LABORATORY FOR CHEMICAL TECHNOLOGY
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Coach	**Supervisor(s)**	**Funding**
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CO_2 utilization through Pressure-Swing Reverse Water Gas Shift reaction

Aim

Material design for **CO_2 utilization** from CO_2-containing syngas, e.g. Blast Furnace Gas from the steel industry, to CO through **Pressure-Swing Reverse Water Gas Shift reaction**.

Justification

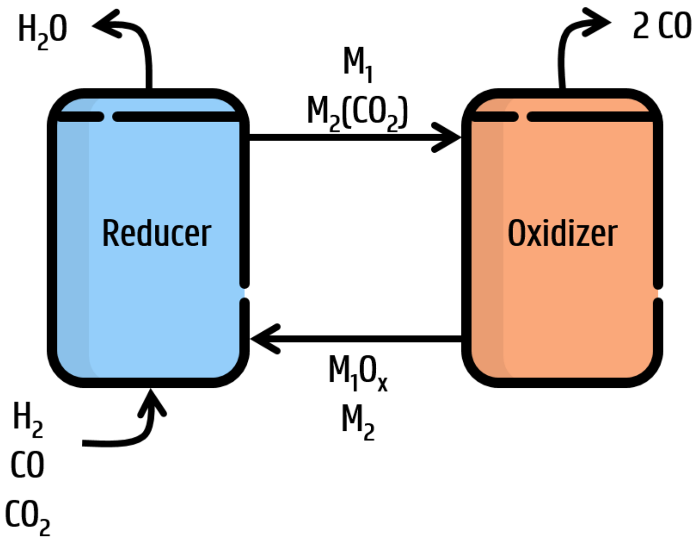

Figure 1. A schematic representation of the proposed Pressure-Swing Reverse Water Gas Shift process.

Steel production is an energy- and carbon-intensive industry responsible for large CO_2 emissions due to the use of coke as reductant source. Steel is produced by removing the oxygen from iron ores, this is commonly done by the CO produced from partial oxidation of coke. Even though steel production is a highly integrated process that reuses its intermediate streams, the thermodynamic limitations of the reactions lead to a loss of significant amounts of CO in N_2-diluted gas mixtures with CO_2, H_2 and H_2O. These gases are unsuitable for their iron ore reduction step due to the oxidizing power of the present CO_2[1] and are thus sent to a power plant to generate electricity and more CO_2.

In the Laboratory for Chemical Technology, a Pressure-Swing Reverse Water Gas Shift process is being developed to upgrade CO_2 to high purity CO while inherently separating inert elements such as H_2O and N_2 (see Figure 1). This chemical looping process consists of 2 combined reactions with 2 solid materials (oxygen storage material, M_1, and CO_2-sorbent, M_2) to maximize the CO yield. Overall, the process uses H_2 to convert CO_2 into additional CO through the reverse water gas shift reaction. The purified CO can be used to produce valuable chemicals such as methanol or to be directly injected in a Blast Furnace. This last route could significantly reduce the carbon footprint of steel production, not only by reducing the amounts of CO_2 released to the atmosphere but also by reducing the amount of coke required in the Blast Furnace to produce the same amount of steel. Therefore, it is of interest to develop materials suitable for the future implementation of this process considering materials that could maximize CO production at realistic process conditions.

Program

- Literature review on pressure swing processes and materials for CO_2 separation and reverse water gas shift reaction.
- Synthesis and characterization of oxygen storage materials and CO_2 sorbents.
- Experimental design for material testing in a fixed bed reactor.
- Process simulation in Aspen Adsorption.

[1] Y. Kapelyushin, et al., 8th High Temperature Processing Symposium (2016), Melbourne.