bioFDCA by Purac

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Purac profile

Focus on:
- Natural food preservation
- Biobased building blocks & chemicals
- Monomers for bioplastics

80 years of experience in the development, production and marketing of natural Lactic acid based chemicals

Global sales network & manufacturing footprint

Headquarters in Gorinchem, The Netherlands

2011 turnover € 407 million

Part of CSM:
- A Dutch multinational
- Listed at Amsterdam Stock Exchange
PURAC Global Footprint – Leverage to develop FDCA

- Purac sales office
- Purac regional application center
- Purac factory
Current Lactic acid production

1. Lime
   - Fermentation

2. Sulphuric acid
   - Acidification

3. Energy
   - Purification

4. Sugar
   - Gypsum
   - Co-Products

5. Lactic acid
   - Residue
Future Lactic acid production with Purac proprietary technology

- **Biomass**
  - Sugar
- **Gypsum**
  - Biomass
- **Sulphuric acid**
  - Sulfur
  - Residue
- **Energy**
  - Purification
  - Co-Products
  - Lactic acid

**Steps:**
- Fermentation
- Acidification
- Purification

**Products:**
- Lactic acid

**Co-Products:**
- Residue
- Biomass
Business development lactides for PLA
Purac - solution provider and enabler for lactic acid based bioplastics

- 1983 Purac introduces PLA for the biomedical market
- 2008 5ktpa Lactide monomers plant in Spain
- 2009 PLA polymerization developed with Sulzer (CH)
- 2010 First commercial PLA plant installed at Synbra (NL)
- 2011 75 ktpa Lactide monomers plant in Thailand
Highly efficient production process for succinic acid

BASF/Purac Strengths:
- High performing proprietary microorganism
- Innovative downstream purification process
- Better eco-efficiency compared to fossil production processes through:
  - CO₂ fixation
  - Use of renewable resources
  - Lean and efficient process

Targets:
- Further market development (volumes available) supported by production campaigns
- Start of new production: Q3/2013
- Use of C5/C6 substrates from biomass
Purac product portfolio development: from promise to delivery

Lactid acid

L and D-Lactide

Succinic acid

FDCA

FDCA: Building on Purac core capabilities
- Gypsum-free production of organic acids
- Purac global production sites & network
- Complementary product properties for polymers

2008
- New PLA process
- 75 ktpa Lactide
- Announcement JV with BASF

2014
- Start-up Plant Spain
- Bird acquisition
Applications and benefits of FDCA in polymers

- Enhanced gas barrier properties
- Mechanical properties
- Favorable carbon footprint/LCA
- 100% Biobased
BioFDCA Value chain

Technology development

Sugars, starch or Biomass

C6 Sugars

HMF Production

FDCA Production

FDCA Recovery

Business development

PEF Polymer Production

PEF Conversion

Brand-owner
Retailer
Consumer
Purac Technology: 100% HMF conversion without by-products by whole-cell bio-catalytic oxidation achieved.
Key Benefits of Purac bioFDCA process

- **Low cost bioFDCA**
  - High yield (> 80%) on C6 sugar feed-stock
  - Low separation costs
  - Virtually no by-products
  - Favorable Capex, Opex due to mild process conditions
  - Smaller economies of scale needed compared to petrochemical route
  - Raw HMF stream usable

- **High purity (> 99%) FDCA**
  - Virtually no by-products
  - Proprietary Purac DSP

- **Favorable CO₂ footprint / LCA**
  - Gypsum-free DSP
  - Mild process conditions
  - High yield feedstock
Purac participates in programs focused at biorefinery research

- Purac is investing several million Euro in next generation feedstock development with various partners:
  - Bio Process Facility (BPF)
  - BE-Basic R&D program: € 120 million
    - Global Industrial, Academic & Financial Partners
    - PURAC is Research Member
  - Oil Palm Biomass Centre (OPBC)
  - Kluyver Centre
  - VITO
  - Institute for Sustainable Process Technology (ISPT)
  - Dutch Separation Technology Institute (DSTI)
  - Bio Based Europe (BBE)
Conclusions

- Commercial BioFDCA development on track, leveraging on:
  - FDCA IP
  - Fermentation capabilities worldwide
  - Gypsum free DSP, Proprietary Purac technology

- BioFDCA fits in current portfolio:
  - 80+ years proven track record Lactic acid, later also lactides, PLA
  - Succinic acid (JV with BASF)
  - Unlocking potential of second generation feedstock

- Purac open to Sustainability-driven partnerships:
  - Development of bioFDCA applications
  - Development of new technology supporting FDCA value chain

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Passion + Partnership = Performance