

Bio Acrylic Acid Development Update

SPECIAL REPORT: ACRYLIC ACID

Amid falling petrochemical prices led by lower crude oil prices, BASF has decided to abandon its collaboration

on bio-acrylic acid development with Novozymes and Cargill stating in a private interview that the company's

global Hygiene business unit could not reach its overall targets for commercialising a dextrose-based product

and that the company does not view investment in scale-up as a viable option at this time.

BASF said it had decided to end the collaboration by the end of November after considering multiple

factors in taking the decision. The company did recognise that the collaboration was able to successfully

convert 3-hydroxypropionic acid (3-HP) into bio-based acrylic acid.

Novozymes announced last month BASF's decision to leave the project. Novozymes and Cargill will

continue to commercialise the technology and said that they have now initiated efforts to find a new

commercialisation partner. Novozymes and Cargill have been working on the project since 2008

and BASF joined the collaboration in 2012. In September last year, the companies reported milestone

achievements in the successful conversion of 3-HP to bio-based glacial acrylic acid and superabsorbent

polymers (SAPs) at pilot scale. The partners have demonstrated the production of 3-HP from dextrose at

pilot scale since July 2013.

Novozymes recently noted in a private interview that the company was baffled by BASF's decision to leave

the project despite the milestone. Novozymes said it had been also in doubt in the first couple of years

whether the technology is economical but after last year, it is confident that the project will be able to push

through to the next commercialisation phase, despite the setback of BASF's departure from the partnership.

However, it will not be easy to find a partner as big as BASF in the acrylic acid demand space. BASF

is a large producer of petro-based acrylic acid but much of it is for captive use in the production and

downstream processing of acrylic acid-based derivatives including SAPs and acrylates. Below are the

world's top acrylic acid producers in the marketplace:

World Top Acrylic Acid Producers 2014

<i>Company</i>	<i>Location</i>	<i>Capacity (ktpa)</i>
BASF	Various	1245
Jiangsu Jurong	China	605
Arkema	US & France	545
Dow Chemical	US	520
Nippon Shokubai	Japan	520
StoHass	US & Germany	430
Formosa Plastic Corporation	Taiwan & China	400
Zhejiang Satellite	China	375
LG Chem	South Korea	353

Source: Tecnon OrbiChem

The global acrylic acid market is estimated almost 5 million tons in 2014. Bulk acrylates account for

the biggest use of acrylic acid with about 45% of total consumption. The second largest use is in SAPs,

accounting for about 37% of consumption. The trend to higher add-on amounts for SAP to diapers in an

effort to reduce fluff pulp content continues to support demand via glacial acrylic acid use.

All commercially produced acrylic acid currently uses propylene feedstock. Four years ago, the projections were

that propylene would be in short supply because of the increase in shale gas use, which leads to less production

of propylene compared to naphtha cracking. It now appears that the increase in global investments for onpurpose

propane dehydrogenation (PDH) plants and other process technologies producing propylene have

changed the projected supply dynamics for propylene and in turn for acrylic acid.

BASF itself has announced planned investments last year for a global-scale methanol-to-propylene (MTP)

plant in the US using methanol from natural gas. MTP is projected to have the lowest cash costs of

production of propylene compared to naphtha crackers and PDH. In China, coal-to-olefins technology is

being used to partly satisfy the domestic demand for propylene.

There are very few developers that are near the commercialisation stage in the bio-acrylic acid space

aside from the Novozymes/Cargill collaboration. OPX Biotechnologies has partnered with Dow Chemical

for the production of acrylic acid using glycerol for feedstock. The companies have been both quiet on

the progress of their collaboration but it was heard that OPX Bio is looking to build a plant in Southeast

Asia pending financing. Glycerine is plentiful in Southeast Asia as it is a co-product in the production of

oleochemicals as well as in biodiesel and soap manufacture. The Malaysian oleochemical and palm

industries, in particular, are looking for more lucrative downstream products using palm oil feedstock. Dow

Chemical, on the other hand, is also building a PDH plant in Freeport, Texas, that is expected to come

online this year.

Major acrylic acid players, Arkema and Nippon Shokubai, have also been looking to produce bio-acrylic

acid from glycerine but there had been no news of further advancements in their projects after reported

success at the pilot scale.

Novomer is pursuing a different route to acrylic acid by using their proprietary catalysts to produce

polypropiolactone from ethylene oxide and carbon monoxide. Polypropiolactone can then be converted

to glacial acrylic acid via pyrolysis. The ethylene oxide can either be bio-based or petro-based depending

on its current economics. Novomer has been planning to run a 5 ktpa pilot plant for producing acrylic

acid this year.

It was reported that Evonik, through its Creavis business, has also developed a catalyst that promotes the

reaction of CO₂ with ethylene to make an acrylic acid ester in a one-step process. Reaction conditions are

said to be milder than BASF's similar process, which is two-stage to make acrylic acid. This development

is still at laboratory stage.

Archer Daniels Midland (ADM) also has a pilot plant that can produce acrylic acid using glycerine.

The company has not announced any plans to further commercialise its technology. ADM is already

commercialising starch-based SAPs as an alternative to polyacrylate-based SAPs. The company partnered

with CIC Holdings and Chemanex in 2013 for a joint venture to build and operate bio-based SAPs

production facility near Colombo, Sri Lanka. ADM will be the majority owner of the venture and will market

the bioSAP™-brand superabsorbents.

It is not known if ADM's BioSAP is 100% renewable-based or a hybrid SAP where polysaccharides are

still copolymerised with acrylic acid or acrylates. However, the company's Lysorb® polysaccharide-based

polymer, a technology acquired from Canadian company, Lysac, is reportedly 100% renewable-based.

Consumer products company, Seventh Generation, reportedly uses Lysorb® in some of its feminine hygiene

a. products.

In an interview with BASF's Hygiene business unit, representatives noted that the company is evaluating

further opportunities along the entire value chain to improve sustainability development for its customers.

An example is its HySorb® Mass Balance approach SAPs that use 3rd party certified waste and biomass-derived

materials such as ISCC-certified bio-naphtha. Mass balance is currently the company's way of deriving products from renewable raw materials, with plans to look at long-term solutions such as resources

derived from lignocellulosic.

BASF said it is currently talking with customers in general about the sustainable disposal of diapers but as

of now there are no biodegradable alternatives to polyacrylates although there are niche suppliers for other

biodegradable materials.

Source: Tecnon Bio-Materials and Intermediates Issue 118 February 27 2015