HIGHBIO - INTERREG NORD
2008 - 2011

Högförädlade bioenergiprodukter via förgasning
Korkeasti jalostettuja bioenergiatuotteita kaasutuksen kautta

EUROPEAN UNION
European Regional Development Fund

FISCHER-TROPSCH AT THE KOKKOLA UNIVERSITY CONSORTIUM CHYDENIUS

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HIGHBIO LULEÅ MAY 2009

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CHYDENIUS

Fischer-Tropsch Background

- Fischer-Tropsch process discovered already in 1923
- Converts H_2 and CO to aliphatic hydrocarbons (FT-fuels etc.)
- Mostly used catalysts Co, Fe and Ru
- H_2 and CO (syngas) derived from coal, methane or biomass
- Lack of oil $\rightarrow$ FT process (CTL) used in WW2 and in South Africa (Sasol)

Franz Fischer

Hans Tropsch

Fig. from Fischer-Tropsch Archive, http://www.fischer-tropsch.org/

F-T Apparatus at the Kaiser-Wilhelm Gesellschaft, 1930

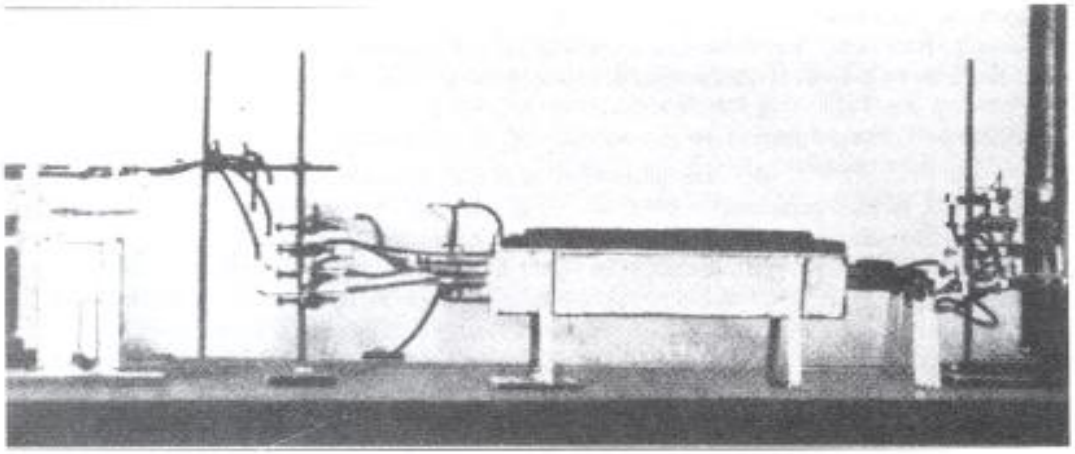


Fig. from Fischer-Tropsch Archive, http://www.fischer-tropsch.org/

Gasification - Options for Bio-based Products

