Ulf Prüße

Production of bio-based Glycolic Acid

REFUCOAT

BIO-BASED RECYCLABLE PACKAGING

Pathways to Glycolic Acid (GA)

fossil based

Current industrial processes:

Carbonylation of formaldehyde — $HCOH + CO + H_2O \xrightarrow{\text{Heteropolyacids}} HOCH_2COOH$

Hydrolysis of chloroacetic acid — $ClCH_2COOH + NaOH \longrightarrow HOCH_2COOH + NaCl$

bio-based

Alternative process options:	Remarks:
Fermentation of sugars (GMOs needed)	Low titer and yield (< 66 g/L, < 0.4 g/g)
Microbial oxidation of ethylene glycol	Cofactor (sorbitol) needed, expensive medium
Catalytic oxidation of glycerol	Low selectivity (approx. 50 %), various by-products
Catalytic oxidation of ethylene glycol	Thünen‘s approach in REFUCOAT

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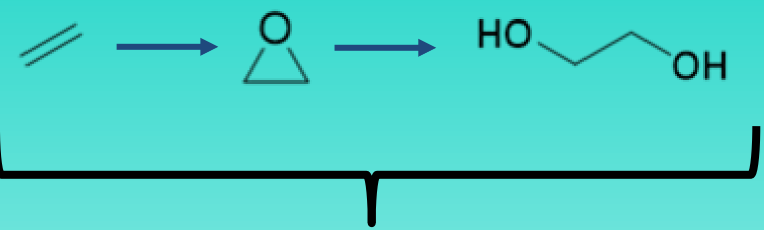
Feedstock for Mono Ethylene Glycol (MEG)



current fossil value-added chain (>25 Mio t/a MEG)

eco-friendly process, 100 % atom efficiency (Ethylene → MEG)

Feedstock for Mono Ethylene Glycol (MEG)

Crude Oil →

non-eco-friendly feedstock

current fossil value-added chain (>25 Mio t/a MEG)

eco-friendly process, 100 % atom efficiency (Ethylene → MEG)

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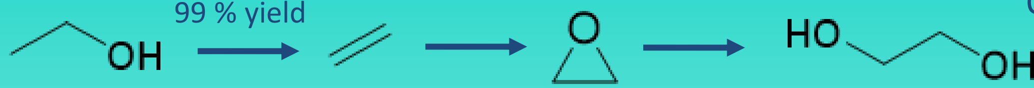
Feedstock for bio-based Mono Ethylene Glycol (bio-MEG)

Biomass



O_2, AuPt/CeO_2

HO-CH_2-COOH

Bioethanol

bio-MEG

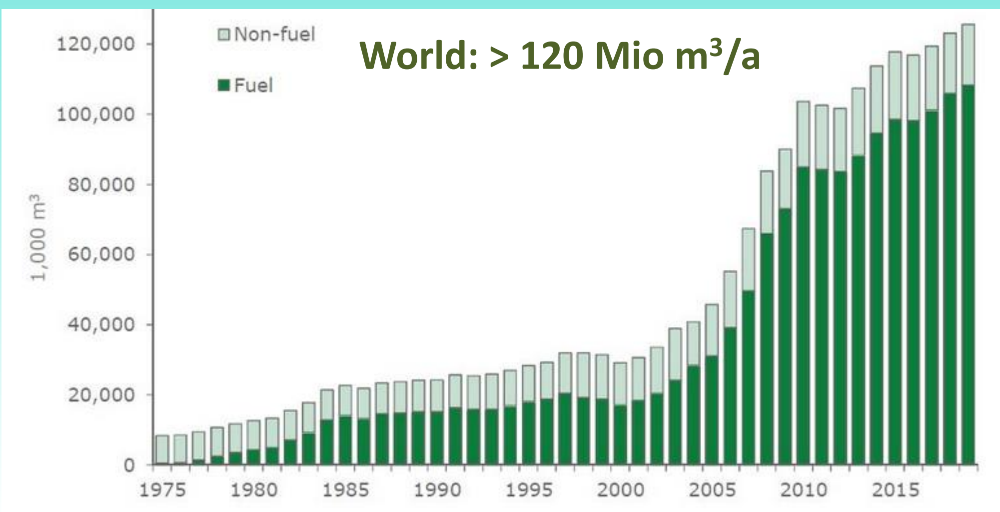
~ 175 000 t/a

bio-Glycolic Acid

Thünen's approach in REFUCOAT

1st Gen.

2nd Gen.



Licht Interactive Data

- Fermentation with yeasts
- Highly sophisticated, eco-friendly process
- Animal feed (DDGS) as by-product
- high purity CO_2 (food industry, future feedstock) as by-product

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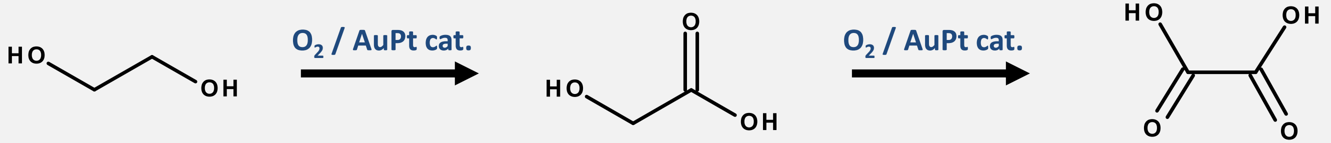
Process for the production of bio-based Glycolic Acid



monoethylene glycol (MEG) glycolic acid (GA) oxalic acid (OxA)

Reactor

1st Reaction: MEG conversion 83% and Glycolic Acid selectivity 77%

10 wt% MEG solution, 0.1 wt% Au-CeO_2 catalyst, reaction time >22 h, no catalyst reuse

Optimisation

- catalyst (metal loading, AuPt ratio)
- catalyst preparation procedure
- reaction conditions
    - pH
    - temperature
    - MEG concentration
- long-term stability of the catalyst

0.1 wt% AuPt(90:10)/CeO_2

Optimised: MEG conversion 90% and Glycolic Acid selectivity > 90%

20 wt% MEG solution, 0.1 wt% AuPt(90:10)/CeO_2 catalyst,
reaction time 1 h, catalyst can be reused at least 10 times

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Isolation and Purification of bio-based Glycolic Acid

Product solution from MEG oxidation

- Glycolic Acid (GA)* (main product)
- unreacted MEG
- Oxalic Acid*

*acids as Na-salt due to alkaline reaction conditions

generated NaOH & unreacted MEG recycled in next batch, Oxalic Acid as by-product

Salt Splitting / Electrodialysis

Na^+

Ion exchange

purified aq. GA solution, water evaporation to 70 wt % GA, overall yield is 87 %, in larger scale > 90 % probable

- ✓ Combination of electrodialysis and ion exchange leads to oxalic acid free and almost sodium free aqueous glycolic acid solution
- ✓ GA solution: 70 % Glycolic Acid, < 3 % MEG, < 3 % Di-Glycolic Acid, < 0.05 g/L Na^+, water
- ✓ Glycolic Acid solution sent to Fraunhofer for polymerisation to Poly Glycolic Acid (PGA)

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