

VBASE Oil Company's Hydro T-EL: A New Environmentally Safe Lubricant for Hydro

VBASE Oil Company's new Hydro T-EL product is a biobased high-performance lubricant that meets the U.S. Environmental Protection Agency's standards for environmentally acceptable lubricants. In this interview, VBASE CEO Jeff DiMaio and Technical Sales Lead Zach Hunt talk about the product's development, its potential, and the barriers to adoption by the hydro industry.

Hydro Leader: Please tell us about your background and how you came to be in your current position.

Jeff DiMaio: I'm the CEO of VBASE Oil Company. I earned my PhD in material science from Clemson University and spent my career working on advanced materials development. I also am the CEO of Tetramer Technologies, an advanced materials company. For the last 20 years, Tetramer has worked under both industrial and government contracts on a broad range of applications. A big area of emphasis has been biobased materials. About 7 years ago, we were using some chemistry, and Zach kept saying we should be able to make an oil out of it. So, we secured funding from the U.S. Department of Energy (DOE) and the U.S. Department of Agriculture (USDA) to develop a new biobased oil. After about 5 years of development, we started VBASE Oil Company in 2021.

Zach Hunt: I am responsible for technical sales and application development at VBASE. Jeff and I met in grad school, and when Jeff finished with his PhD, he went to work at Tetramer. When I finished my master's at Clemson, Jeff hired me. As Jeff said, we've been working in biobased and renewable materials for the last 15 years, culminating with the foundation of VBASE and the development of these novel oils.

Hydro Leader: Please tell us about your products for the hydro industry.

Jeff DiMaio: VBASE Hydro T-EL is a biobased, biodegradable turbine lubricant that was developed specifically for hydropower. Our scientists designed the oils that form the base of Hydro T-EL to have some of the highest performance you will see in any lubricant. At the same time, we carefully engineered a degradation pathway so that the product will safely break down into nontoxic, nonbioaccumulating components if it is released into the environment. The result is a lubricant that is extremely stable in equipment, even when water might leak into the equipment. Traditionally, an oil that is stable to water, higher in viscosity, and biodegradable has not been an option. We are the first.



Products in the VBASE warehouse.

Zach Hunt: In most facilities, the turbine oil that goes into the guide bearings and thrust bearings, which keep the turbine in place, is also used in the governor systems and some of the ancillary hydraulics that control things like the wicket gates. With the understanding that in a hydropower facility, turbine oil will be used across a broad spectrum of applications, we designed Hydro T-EL to meet all the requirements for a facility, not just the turbines.

Jeff DiMaio: We are also working with turbine manufacturers and end users to develop higher-viscosity gear oils, and we've seen lots of interest in grease as well.

Hydro Leader: Would you tell us more about the DOE grant you mentioned?

Jeff DiMaio: In 2017, there was a call from the DOE's Water Power Technologies Office to develop an environmentally acceptable lubricant for use in hydropower turbines. The call was pretty much that simple. They needed a new lubricant that could withstand hydropower conditions and that would also be safe for the environment if an accidental discharge of oil into the water around the facility were to occur.

Zach Hunt: The DOE wanted a turbine oil that could meet the environmental specifications of the Vessel General Permit, now the Vessel Incidental Discharge Act (VIDA), which regulates lubricants on ships in U.S. navigable waterways. Under VIDA, any lubricant that could contact water has to be biodegradable, nontoxic, and nonbioaccumulating. The call

included a list of specifications from the U.S. Army Corps of Engineers indicating what it would want to see from that oil—things like viscosity grade, flashpoint, and oxidative stability—and Hydro T-EL meets all those specs. However, the costs of development and testing, getting approvals, and eventually seeing a product through to adoption within the industry are substantial. In addition, there's a perception that switching oils in a hydropower system is risky.

Hydro Leader: Why is it viewed as risky?

