Water gas shift reaction in packed bed clc using ilmenite as oxygen carrier

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Abstract title	WATER GAS SHIFT REACTION IN PACKED BED CLC USING ILMENITE AS OXYGEN CARRIER
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Chemical-looping combustion (CLC) has shown to be a promising combustion technology for energy production with inherent capture of CO_2. Most of the CLC pilot plants existing at the moment use the configuration composed of two interconnected fluidized-bed reactors working at atmospheric pressure. However, the efficiency of power cycles increases at elevated temperatures and pressures and in this respect, operation of pressurized CLC plants at very high temperatures based on interconnected fluidized bed technology could pose technical difficulties especially due to the gas/solid (fines) separation. With the aim to work at elevated pressures, dynamically operated packed-bed reactors have been proposed for CLC [1]. At least two reactors in parallel working in alternating cycles must be used to assure a continuous high temperature gas stream supply to the downstream gas turbine. The process consists of consecutive oxidation and reduction cycles in two separate reactors. The main advantages of packed-bed reactor technology are that the separation of gas and particles is intrinsically avoided, the easiness in design and scale up and the possibility to work at elevated pressure (resulting in increased process efficiency). Disadvantages of the concept include the necessity to use a high temperature gas switching valves.

The use of ilmenite has been extensively analyzed as oxygen-carrier for CLC. Ilmenite is an iron mineral naturally available (thus inexpensive as raw material) and attractive for packed bed CLC because it has showed to have high conversion for syngas applications. The main problem of using ilmenite as oxygen carrier is the slow kinetic of solid reduction reaction with CO. But if the syngas has high CO and H_2O content, Water Gas Shift (WGS) reaction may occurs as heterogeneous reaction and the combined effect of WGS and H_2 oxidation helps the syngas conversion as it was found by Schewebel et al. [2]. Spallina et al. [3] demonstrated that the WGS activity would make ilmenite also suitable for dynamically operated packed bed chemical looping process.

In this work, the activity of ilmenite for the WGS reaction has been studied. The experiments were performed in a micro fixed bed reactor. Different syngas composition and temperatures were studied and it was found that ilmenite presents a certain activity for the WGS reaction. The kinetics of this reaction in presence of ilmenite was also determined. It was studied the influence of CO, CO_2, H_2O and H_2 concentration on WGS reaction rate and finally, the kinetics of WGS over ilmenite could be described by a power-law expression.

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