Helmholtz-Zentrum Geesthacht
Zentrum für Material- und Küstenforschung

IP Management

TECHNOLOGY AND KNOWLEDGE TRANSFER

Tailored membrane technology
We satisfy your fluid separation needs

Optimized Fischer-Tropsch Synthesis by a highly efficient membrane system

POSSIBLE APPLICATIONS

- Fischer-Tropsch Synthesis
- Biomass gasification
- XTL (GTL, BTL, ...)

PROJECT KEY WORDS

- Membrane system
- CO_2, H_2, H_2O separation
- FTS Process gas treatment

DEVELOPMENT STATUS

- Pilot plant and laboratory scale tests on individual separation stages
- Further development of membranes ongoing

PATENT PROCEDURE STATUS

- US and EP Patents granted
- EP 2727979
- US 2014/0142205

POTENTIAL FOR COOPERATION

- R&D Cooperation
- Licensing

Innovation & Customer benefit

Biomass gasification has attracted a remarkable interest from the scientific and industrial communities for decades, since it allows the sustainable reuse of an important residual material.

Gasification of biomass for syngas (CO and H_2) generation is becoming increasingly attractive. This has in turn increased the interest in the Fischer-Tropsch Synthesis (FTS), since syngas can be processed further to produce hydrocarbons by means of FTS.

Irrespective of the gas source, the compositions of the gas mixtures of the different gas streams are strongly influencing the yield of FTS and the quality of the reaction product. Hence, the concentrations of gas components present in the process, as CO and H_2 require a fine control.

The presented technology represents a complete membrane separation system for the optimization of the output and performance of FTS facilities.

Possible Applications

Individual membrane separation stages have successfully been investigated in laboratory and pilot scale. The system is however not limited to FTS and can be implemented into other processes as well. Examples are the separation of CO_2 from flue- and biogas or the separation of higher hydrocarbons from industrial off-gases.

The polymeric membranes and the presented procedure have been specifically developed to improve the performance of current FTS production plants and effectively generate high-quality reaction gas mixtures.

On the basis of the high interest in XTL technologies, this invention opens the door to an upgrade of existing plants and/or design of new facilities employing flexible membrane technology.

Commercial Opportunity

The development of this procedure and multilevel membrane system relies on the solid expertise of the Helmholtz-Zentrum Geesthacht, and is available for licensing and further research and development.

Technical Description

The presented system is based on an arrangement of membrane stages placed at sections of a typical FTS production process where gas separation is required. This modular property defines a very flexible system, adaptable to special requirements.

The permselective nature of the employed membrane materials allows for the targeted removal of components from gas mixtures, provided that a partial pressure driving force is applied. Hence the membrane technology can adjust the concentrations of the gas mixtures up- and downstream of the FTS reactor. This allows for a higher conversion of CO_2 in the FTS reactor and an alternative for separation the product without the need of complex absorption, adsorption or cryogenic distillation technologies.

The different membrane materials employed allow for the preferential permeation of CO_2, H_2 and H_2O vapour or higher hydrocarbons. This ensures that undesired components are kept at low concentrations, not-used reactants are recycled and products are separated.

Multiple tests have proven the stability of the membranes in laboratory scale (H_2-selective), pilot plant (CO_2-selective) and industrial (higher hydrocarbon selective) operating scenarios.

We present here a highly versatile system that allows a convenient adaptation to the variations in the process, as fluctuations in the syngas composition or the reaction outlet streams.

Furthermore, the space requirements for a system equipped with membranes are typically lower compared to separation units used in existing FTS-facilities without the requirement of additional separation agents as solvents and the associated regeneration stages.

The presented innovation offers the possibility to improve the performance of FTS and XTL production plants.

