



Betting on bio to win

Sustainability, regulation and performance arguments are driving the use of bio-based lubricants, produced using a variety of technologies, both old and new

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The lubricants market is committed to increasing the sustainability of its products and processes, but that is not the primary driving force behind the growth of bio-based base oils, lubricating oils and greases. Cost-effective performance remains paramount and both vegetable-derived and biosynthetic base oils provide certain performance advantages over their petrochemical counterparts for some applications. Their biodegradability is an added advantage.

Bio-based lubricants account for only a small fraction of the total lubricants market: estimates range from 2–5% to less than 1%. However, demand is growing at a healthy rate – most believe about 5–10%/year globally. Major players include large agribusinesses such as Minneapolis, Minnesota-based Cargill, which offers vegetable-based oils, but there are many smaller companies participating in the market such as LubriGreen Biosyn-

thetics, of Irvine, California, and Performance Biolubes, of Cedar Falls, Indiana.

More recently, biotech start-up companies such as Elevance Renewable Sciences in Woodridge, Illinois, and Californian firms Amyris in Emeryville, and Solazyme in San Francisco, have developed fermentation-based processes for the production of base oils from renewable raw materials.

PETROLEUM DISCONNECT

All of these companies are taking advantage of the growing need for higher performing, longer-lasting lubricants that are cost-effective and avoid the uncertain pricing schemes associated with lubricants derived from crude oil. “The desire to disconnect from petroleum pricing and not rely on a single source of supply has been a key driver for the interest in our *NovaSpec* base oils and *EvoShield* lubricants,” notes Jim Richardson, president of lubricants and fuels at Amyris.

Cargill has had a similar experience, with

most customer inquiries centered around finding an alternative to petroleum-based products, says Cargill industrial oils and lubricants president Kurtis Miller.

Lubricant end-users are also operating their equipment for longer periods under more extreme conditions. “Lubricants that can withstand these more severe operating conditions, plus contaminants such as dirt, sludge and water, will be more valued by the industry, says Dan Deneen, Solazyme director of business development, lubricants. For these value-added applications, polyol esters derived from fatty acid feedstocks between C8 and

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CEO, LubriGreen Biosynthetics

C18 have worked well, because they exhibit good cost performance, a wide temperature operating range and good oxidative and thermal stability.

“The need for improved longer-term performance has been a real driver for our business. And with states like California calling for longer lifetimes for lubricants, we only see this demand driver becoming more important,” adds Jacqueline Garmier, president of Renewable Lubricants in Hartville, Ohio.

The “green” nature of bio-based lubricants is the third factor contributing to their growth. “Like bio-fuels, the use of sustainable lubricants helps to reduce carbon in the atmosphere,” says Allen Barbieri, CEO of LubriGreen Biosynthetics. “They are also non-toxic and biodegradable. According to the EPA [US Environmental Protection Agency], over 40% of water pollution in the US comes from used motor oil that is either improperly disposed of or that leaks on to roadways and washes into streams and lakes.

The biodegradability of bio-based lubricants is therefore a key advantage, particularly for lubricants used in “total loss” applications, and even more so when these applications are environmentally sensitive, such as forestry, marine and mining, says Deneen.

“New oils, however, such as Solazyme’s algal oils, offer oxidative stability never before seen in vegetable oils, providing increased oil and equipment life while continuing to be both biodegradable and now sustainable as well,” Deneen adds.

Advances in technology have made these high-performing, cost-effective sustainable lubricants possible. In fact, today’s bio-based lubricants often offer additional performance advantages over conventional petrochemical

» products. The chemistry of bio-based oils can also be adjusted to tailor performance to the specific needs of customers and their particular end-use applications.

Stability, reactivity and stain-resistance requirements can be controlled by the choice of vegetable oil, says Miller. The oils can be functionalized through hydrogenation, oxidation, polymerization, amidation and esterification to impart certain performance characteristics. “There is definitely growing interest as people formulate with these new products and get familiar with their chemistry,” he says.