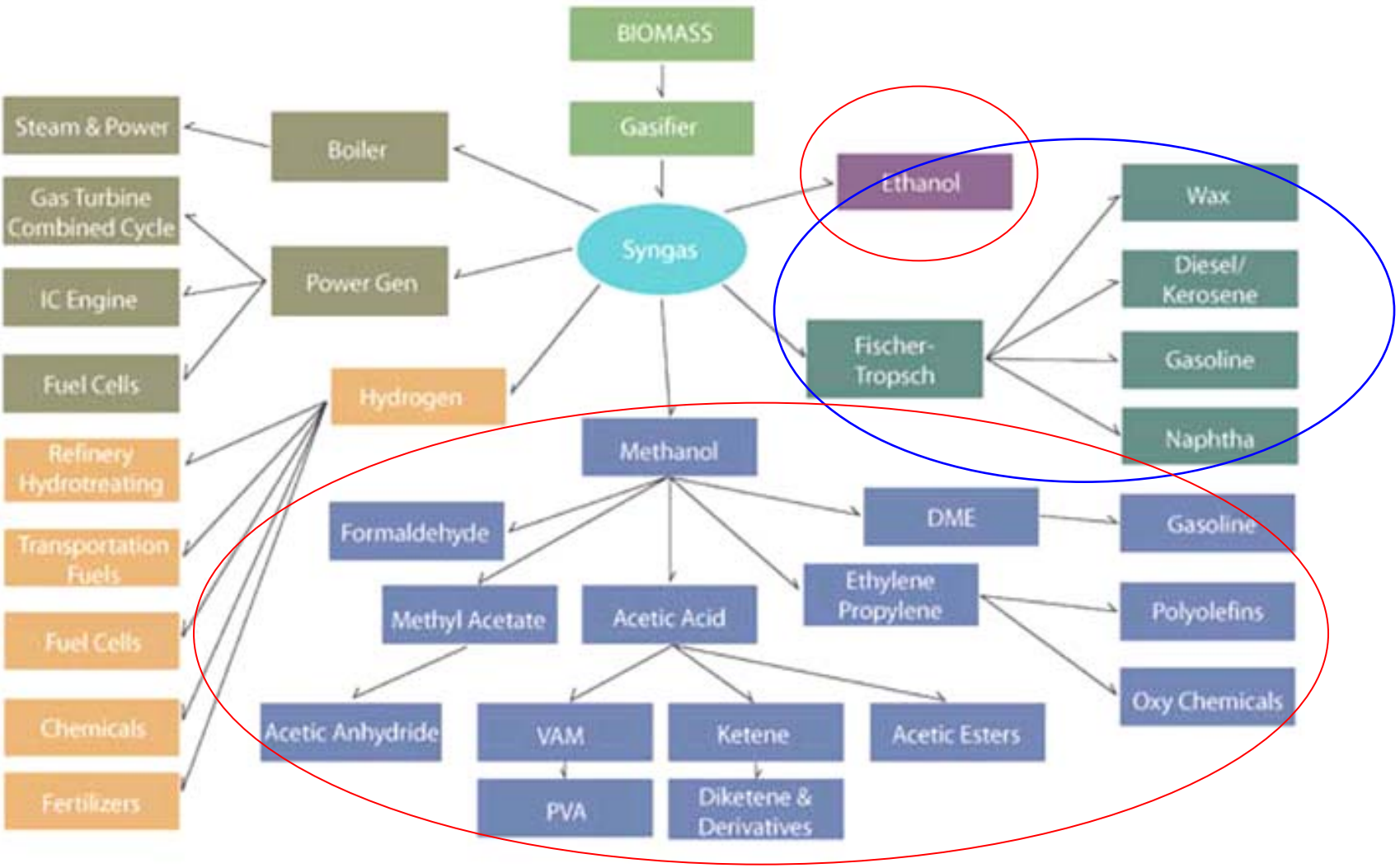


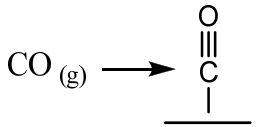
Fig. from Biomass Magazine, Syngas 101, January 2009, www.biomassmagazine.com

Fischer-Tropsch Reaction

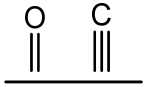
- Basic FT: $2\ H_2 + CO \xrightarrow{\text{Catalyst}} -CH_2- + H_2O$
- ΔH_r = -165 kJ/mol $\rightarrow$ highly exothermic
- Stoichiometric Ratio: $H_2/CO = 2/1$
- If H_2/CO lower than 2/1 then water-gas-shift (WGS) is needed
- WGS: $CO + H_2O \rightarrow CO_2 + H_2$
- Pressure 5 - 60 bar
- Temperature ~ 200 - 400 °C

Reaction steps in the catalytic reaction Fischer-Tropsch synthesis (Co and Fe catalyst):

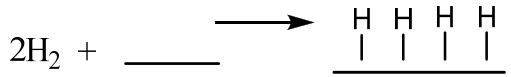
- Adsorption of CO on the catalyst surface



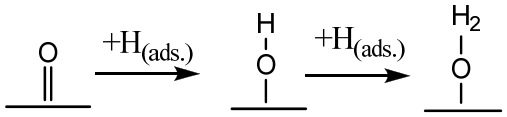
- Breakage of a C-O bond



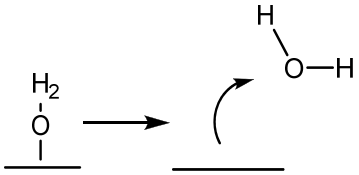
- Dissociative adsorption of two H_2 molecules on the catalyst surface



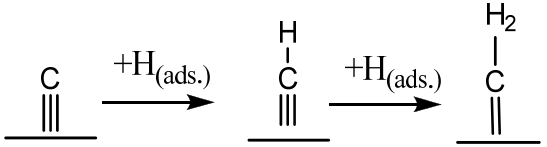
- Bonding of two hydrogen atoms with an oxygen atom resulting in the formation of a water molecule, H_2O