Ref: HZG-EP2727979
July 2017

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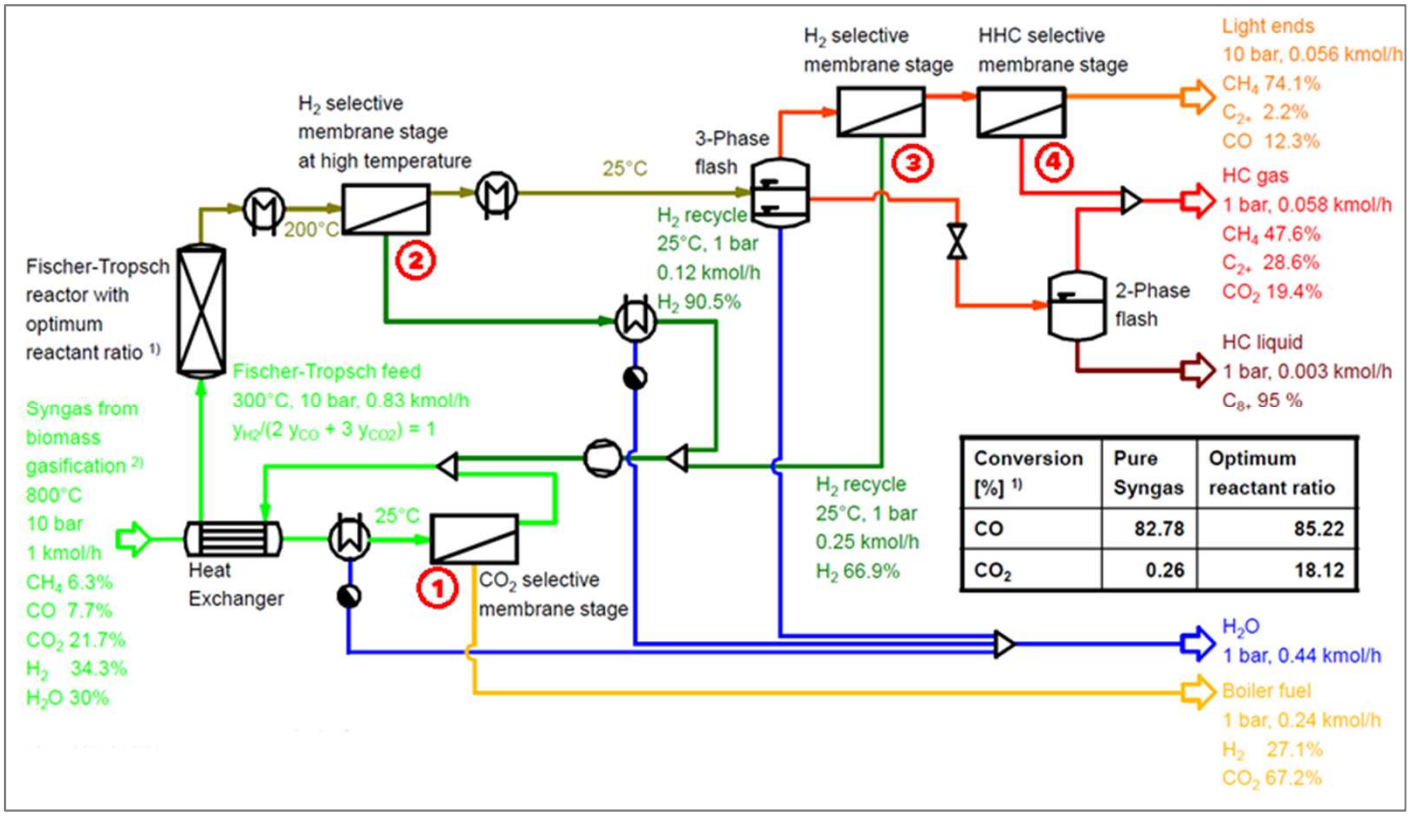

Conversion [%] 1)	Pure Syngas	Optimum reactant ratio
CO	82.78	85.22
CO_2	0.26	18.12

Scheme of the system including the membrane positions, identified in red circles (process design example).

Description of the membranes/separation steps

1) A CO_2 and H_2O selective membrane treats the feed gas prior to directing it to the reactor. At this step, part of the CO_2 is separated and a gas mix with a defined reactant ratio made available for the reactor. This step improves the general efficiency of the reaction inside the reactor and fosters the conversion of CO_2.

2) The second membrane, placed down-stream of the FTS reactor, pulls valuable, unreacted H_2 under high temperature out and allows its recirculation through the reactor. It also removes part of the generated H_2O from the process. This step optimizes the use of the not reacted reactants and facilitates part of the required water separation.

3) The third membrane separates H_2 from the remaining hydrocarbon gas. The separated H_2 can be recycled as well.

4) The membrane at the latter stage allows for a first separation stage between other valuable products such as propylene, which represents an additional exploitable product, from lighter gases.

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