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**K1-MET**
**Competence Center for Advance Metallurgical and Environmental Process Development**

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# $CO_2$ REDUCTION IN ENERGY INTENSIVE INDUSTRIES

## REFORMING METHODS AS SOLUTION FOR $CO_2$ UTILIZATION AND FURTHER PRODUCTION OF CLEAN FUELS

Steam methane reforming (SMR) is the worldwide leading technology to produce hydrogen. In this process, desulfurized natural gas reacts with water vapour in the presence of a metal catalyst (usually Ni-based) in a reformer under high temperature conditions. Syngas, a mixture of CO and $H_2$, is obtained as a reaction product. As SMR leads to the highest $H_2$/CO ratio among other reforming processes, it is considered ideal to obtain a high purity $H_2$ flow from syngas. The current major application of syngas includes methanol and Fisher Tropsch (FT) synthesis.

There are further reforming alternatives where not only steam but also $CO_2$ can be used to produce syngas. $CO_2$ being utilized as raw material will help to reduce the carbon emissions released from energy intensive industries like steel, refining or refractory.

Among the different reforming possibilities, “Bi-reforming of methane” (BRM); which is a combination of steam reforming and dry reforming was chosen for this study due to its ability to produce syngas with the desired $H_2$/CO ratios and mitigate carbon formation, when compared to dry reforming. Additionally, it has the advantages of efficient $CO_2$ conversion and no safety issues due to the absence of oxygen in the system; other than “Tri-reforming of methane”, which includes the partial oxidation of methane.

A single reformer unit at lab scale (seen in the figure below) was built in the facilities of the Montanuniversitaet Leoben (Chair of Process Technology and Industrial Environmental Protection), with the purpose of studying the reforming of the flue gases from different energy intensive industries to produce syngas.

Federal Ministry
Republic of Austria
Climate Action, Environment, Energy, Mobility, Innovation and Technology

Federal Ministry
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Labour and Economy

Reformer laboratory facility. © Montanuniversitaet Leoben

Experimental trials were carried out using three different commercial Ni-based catalysts (CP1444, CP1443, and SNG1000) under diverse gas-compositions and process conditions. The results showed that at around 890°C, it was feasible to achieve more than 90% and almost 100% $CO_2$ and $CH_4$ conversion respectively with a $H_2$/CO ratio of 1.83. Additionally, the experimental findings presented much higher conversions than those reported in the literature and were in good agreement with the theoretical outcomes simulated by ASPEN plus. In all circumstances, the catalyst CP1444 showed a higher activity in contrast to SNG1000 and CP1443.

**Impact and effects**

According to the ecological and economic analysis performed during this project, the integration of bi-reforming of methane into existing processes such as methanol production and Fischer-Tropsch synthesis seems to be a feasible alternative to reduce $CO_2$ emissions. Additionally, a possible decrease in the production costs of those products, when compared to the conventional production methods (SMR) was also shown.

**Project coordination (Story)**
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- OMV Refining and Marketing GmbH, AT
- RHI Magnesita GmbH, AT
- Montanuniversitaet Leoben, AT
- TU Vienna, AT

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