range of applications. The largest quantities are still used in pulp bleaching and in manufacturing washing powders and liquids. However, the chemical industry is also increasingly using hydrogen peroxide as an environmentally friendly oxidant in chemical synthesis. Other areas of use include environmental protection, packaging, and the electronics industry. Or—as shown by the rocket launch in Kourou—in propulsion systems for space rockets.

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