Development of new CLC processes for natural gas

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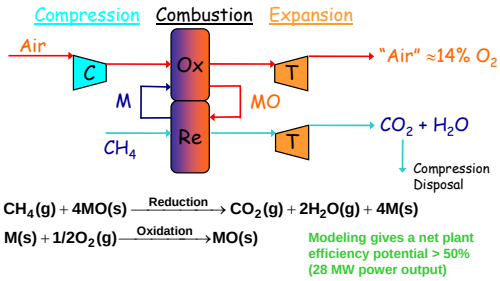
Chemical looping combustion (CLC) is one way to generate energy from natural gas with inherent carbon dioxide capture. In this concept a solid oxide material is used to oxidize natural gas to water and carbon dioxide, while the (partly) reduced oxide is re-oxidized by air in a separate gas stream. By splitting the oxidation and reduction reactions in this manner, the effluent gas from the reactor in which the oxidation of natural gas takes place will be a "pure" CO_2/H_2O stream as if pure oxygen was used as oxidant. The principle is shown schematically in the Scheme below.

What is Chemical Looping Combustion (CLC)?



$CH_4(g) + 4MO(s) \xrightarrow{\text{Reduction}} CO_2(g) + 2H_2O(g) + 4M(s)$

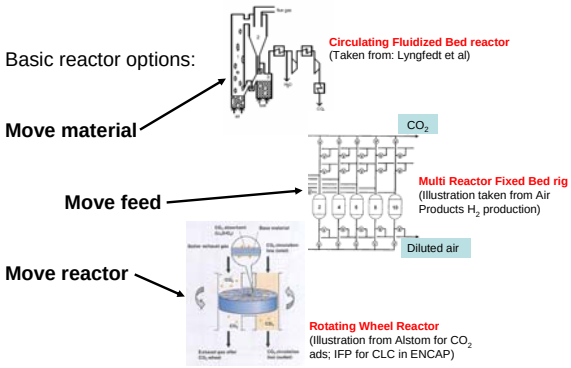
$M(s) + 1/2O_2(g) \xrightarrow{\text{Oxidation}} MO(s)$

Modeling gives a net plant efficiency potential > 50% (28 MW power output)

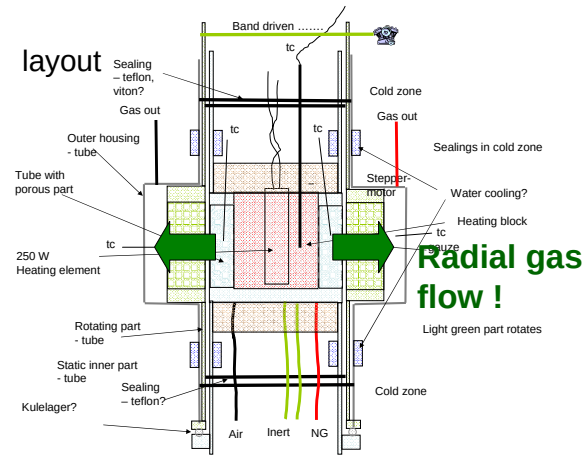
Using this technology, natural gas is combusted to pure CO_2 without the need for an expensive oxygen plant !

For processes that involve powder cycling one can envisage at least three fundamentally different process concepts as shown below:

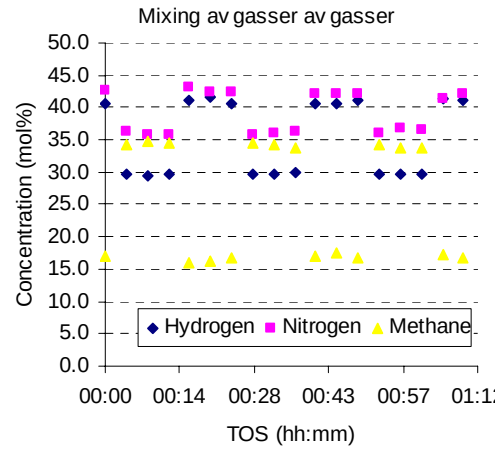
Possible reactor concepts for CLC:



Most of the CLC demonstration work has been on circulating fluidized bed (CFB) kind of reactors. We believe that very compact reactors for CLC can be developed using rotating reactor concept. At present we are developing such a reactor – having a radially directed gas flow as shown below:



Since the oxygen carrier bed is rotating, one of the critical points is to avoid mixing of gases between the two gas streams. Below are the results from our initial experiments showing significant mixing: .



We are now working on a improved ways to avoid gas mixing. These results and initial CLC will be presented on the next occasion!

Acknowledgement: This work has been carried out in the BIGCO2 project funded by the Norwegian Research Council CLIMIT program .