**EXPERIMENTAL INVESTIGATION OF THE IMPACT OF DIFFERENT WATER SORBENTS IN SORPTION**

**ENHANCED CO2 HYDROGENATION OVER A COMMERCIAL Cu/ZnO/Al2O3 CATALYST**

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**ABSTRACT**

The production of methanol via CO2 hydrogenation is thermodynamically favored at high pressures and low temperatures. However, CO2 activation requires reaction temperatures above 240°C, thus limiting methanol yield to low levels. Our group has previously demonstrated, both computationally [1] and experimentally [2], that the methanol yield can considerably increase (up to 130%) in the presence of a sorbent which continuously removes the produced water, thus alleviating the thermodynamic barriers.

In this work, we extend our investigation by experimentally studying the effect of the type of water sorbent (zeolites 3A, 4A, 5A and 13X) on the performance and stability of the sorption enhanced CO2 hydrogenation reaction. All experiments were performed in a continuous high-pressure fixed-bed reactor unit with a standard commercial Cu/ZnO/Al2O3 catalyst at constant reaction conditions (250 oC, 70 bar, H2/CO2 ratio 3 and sorbent/catalyst ratio 8). Under these conditions, CO2 hydrogenation leads to the production of CH3OH, CO and H2O.

Comparison of the conventional and sorption enhanced experiments confirms that the sorbent addition leads to a distinct increase in CO2 conversion and CH3OH yield. The positive effect of sorption gradually diminishes as the sorbent becomes saturated and the system eventually reaches the same steady state as the conventional process. In the presence of the zeolites, CO2 conversion increases by 55-66%, while the CH3OH yield increase ranges from 77-92%. Although CO production also increases simultaneously with CH3OH, the zeolites preferentially enhance the production of methanol. Zeolite 4A exhibits the highest enhancement in performance and zeolite 3A the worst. Experiments were also conducted in the absence of catalyst and reveal that the zeolites adsorb, not only water, but also part of the CO2 and H2 reactants. The stability of the sorbents was examined over three consecutive sorption-regeneration cycles. Zeolite 13X presents the highest deactivation, closely followed by zeolite 5A. The regeneration also deteriorates the performance of zeolite 3A, especially regarding methanol, the reduction of which is disproportional to the activity loss. Zeolite 4A presents the highest stability over the consecutive sorption-regeneration reaction cycles, thus rendering it the more suitable water sorbent for this process.

**KEYWORDS:** CO2 hydrogenation, water sorbent, zeolite, methanol, sorption-enhanced

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**REFERENCES**

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