Smart Biomaterials from Sustainable Biomass

Haldor Topsøe MOSAIK™ Technology

Lars Storm Pedersen

HALDOR TOPSOE

Consumers Want Greener Products

Pull is getting stronger

Can Biomass Replace Oil?

In some cases, biomass can not only replace oil – it can be a better option.

- Biomass offers a lot of “chemical functions” that can be reused or slightly altered.
- The global production of bio -based polymers is expected to more than triple from 5.7 million tons in 2014 to approximately 17 million tons in 2020.
- The anticipated growth rates are far higher for bio -based polymers compared to oil -based polymers

Predicted EU bio -based production and private investment in 2025

Product category	CAGR (%)	Bio-based production in 2025 (kt/a)	Total private investment (EUR million/a)
Platform chemicals	10	353	128
Solvents	1	80	16
Polymers for plastics	4	353	144
Paints, coatings, inks & dyes	2	1,151	437
Surfactants	4	1,974	805
Cosmetics and personal care products	3	687	349
Adhesives	10	462	195
Lubricants	1	254	63
Plasticisers	3	83	52
Man-made fibres	3	738	494
Total	2	6,134	2,683

Source: Insights into the European market for bio-based chemicals, 2019

The shift from fossil -based to bio -based chemicals has moved closer

- Haldor Topsøe's MOSAIK™technology produces chemicals from biomass at a cost that can compete with that of traditional oil-based chemicals.

- Cost often put an end to the desire of lawmakers, industry, and consumers to replace oil with sustainable raw materials, such as biomass. However, new technology can change that.

- Haldor Topsøe researchers have devised a novel process that produces several chemicals from biomass – at an attractive cost that can compete directly with similar oil-based chemicals.

MOSAIK™ is a new platform for Oxygenated Chemicals from Biomass

Oxygen retained in the C1-C3 is a competitive advantage compared to e.g. gasification

Sugars

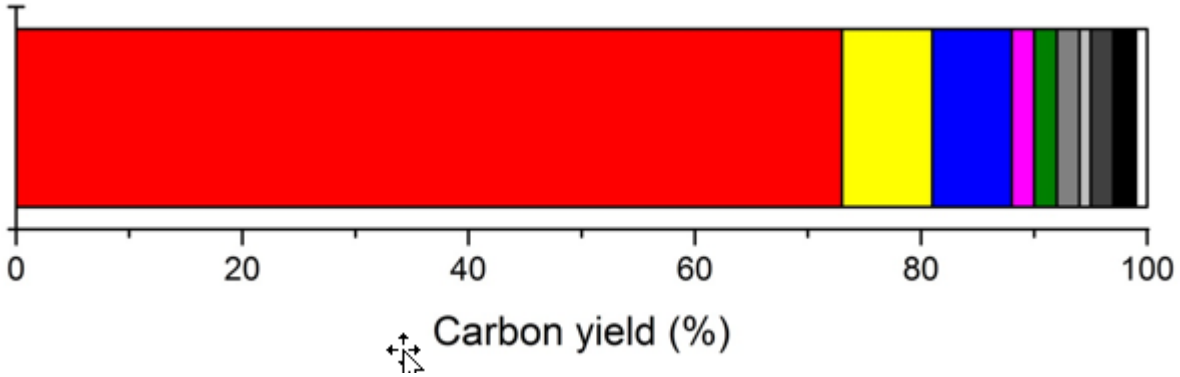
Sugar conversion pilot

C1-C3 oxygenates

- Glyoxal , 2 $bn/y
- Pure glycolaldehyde
- Ethylene glycol, 20 -25 $bn/y
- Glycolic acid
- Ethanol amine, 3 $ bn/y
- Methionine hydroxy analogue, 3-4 $bn/y
- Methyl vinyl glycolate

Product composition
C1-C3 oxygenate products

- Process is highly selective towards C1 -C3 with 85% of carbon in useful compounds



Technology Upscaling

10 years of R&D and proven in pilot scale

2011

5-10 g glucose per hour

2013

60-90 g glucose per hour

2014

(External)
500-1000 g
glucose per hour

2018

50 kg
sugars per hour

Chalcat

PSRI
Particulate Solid Research, Inc.

Partnerships

- In 2017 Topsøe and Braskem made a partnership to commercialize ethylene glycol production from Topsøe MOSAIK™ technology, based on sugar as bio feedstock
- Ethylene glycol is a platform chemical for PET plastics
- Innovation Fund Denmark invested in the development of the MOSAIK™ technology platform in 2017

MOSAIK™ demo plant in Lyngby, Denmark

Process validation in 50 kg/h hot demo scale plant

Summer 2017
Engineering started

May-Dec 2018
Construction

Jan-Feb 2019
Commissioning

Since Mar 2019
Operation and optimization

Conclusions

- The market for bio-based platform chemicals is expected to grow in the next 5 years
- Our objective is to commercialize the MOSAIK™ technology which is a platform for a number of chemicals
- A full scale plant can be up running +2023 for producing a platform chemical for PET plastic