

Dry route: CO₂ - gasification of dry biomass in combination with e-fuel synthesis

27-28 April 2022



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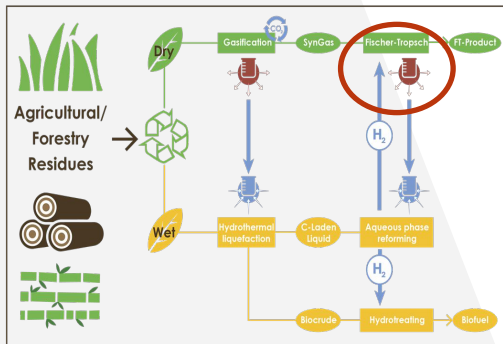
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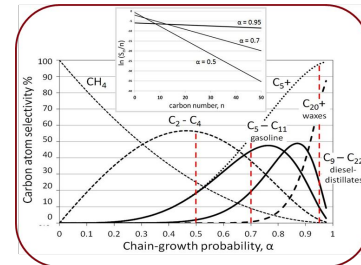


FT catalytic reaction in Heat to Fuel

Context: FT reaction from **Syngas** to **Hydrocarbons**



- **Non selective reaction**
Infinite of possible products depending on:
 - ✓ the reaction conditions
 - ✓ the catalyst
- **Highly exothermic reaction :**
- 170kJ/mol converted CO
- Need to control the thermal behavior (catalyst aging and control of the



Heat to Fuel objectives:

Liquid fuel efficiency from 35 to 50%.

Long Chain Hydrocarbons Production for Diesel and Kerosene

Catalyst development

gasification

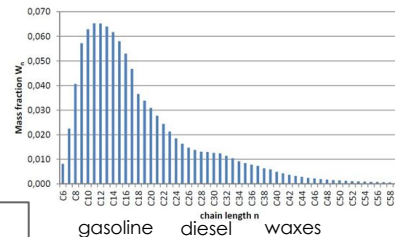
reforming

T= 230°C
P=20 bar

FT reactor

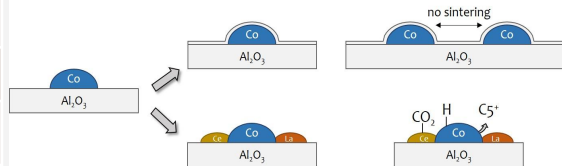
fuel

syngas
 $2=H_2/CO/(CO_2)$



For long liquid hydrocarbons
FT at low T using cobalt

Cobalt micro-catalyst



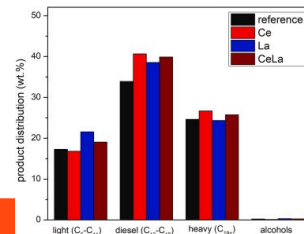
An innovative
catalyst

+ stable

+ selective

Promoted by lanthanides

Incorporation of Cerium and Lanthanum by incipient wetness impregnation



Parameter	cobalt	iron
α	high	low
activity	high	medium
olefin selectivity	low	high
H_2/CO ratio	>2	0.5-2.5
rWGS	very low	high
methane selectivity	high	low
Temperature	low	low to high
stability	long	short
cost	expensive	cheap
separation from wax	easy	difficult

Reactor development

Selected catalyst

Highly instrumented
HX reactor

Based on experimental and numerical results

Catalyst and reactor
characterisation

Design tools and
detailed analysis

Gas lines:
Ar, CO₂, CO, H₂, CH₄
(CH₄ + C₂H₆)



Pressure : 1-70 bars
Temperature : 20-350°C
Total Q : 1 to 60 NJ/min

Wide range of inlet gas
composition



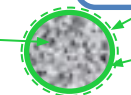
Catalyst analysis
Evolution of physico-chemical properties

Instrumentation
T (°C) profile along reactor

Gas Analysis (μ-GC):
CO₂, CO, H₂, CH₄

Liquid analysis (GC-MS)

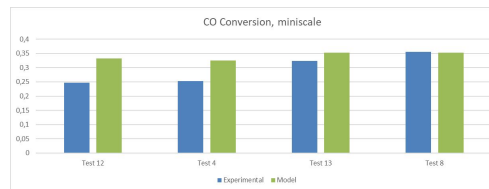
Catalyst particle
liquid phase



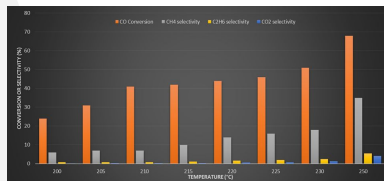
Gas film

Gas-liquid
interface

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Comparison experiment-model



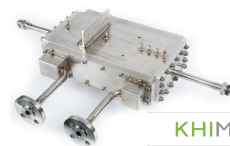
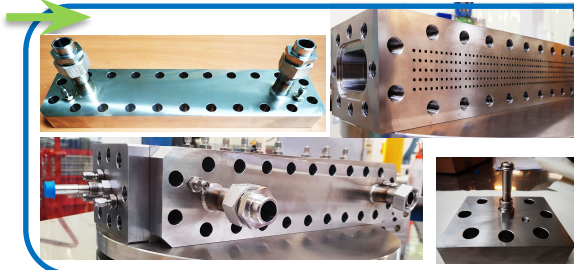
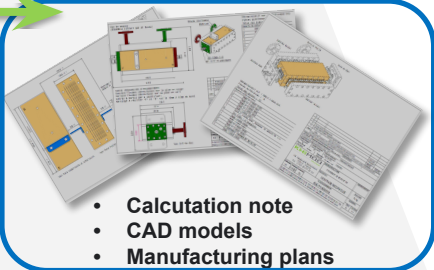
Temperature sensitivity of the coolant and the inlet gases (H₂/CO)
Evolution of CO conversion and selectivities to methane and ethane

An optimised FT reactor
at upper scale



FT reactor manufacturing

An optimised FT reactor at upper scale



Catalyst filling; the catalyst selection and in situ activation method was a previous work made by IREC-JM- CEA.



JM



IREC



- Development of a reactor filling technique

KHIMOD
ILLUEN



- Final instrumentation
- Leak test
- Tightening report
- Final documentation
- Available for operation



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THANK YOU

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