Cargill sees the greatest interest in its bio-based base oils for functional fluids such as hydraulic and transformers oils and crop protection adjuvants. Cargill is also looking at hydraulic fracturing fluid applications, and Miller expects to see big growth in this market in 2013. Renewable Lubricants, which manufactures bio-based lubricants and markets more than 250 patented products, including biosynthetic engine, hydraulic and gear oils, has seen more than 30% growth in recent years and expects to maintain that level.

Garnier sees growing interest across the globe and in the US. She points to the US Department of Agriculture’s biopreferred program and growing interest for equipment used by the food industry, since the products are derived from edible oils. She also points to recent legislation requiring the use of lubricants approved for indirect food contact in water-processing units as an additional driver for growth.

DROP-IN AUTOMOTIVE REPLACEMENT

The greatest interest at LubriGreen, meanwhile, is being seen in its new drop-in biosynthetic lubricants for engine oil applications. Barbieri says the company has developed a process for the manufacture of biosynthetic oils that achieve test results equal to petroleum-derived synthetic base oils in GF-5 engine testing, and expects to offer these products at pricing competitive with group III and IV base oils.

He notes that in 2012, several finished passenger car motor oil products will be tested and certified (API and otherwise) by LubriGreen’s global manufacturing/distribution partners, and the company’s pilot plant will be completed. Product launches are planned for 2013, and a full-scale manufacturing plant will be built in Houston, Texas, in partnership with a global chemical company. LubriGreen is also in discussions with manufacturing partners in Europe and Asia.

Solazyme and Amyris start with a more basic feedstock – algae oil for Solazyme and plant sugars for Amyris – and convert them via microbial transformations into products that can be used as base oils for lubricants.

Solazyme has focused on developing oils with improved resistance to oxidation and better low-temperature properties. The oils can be



Green products from Renewable Lubricants (left, top right) and Amyris (bottom right)

produced with controlled chain lengths, saturation levels and functional group additions, and thus can have specific melting points, varying concentrations of desired fatty acids, and high concentrations of unusual fatty acids.

The technology benefits from the use of non-edible feedstocks and the ability to control the types of oils that are produced, thus eliminating any effects of the unpredictable supply-and-demand situation seen with vegetable oils, says Deneen.

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KURTIS MILLER
President, industrial oils and lubricants, Cargill

In February 2011, Solazyme entered into a joint development agreement and a letter of intent with Dow Chemical for the commercialization of bio-based dielectric insulating fluids for transformers and other electrical applications. Dow will contribute its formulation expertise and Solazyme’s algal technology and oils. In 2012, the company plans to introduce a portfolio of products that can be used to meet industry performance requirements and represent an upgrade in performance.

Amyris has also formed partnerships to advance its biosynthetic base oils. Novvi, its 50:50 joint venture with leading Brazilian sugar cane biofuel producer Cosan, was formed in June 2011 to develop, produce and commercialize renewable base oils made from

Biofene, Amyris’s renewable farnesene, which is produced from plant-sourced sugars via fermentation. Biofene is a pure C15 hydrocarbon with multiple sites of unsaturation that offer flexibility for chemical transformation.

The base oils Amyris makes from *Biofene* are fully saturated, branched-chain alkanes (iso-paraffins) with low volatility that, because of their branched structure, also have a good mix of cold flow properties, biodegradability and oxidative and thermal stability.

US specialty chemical producer Albemarle, of Baton Rouge, Louisiana, has been selected as the manufacturing partner for the joint venture, which will market the synthetic base oils under trade name *NovaSpec*.

Amyris has also formulated its own line of renewable lubricants marketed under the name *Evoshield*. In 2012, the company expects to start scale production and sales. “The strongest demand for our lubricants is in the large automotive sector, which requires the high-performance characteristics that our *NovaSpec* base oils offer,” Richardson notes.

The development of bio-based lubricants is a natural part of the “greening” process in the industry. The first step, Richardson says, was increased efficiency and waste minimization. The second stage involves the re-refining of used oil, which Valvoline has recently made mainstream with its *NextGen* product, and which will be a critical component of the lubricants market (see page 21).

Using renewable feedstocks is the most recent phase. “It is only a matter of time before the economics drive the adoption of bio-based lubricants,” he concludes. ■

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