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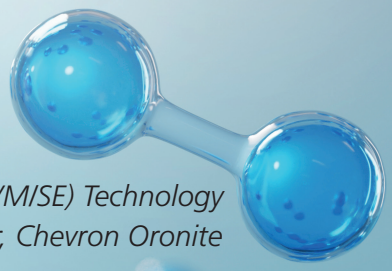
The emergence of hydrogen fuel: what It means for lubricant additive suppliers



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As automotive manufacturers around the world race to meet lower carbon aspirations, much of the industry has focused its efforts on vehicle electrification. However, governments and automotive OEMs are realising that the electrical energy grid may not yet be fully prepared to support electric vehicles (EVs) at scale, especially in developing countries that are still struggling to deliver reliable power to their populations. As a result, the discussion has broadened to include alternative fuels that could more quickly take the place of diesel and petrol. And among those fuels, hydrogen has emerged as an attractive near-term solution – the most attractive, in the eyes of several industry experts. With this in mind, Chevron Oronite has been actively studying the impacts and any associated special needs of lubricant additive formulations that are designed for use in a hydrogen fueled internal combustion engines (ICEs).

Hydrogen is a non-toxic fuel that does not produce greenhouse gases when used in ICEs. It is also recognised for high energy per unit mass and flame velocity well suited to ICEs. Recent regulatory decisions appear to favour the advancement of hydrogen as an alternative fuel in conjunction with the advancements in battery power. For example, engines fueled by hydrogen could fall well within the current EU definition of zero-emission (less than 5 grams/t. km of CO_2 emissions), which is likely to help speed its adoption over other alternatives. In India, where electric vehicles may be too taxing for the country's tenuous power grid, the government is backing research and development on hydrogen. Moreover, where EVs may require a wholesale re-tooling of manufacturing processes and factories, hydrogen proponents point out that the transition from diesel to hydrogen-powered ICEs is far less of a leap for OEMs. Meanwhile, Europe and the US have taken important steps toward developing a hydrogen fueling infrastructure, addressing one of the key bottlenecks to widespread hydrogen adoption.

Lubricants and additives implications

So, what does all this mean for lubricant and lubricant additive manufacturers? Beyond the basics of engine cleanliness, wear protection and oxidation stability, will hydrogen-powered ICE engines present any performance nuances that will require new oil formulations? The answer is still largely uncertain, but that initial testing (conducted by Oronite) has pointed towards certain performance needs. While there are some light duty vehicles on the road using hydrogen fuel cells, OEMs are still working to determine the optimal engine technology and architecture for hydrogen-powered ICEs. Issues such as spark versus compression ignition or fuel injection pressure need to be resolved. Nonetheless, some road trials are underway and lubricant additive research is proceeding in parallel.

One issue that researchers anticipate is the potential for water buildup in crankcase oil. Water vapour is a major byproduct of hydrogen combustion which travels with blowby gases into the crankcase. Will oils need to be able to hold water and prevent phase separation? Will bearings and bushings be vulnerable

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to wear, corrosion, or degradation due to the intrusion of water into the oil system? Another potential issue may arise from additives, such as detergents, that contain metallic components. These metal ions, under certain engine operating conditions, could eventually form "hot spots" resulting in uncontrolled ignition, termed as pre-ignition, in the combustion chamber. This area is being actively researched by the OEMs, and Chevron Oronite is also investigating engine operating conditions and the lubricant additive formulations that influence uncontrolled pre-ignition in hydrogen internal combustion engines.

These are the types of questions researchers are seeking to answer. Some chemists have theorised that there may be unknown physical and/or chemical changes when the lubricant comes into contact with hydrogen in liquid or gaseous form. Exhaustive bench testing at Chevron Oronite has found this not to be the case in a normal engine environment. However, this is an example of the type of phenomena that scientists are trying to anticipate and test for proactively.

Versatility is key

The performance demands on lubricant additives in a hydrogen-powered ICEs will depend largely on the application – long-haul on-highway, urban stop-and-go (school buses or waste haulers, for instance), off-road for mining or construction, possibly even passenger cars. No one is certain at this point which applications are likely to lead the transition into hydrogen use in ICEs. Lubricant producers need to be prepared with versatile solutions that can suit a variety of applications. Additive formulators, meanwhile, can adjust the levels of their various components – detergents, dispersants, antioxidants, friction modifiers and so on – to understand the effects of different balances in various test cycles.

A major challenge confronting the study of lubricant additives in this space is having the right facilities and equipment for testing. With hydrogen ICE technology still in a nascent stage, engines and vehicles for testing are understandably in a short supply. However, seasoned lubricant and additive formulators are in a position to make well-educated assumptions based on years of experience working with similar challenges encountered in areas of gaseous ICE fuels, ICE pre-ignition in light-duty vehicles, and water emulsion formation in the short driving cycles. The challenges of hydrogen-powered engines are not too dissimilar from those associated with diesel or natural gas. Formulating for hydrogen is a matter of figuring out the nuances.

Notwithstanding the promise of hydrogen, there is still much to be proven. For now, it is one of the many alternative routes to lower carbon energy sources that is under consideration. However, based on preliminary results for fuel economy and lower emissions, it has the potential to figure more prominently in the mix. Given the level of interest and investment in hydrogen, it may well advance quickly and become commercially viable sooner rather than later, and the lubrication industry needs to be ready for a variety of application scenarios.

Chevron Oronite anticipates a greater demand for hydrogen-powered ICEs and is actively working with OEMs and its lubricant partners to identify additive solutions that will meet their needs.

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