Glycerine

Will glycerine replace conventional petrochemical feedstocks?

The biodiesel trend has led to a glut of cheap glycerine

Growing concerns about the environment and the ever more restrictive regulations to control environmental pollution have caused researchers to search for innovative and economically viable alternative raw materials to use in the industrial and energy production sector

Fatty acid methyl esters (FAME) derived from vegetable oils and fats is considered as one such alternative renewable fuel. FAME was initially produced for use as the intermediate feedstock for natural-based detergent (fatty alcohol) production but is increasingly used as a fuel blending component or as diesel replacement (i.e. biodiesel) since the introduction of the European Biofuels Directive in 2001. This helped to drive biodiesel production, which in turn produced a by-product called glycerine/glycerol.

Glycerine was not always found to be compatible with its growing availability. For every 10 kilograms of biodiesel produced, approximately 1 kilogram of a crude glycerol by-product is formed. As global biodiesel production expands rapidly, the quantities of crude glycerine entering the supply chain has flooded the market and caused a precipitous drop in price of both refined and crude glycerine. As a result, much of the crude glycerol by-product of biodiesel production is currently disposed of or is sold at a very minimal price.

Glycerine is a cheap alternative raw material, but some conventional synthetic routes are still competitive

As glycerine prices dropped and petrochemical raw material prices increased during the 2000-2010 period in line with crude oil prices, efforts were made to try to capitalise the cheap glycerine and use it as petrochemical feedstock substitutes. The following table represents Nexant's estimation of select products that can be produced via glycerine and synthetic routes (i.e. crude oil or gas).

	Glycerine-route	Conventional synthetic route	Winning (Cost-wise)
Propylene glycol	765	1486	Glycerine
1,3-Propanediol	832	1056	Glycerine
Crude acrylic acid	1069	961	Synthetic
Epichlorohydrin	1232	1224	On-par

Propylene glycol

It is estimated that the cash cost propylene glycol from glycerine could have a differential as high as $700 per ton versus the generic synthetic route, which is produced from propylene oxide. The glycerine route is also commercial, with plants as large as 100 000 tons per year (ADM in the U.S.) still operating. Thus although it would seem that the glycerine-route is winning in terms of production cost, the reality is far from this with most of the propylene glycol produced in the world being from the synthetic route.

The reason is because there is a huge capacity for the production of propylene oxide as a co-product which includes the PO/TBA (propylene oxide/ter-butyl alcohol) route and the POSM (Propylene oxide styrene monomer) routes. Both synthetic routes produce TBA and styrene co-products respectively. TBA is typically integrated to a MTBE plant for gasoline oxygenate while styrene is typically integrated to polystyrene plants which is a high volume commodity plastic.

Thus for these synthetic route plants, there is already some cost savings that will be captured within the complexes producing two different products that is not fully reflected in the cash cost shown above (PO price in this calculation is based on market value). As propylene oxide is a hazardous product to transport, synthetic route producers which has propylene oxide as a co-product tend to utilize it on-site and convert it into other higher value chemicals such as propylene glycol.

1,3-Propanediol and Crude acrylic acid

The production of 1,3-Propanediol (1,3-PDO) on the other hand, clearly reflects the economic advantages of the glycerine route over the generic synthetic route. Shell operated the last known ethylene oxide based synthetic route but exited the PDO business completely in the mid-2000s. Today 1,3-PDO is produced exclusively from bio-based raw materials such as corn syrup and glycerine due to the higher costs involved in the synthetic route.

The same logic applies to the production of crude acrylic acid whereby the synthetic route currently has a lower production cost than that via the glycerine route, with all commercial production of acrylic acid being made from propylene oxidation.

Epichlorohydrin

For epichlorohydrin however, both the glycerine and synthetic routes are on par in terms of production costs. In addition, the advantage of being less environmentally pollutive for the glycerine route has made it particularly attractive in regions where there are strict environmental regulations. In China for example, there is currently a large demand for glycerine for the production of epichlorohydrin as the government initiated its nation-wide cleaning effort and shutting down polluting plants that are either old or employing technology that uses hazardous chemicals (the synthetic route for epichlorohydrin uses chlorine as one of its key raw materials).

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