Jeff DiMaio: Whenever you switch from one type of oil to another, you need to make sure that the current gaskets and seals are compatible with the new oils and that the used oil and the new oil can be safely mixed together. Again, we designed Hydro T-EL for compatibility with most common seal types and lubricants, and we have the data to show that, but before we put Hydro T-EL into a new facility, we work with operations and maintenance to test and confirm that there are no surprises. The lubricant experts at each hydro facility understand these technical details.

Zach Hunt: It's an aggregate risk. As we understand it, a lot of the hydropower in the United States is regulated production. Facilities are mandated to keep producing power, and they have to account for the loss of production during any shutdown. Therefore, any change to any system is avoided—and shutdowns that can't be avoided are thoroughly planned in advance. So, in addition to the inherent risks that come with adopting new things in any system, because hydropower is so regulated, the industry is cautious about making changes.

Jeff DiMaio: We've seen that operators are even reticent to make the switch between mineral oils, brands, or grades within the same brand. If they start with a brand in a particular viscosity grade and it works, they never change. As Zach said, this aversion to risk is understandable within the realities of operating a hydro facility. At the National Hydropower Association's Clean Currents meeting this year, the Waterpower Innovation Council had a discussion on this exact topic: How do we innovate in an industry that, for good reason, is fundamentally risk averse? We can show that our product is environmentally acceptable, and we can demonstrate that it's a high-performing lubricant, but it's still a hard sell in the highly regulated hydro industry. Every time we add a new installation, though, that perception of risk goes down a little bit for the next facility. The commercialization work is just the hard work of innovation.

On the positive side, there are now incentives that didn't exist when we started developing this product. Grant funding from the Bipartisan Infrastructure Law and tax credits from the Inflation Reduction Act have the potential to incentivize and subsidize the switch from a mineral oil to an environmentally acceptable lubricant.

Hydro Leader: What standards do you follow to ensure that your product is environmentally safe?

Jeff DiMaio: Various laws regulate what oils can be used in applications that involve a risk of spillage into waterways. We built our product based on the European Union's Ecolabel Lubricant Substance Classification List, which establishes a standard for an environmentally acceptable lubricant, and we've done third-party testing. The list requires that a biodegradable substance degrade 60 percent within a 10-day window. VBASE exceeds the minimum requirements and further degrades more than 80 percent within 28 days. It also needs to be nontoxic and nonbioaccumulating, which means that if it's ingested by an animal, it doesn't build up over time. We've done toxicity testing on invertebrates and fish. The third requirement is that it is biobased, and although the percent of biobased content varies by viscosity grade, all VBASE products meet USDA biopreferred status and are over 50 percent biobased.

Hydro Leader: Are the grants competitive? Did other companies receive grants under that same program?

Zach Hunt: All the Small Business Innovation Research programs are competitive. For the DOE solicitation, two or three other companies won awards for phase I, and two others for phase II. The phase I program, which is effectively a proof of concept, lasts roughly a year. Phase II and sequential follow-on funding are intended to push a technology that's been technically vetted closer to commercialization. We're presently on our second phase II. We've been working on this specific problem for 6 years.

Hydro Leader: Is there any other product like Hydro T-EL?

Jeff DiMaio: We developed the molecule that forms the base oil with the end of the life cycle in mind. We asked how we could develop a high-performance oil that is also safe for the environment. To do that, we took traditional synthetic ester lubricant chemistry, which is generally known to be the best-performing lubricant system, and we stabilized the ester bond from attack by water (hydrolysis). This is one of the major issues inherent to traditional synthetic esters. We've termed the material we developed *secondary polyol esters*. The word *secondary* refers to the fact that it involves a different type of bond than traditional polyol esters, and it's that structural difference that improves stability. There's nothing else like it on the market right now.

Hydro Leader: What can you tell us about field use of your turbine oil?

