New, innovative and sustainable transportation fuels

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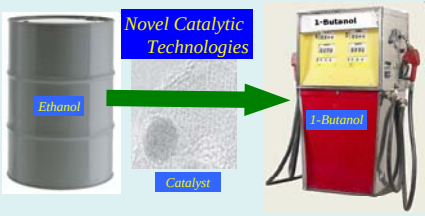
SusFuFlex project focuses on the production of higher bioalcohols and other compounds suitable as oxygenates (e.g. butanol, pentanol, mixed alcohols).



Objectives of the research:

1) to evaluate the old and novel procedures for microbiological production of butanol, higher alcohols and oxygenates as fossil fuel substitutes,

2) to develop and optimize catalytic materials and chemical (catalytic) reaction routes for the production of bioalcohols and other bio-derived compounds,

3) to conduct a sustainability analysis of the processes to be developed, to analyze the atom economy of the new processes and to make a preliminary economical analysis, and

4) to integrate the processes and know-how developed by the research groups.

Why higher alcohols as transportation fuels?

1) Butanol, pentanol and mixed alcohols have higher energy content and are less corrosive and less water-soluble than ethanol

2) They can be used for replacing fossil fuels in existing combustion engines (air-to-fuel ratio)

3) Higher alcohols can be distributed via the existing pipelines (low vapour pressure)

4) They can be produced in an industrial-scale.

Table 1. Fuel properties of gasoline, diesel and C1-C5 alcohols.

Fuel	Energy density (MJ/l)	Air-to-fuel ratio	RON*	MON**	Water solubility (%)
Gasoline	32	14.6	91-99	81-89	negligible
Diesel	35.5	(60 to 100 on idle) 14.7	-	-	Negligible
n-Pentanol	27.8	11.68	Low	Low	0%
n-Butanol	29.2	11.12	96	78	7%
Ethanol	19.6	8.94	130	96	100%
Methanol	16	6.43	136	104	100%

** Reseach octane number (RON), ** Motor octane number (MON)*

Research approaches:

1) Microbiological approach in biobutanol production

- ***Pre-treatment of biomass*** (lignocellulosic and starch-based biomass or a low-value by-product from food industry, e.g. waste potatoes and potato peels)
- ***Fermentation of sugars to alcohols***
- ***Solvent recovery***

Fig 1. Biomass pre-treatment (left), fermentation (middle) and recovery of solvent (right).

2) Novel chemical (catalytic) reaction routes

Several chemical reaction pathways are studied in which butanol (and higher alcohols) are produced catalytically.

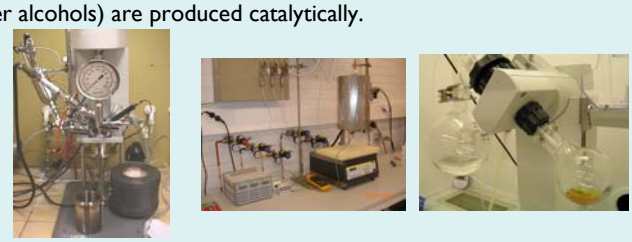


Fig 2. Batch reactor for kinetic experiments (left), gas-phase reactor (middle) and catalyst preparation by wet impregnation (right).

Technological challenges

- Digestion of the raw material to fermentable sugars
- Inhibition caused by the high solvent content, possible decomposition of solvent and the loss in microbiological activity
- Separation of butanol can be carried out without distillation due to its limited water solubility
- Novel catalysts and catalytic processes for chemical synthesis are needed (e.g. starting from glycerol), since no direct catalytic reaction routes with high selectivity and conversion are today available

Opportunities

A novel liquid biofuel, n-butanol, which can be distributed via existing pipelines.

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