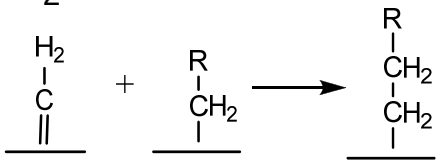
- Desorption of water



- Bonding of two hydrogen atoms with a carbon atom resulting in the formation of CH_2



- Formation of a new C-C bond



Products from the Fischer-Tropsch process

Carbon number:	Name:
C1-C2	SNG *
C3-C4	LPG **
C5-C10	Petroleum
C5-C7	*Light*
C8-C10	*Heavy*
C11-C20	Middledestillate
C11-C12	*Kerosine*
C13-C20	*Diesel*
C21-C30	Softwax
C31-C60	Hardwax

*SNG = Synthetic Natural Gas

**LPG= Liquefied Petroleum Gas

Table from http://www.zero.no/transport/bio/fischer-tropsch-reactor-fed-by-syngas

Preparation of the Co catalysts

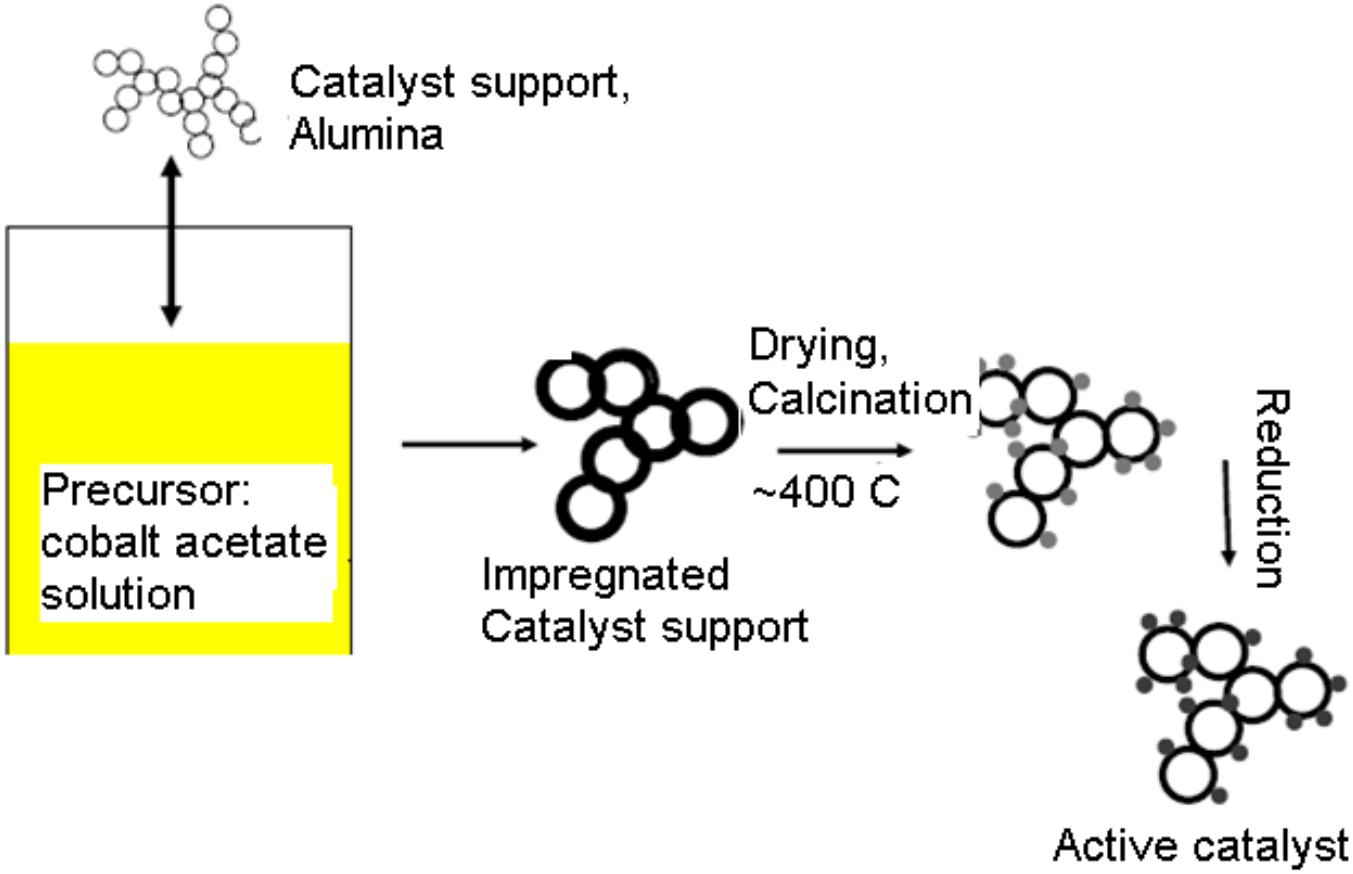


Fig. from HighBio project INFO done by Kirsi Partanen and Ulla Lassi

FT reactors

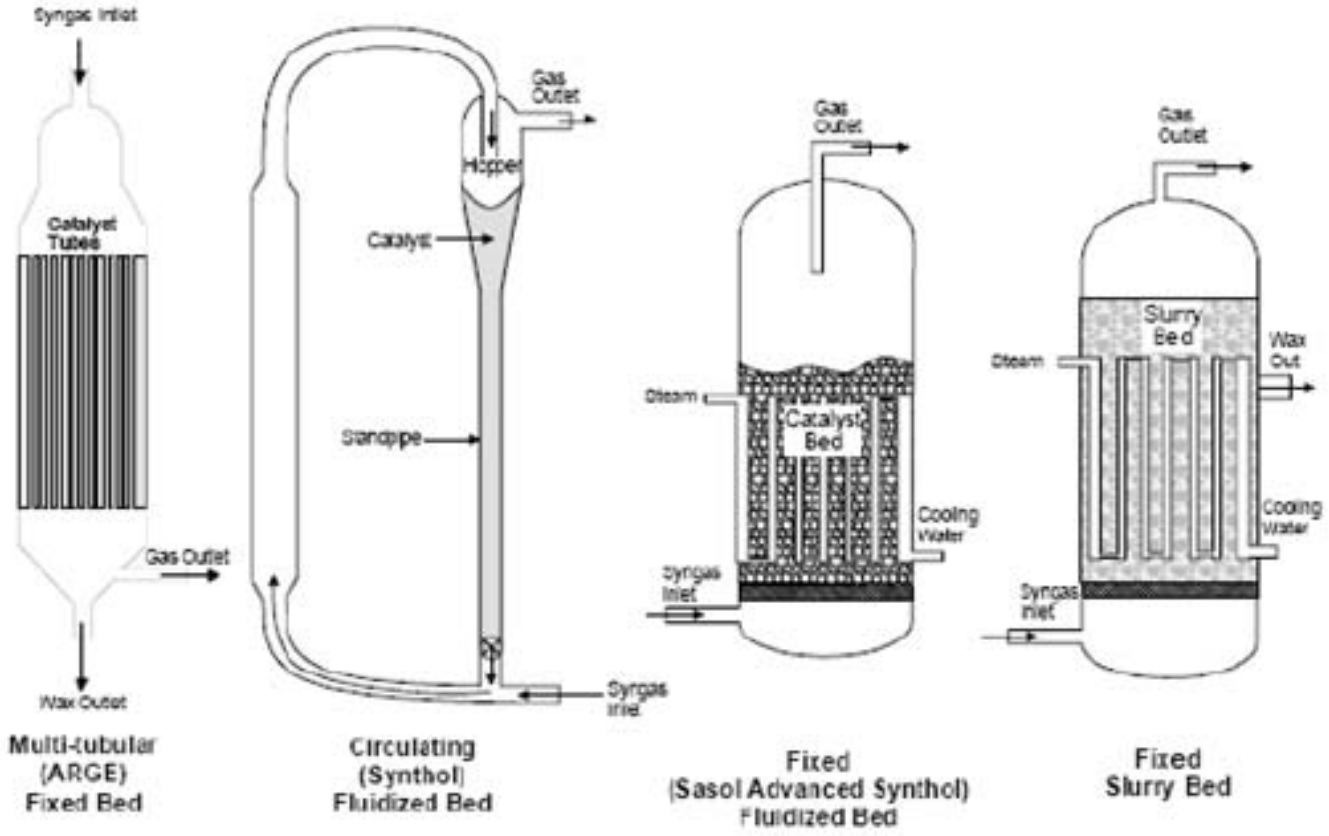
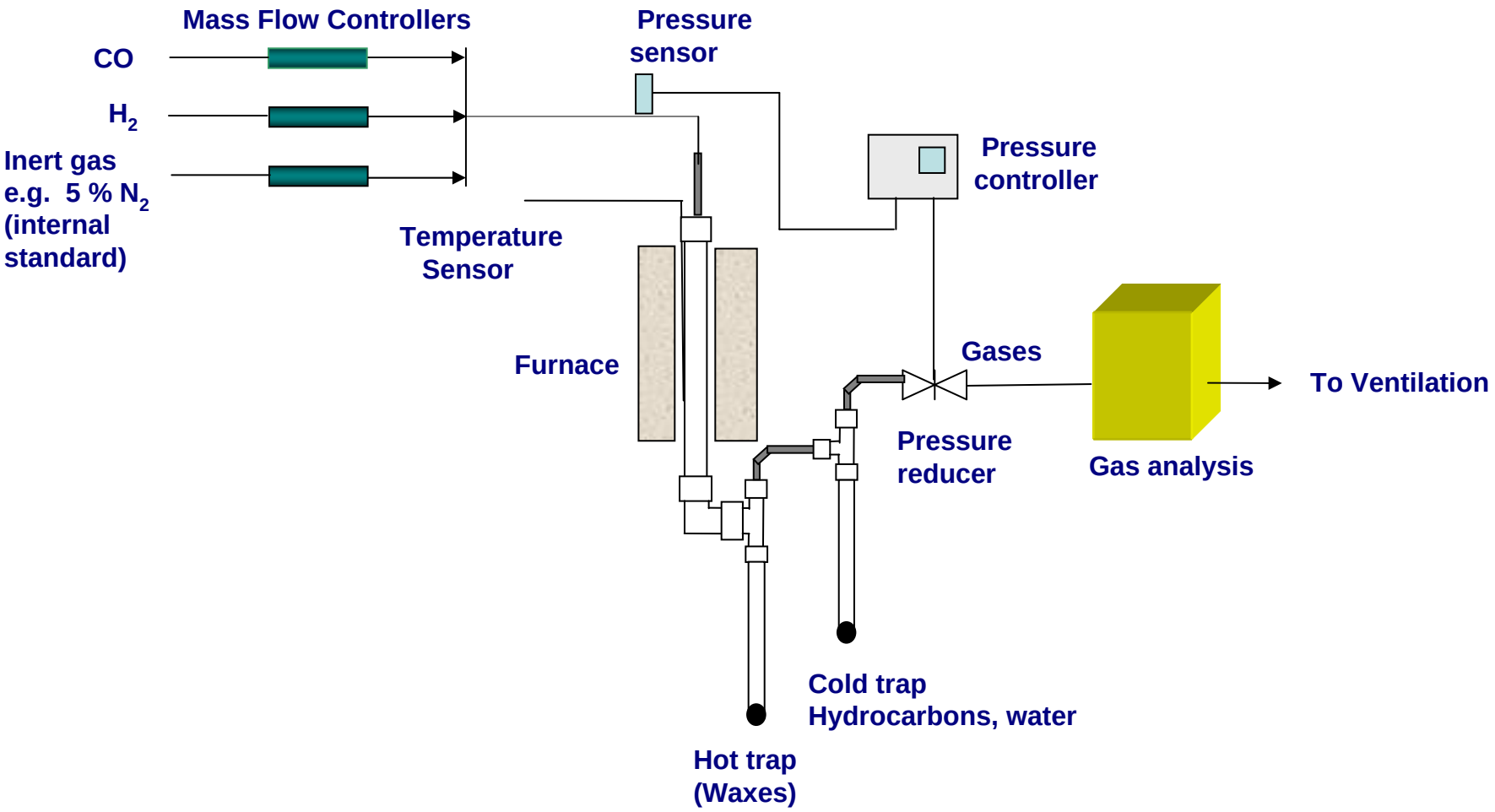


Fig. from http://www.zero.no/transport/bio/fischer-tropsch-reactor-fed-by-syngas

Reactor Configuration in Kokkola for the Conversion of Syngas; Testing (activity and selectivity)



Kokkola Fischer-Tropsch reactorsystem

Conclusions

- FT synthesis over Co catalysts has been preliminary tested
- Some hydrocarbons (mixture) are formed
- System will be further developed e.g. for continuous gas analysis (from inlet and outlet flows)
- M.Sc. Thesis (Riikka Lahti) will start (in August) on that topic

- Currently two B.Sc. theses under preparation;
  Tong Shu: Preparation of heterogeneous Co catalysts
  Leena Saukkonen: Kobolttikatalyyttien sovellukset ja epäpuhtauksien vaikutus

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