Zach Hunt: We have Hydro T-EL in turbines in the field, but we can't always share who we are working with. We have been fortunate to work with GE Renewable Energy in phase I and our initial phase II. That collaboration allowed

us to test our oil on a bearing test rig at GE's Global Center for Excellence in Switzerland. The GE engineers validated that this oil performs at the level they would expect for a commercial turbine. Based on those results, in 2023, we will run a demonstration trial on a 10-megawatt turbine at the Porjus Hydroelectric Power Station in Sweden. The station, which is Europe's preeminent hydropower research and development facility, is operated by Porjus Hydropower Centre Foundation, a joint collaboration of Andritz, GE Renewable Energy, and Vattenfall. We're probably looking at a 12- to 18-month run time.



VBASE Hydro T-EL will be in field trials in the 10-megawatt turbine at the Porjus Hydroelectric Power Station in Sweden. The station, which is Europe's preeminent hydropower research and development facility, is operated by Porjus Hydropower Centre Foundation, a joint collaboration between Andritz, GE Renewable Energy, and Vattenfall.

Jeff DiMaio: Thankfully, we do have operators who are willing to be earlier adopters, and over the next year, we will have more and more announcements so that information can be shared among the different facilities. This is why we are fortunate to have access to the Porjus facility. Overall, the lack of large-scale research facilities in the United States, and really throughout the world, is a challenge for all hydropower innovators. Thankfully, the DOE and the hydropower industry are aware of this and are actively working to identify a location for a research facility or a network of asset owners who are willing to do different types of research at their facilities. With that distributed capability, one asset owner may be willing to try different lubricants and another one may be able to test different types of fish passages or advanced turbine designs.

Zach Hunt: The industry itself, from massive producers like the Tennessee Valley Authority and the Army Corps to smaller producers like Duke Energy, realizes that there needs to be a place to do this research to advance the industry.

Hydro Leader: Are you marketing internationally, or is your focus domestic right now?

Jeff DiMaio: We're definitely marketing internationally. As we said, we did all our testing in Switzerland and our first field trials are in Sweden. The bulk of our efforts are focused on North America, but we are getting inquiries from throughout the world, and we are working on getting appropriate certifications to serve those markets.

Hydro Leader: What is your company's vision for the future?

Jeff DiMaio: People have asked us, "If you're making a biobased, environmentally acceptable lubricant, why did you put the word *oil* in your company name? That sounds dirty." We reply that we want to remove the stigma from oil and lubricants. Fundamentally, oil and lubricants in general are among the technologies that best support sustainability. They increase the efficiency of machines and improve the overall lifetime of equipment. Lubricants reduce carbon emissions and decrease waste. For this reason, we wanted to highlight the fact that we are an oil company. But we are an oil company that is going to use chemistry and materials science to do no harm. That is to say, we can have all the benefits of a high-quality lubricant without the negative effects that are associated with the use of petroleum. Our start is with hydropower turbine lubricants, but we are growing VBASE Oil Company globally as a base oil company. We are already working with multinational partners that are qualifying our base oils for their formulated lubricants. Interest and excitement are primarily being driven by the oils' performance, but the environmental aspect is definitely an attractive part of the story. As we look beyond our adoption and growth phase, VBASE Oil Company is already working in our labs on technologies for molecular recycling of the oil molecule. While it's over 50 percent biobased, we are looking at how we can work to bring that oil back at its end of life and convert the oil back to its starting components so that they can be cleaned up, purified, and used to make new oil again. H



Jeff DiMaio is the CEO of VBASE Oil Company. He can be contacted at dimaio@vbaseoil.com.



Zach Hunt is the technical sales lead at VBASE Oil Company. He can be contacted at hunt@vbaseoil.com.

For more on VBASE, visit vbaseoil.com.

LEFT PHOTO COURTESY OF VATTENFALL. HEAD SHOTS PHOTOS COURTESY OF VBASE.

Hydro Leader

VOLUME 4 ISSUE 2

FEBRUARY 2023



**Bill McCormick:
Advocating
for the Most
Accurate Tools
to Estimate
Extreme
Precipitation**