

Sustainable (Bio-)Chemistry

Tallinn, May 2015

The NordBioChem's way out of Fossils

Technology platform

NordBioChem Ltd. (NBC), as a private, profit oriented R&D management company:

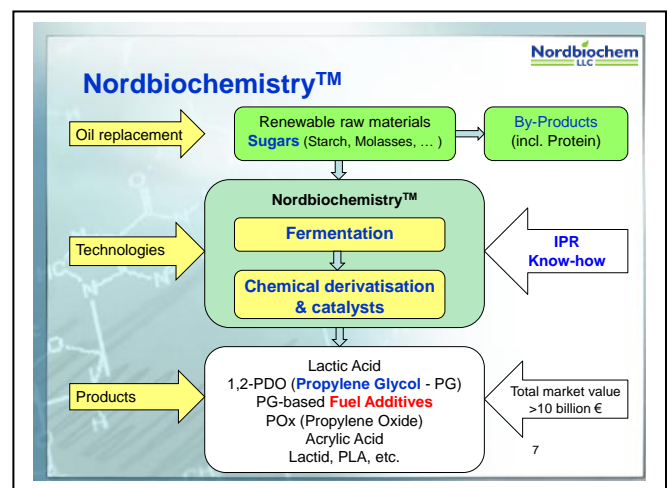
- has created a **unique**
- protected by several patents
- **technological platform for fermentative chemistry** (we call it **Nordbiochemistry™**) incl.
- **catalysis and chemical derivatisation**
- allowing high-volume & fully competitive (high cost benefits against oil-chem) propylene/C3
- **replacements for basic petrochemicals** as standardized commodity chemicals like **Lactide**, **PLA**, **Propylene Glycol & derivatives/fuel-additives**, **Propylene Oxide**, **Acrylic Acid** etc. and
- significant **reduction of CO₂ emission** and **toxic** reaction components.

NordBioChem OÜ

- established 2004, has on the pay list 10 employees and 100 contract researchers and developers in several countries;
- owns unique know-how, protected by 11 published patents + a number of filed patent applications, as well as applications in preparation;
- **is offering licenses of developed technologies and/or looking for partners for industrial implementation of developed technologies and/or for further R&D.**

Contributions to replacement chemistry by NordBioChem

- NordBioChem has developed whole technological platform starting with the Lactic Acid fermentation technology suitable for large-scale production and has combined it with new solutions in catalytical mechanisms and chemical derivatisation technologies;
- Raw materials (non-food, low-quality): sugar derivatives e.g. molasses, starch or cellulose*;
- The NBC's fermentation technology is
 - developed until large scale pilot unit and
 - confirmed through independent secondary opinions incl. Germany's Leibniz-Institute



Business opportunities

- Nordbiochemistry™ affects markets with current size of 100 billion € allowing replacements in petrochemistry in an annual market share of about 8 mil. tons and 10 bn. EUR;
- Competitive at oil price level about USD 40-50 per barrel;
- The implementation of Nordbiochemistry™ decreases considerably capital expenditures and could lower the production costs of relevant chemicals up to 40%

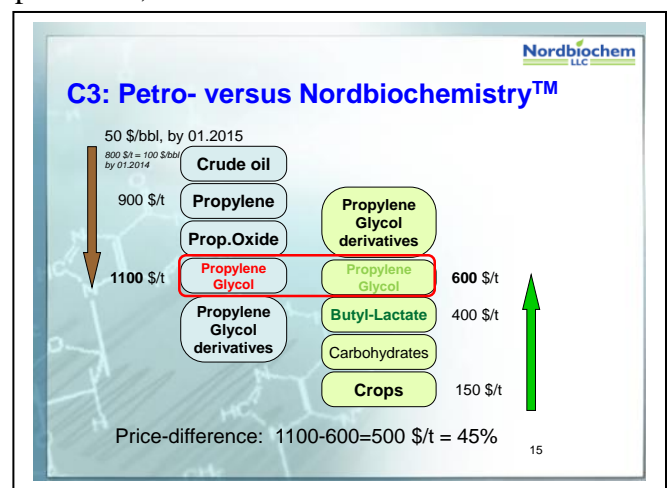
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Fuel Additives

1. Based on bio-propylene-glycol ethers:
 - Di-propylene glycol (+ methyl, ethyl etc. groups)
 - Tri-propylene glycol (+ methyl, ethyl etc. groups)
2. The formation of propylene-glycol based ethers is well known process. Now NordBioChem added new catalysts for the leveling up the efficiency of that process based on Bio-Propylene-Glycol.
3. Di- and Tri-propylene-glycol combined ethers are well known oxygenates, whose widespread usage was suppressed by the high price of these compounds.
4. The sector of bio-based fuel additives is a very promising and growing sector of the chemical industry.

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Effectiveness of Di- and Tri-propylene glycol type fuel additives:

Engine-test of diesel oil blended with 10% of PG-additives reduces

- specific fuel consumption up to 8%
- Emissions
 - Sulfur content up to 9%
 - SO_x emission up to 26%
 - NO_x emission up to 27%

These characteristics are main differences and advantages compared to bio-ethanol & bio-diesel based fuel additives.

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Motorentest für Bio-Kraftstoffzusätze

Auszug aus dem Messprotokoll

Tallinn, 31.01.2014

Tests

1. **Test 1** 96,5% (v/v) Dieselkraftstoff + 3,5% (v/v) Thiophen (um einen schwefelreichen Treibstoff zu simulieren)
2. **Test 2** Test 1 + **5 %** (v/v) **Dipropylenglykol**
3. **Test 3** Test 1 + **10 %** (v/v) **Dipropylenglykol**

Testmotor: 1-Zylinder Diesel-Motor „Ricardo Hydra“ mit ungeteiltem Brennraum
Drehzahl der Kurbelwelle $n = 2000 \text{ min}^{-1}$.

Kennzahlen	Test-methode	Maß-einheit	Messwerte				
			Test 1	Test 2		Test 3	
			Wert	Wert	Änderung %	Wert	Änderung %
Treibstoff							
Schwefelgehalt	EVS-EN ISO 20846	Masse-%	1,65	1,59	-3,6	1,50	-9,1
Abgasemission							
CO ₂		Masse-%	2,23	1,59	-28,7	1,49	-33,2
CO		ppm	43	21	-51,2	18	-58,1
NO		ppm	189	154	-18,5	137	-27,5
NO _x		ppm	199	162	-18,6	144	-27,6
SO ₂		ppm	134	123	-8,2	99	-26,1
H ₂ S		ppm	42,5	34,3	-19,3	23,3	-45,2
Motoren-Kennzahlen							
Effektivleistung des Motors		kW	3,4	3,6	5,9	3,8	11,8
Spezifisches Treibstoff-Verbrauch	GOST 18509	g/(kW h)	387,2	380,0	-1,9	356,4	-8,0