Biobased products

Green Biologics: Selling commodities as specialties

Industrial biotechnology company Green Biologics Ltd. (GBL; Abingdon, United Kingdom) produces *n*-butanol and acetone by fermenting sugars from renewable feedstocks. The two products are drop-in alternatives to petroleum-based chemicals and find use in a variety of applications. Although *n*-butanol and acetone are typical examples of commodity chemicals, sold on volume and price, GBL is effectively selling its versions of the products as specialties. "What I think is interesting around Green Biologics is how we are developing a specialty chemicals market in what is effectively a commodities space," says Sean Sutcliffe, CEO at GBL. "We're not really competing with our friends at BASF [SE] or Dow [Chemical Co]. They focus on volume, price, and supply chains. We're focusing on similar molecules but on a different sector entirely, where it's performance and downstream value that count."

SUTCLIFFE: *Focused on performance and value.*

The company's objective is to apply synthetic biology and modern process technology to the clostridium microbial fermentation process to develop and produce renewable biobased products. "It's a specialty chemicals business but with perhaps a stronger intellectual property [(IP)] base than usual," says Sutcliffe. "Our IP base is particularly strong in this sector, with the technology underpinning the strategy. Our key strategy is bringing specialty chemical applications that provide a mixture of higher performance and natural ingredients ... . There is a strong market drive towards green, natural, sustainable ingredients." GBL says that its competitive advantage straddles the biology, the process, right through to the end market. "Our business model is that we develop the technology; we own, operate, make, and sell the product, and work [closely] with customers," Sutcliffe says.

People prefer the term *natural* to *low-carbon*, according to Sutcliffe. Consumers, in his view, do not buy low-carbon because it does not resonate with them, [whereas] natural does, particularly with something they are going to use and feel and touch. The perception is that a "natural" chemical or formulation will most likely have fewer "nasties" in it than a petroleum-based product, he says. "Technically speaking, this is true," Sutcliffe says. "Consumers perceive that *natural* is some way better for them. That's where the branding seems to be very powerful, particularly in the United States, which is our focus. Ultimately, I believe the driver is better performance, and if you can combine that with a natural branding, your point is spot on."

Renewable *n*-butanol provides a route to sustainably sourced esters of naturally derived fatty acids, such as oleic and palmitic acids, routinely used in the personal-care industry. GBL is using this approach to introduce a series of unique esters to enhance performance in cosmetic and personal-care products. Bioacetone offers a renewable alternative to petroleum-based acetone and other chemicals widely used in cosmetics and personal care. "[Our bio]acetone is benzene-free, and benzene is a known carcinogen," says Sutcliffe. "The benzene in [synthetic] acetone is a big issue in home applications, so a benzene-free, natural nail polish remover is a winner." Isopropyl alcohol can be made from bioacetone by hydrogenation. Esterification of renewable acetic acid with biobutanol results in butyl acetate that is 100% biobased.

The company is collaborating with third parties to convert these chemicals into high-value derivatives, such as dibutyl succinate (DBS), butyl acrylates, butyl acetate, other butyl esters, and butyl glycol ethers, as well as amino resins, amines, and plasticizers. "We've done a bit of test tolling synthesis to make dibutyl succinate, like 100 gallons of product for sampling," Sutcliffe says. "If we were doing it full scale, we'd toll manufacture that." Combining biobutanol with biobased succinic acid would result in DBS that is based 100% on renewable feedstock.

Central Minnesota Renewables, an affiliate of GBL, is producing about 75% biobutanol and 25% bioacetone, according to Sutcliffe. GBL has been producing renewable *n*-butanol through a collaboration in China since 2012, using corn cobs and corn stover as a feedstock.

PROCESS INNOVATION: *GBL uses fermentation to make drop-in alternatives to petroleum-based chemicals.*

GBL's first commercial facility for renewable biobutanol and bioacetone is being built at Little Falls, Minnesota. Start-up is scheduled for later this year, with shipments to customers due by the fourth quarter, GBL says.

GBL's advanced fermentation process (AFP) has been developed with an initial focus on producing biobutanol and bioacetone. The company says its technology platform is well positioned to deliver other renewable, high-value chemicals. GBL is assessing opportunities across a range of C3 and C4 chemistries capable of being produced by using its clostridium technology platform, as well as derivative products produced through synthetic chemistry.

The AFP combines the company's proprietary solventogenic clostridium and a process configuration. Compared with traditional fermentation platforms, the GBL platform can reduce the production cost and the capital cost of implementation, the company says. "[AFP] is giving us something like four times the productivity of a standard process, which obviously brings a [capital expenditure] advantage as well as an [operating expenses] advantage," says Sutcliffe.

Lower oil prices have changed how companies see drop-in renewable chemicals. The focus has shifted from making drop-in chemicals to differentiated materials that benefit performance.

—MICHAEL RAVENSCROFT