Preparation of polymetallic and hidrotalcites catalysts. Synthesis of Methanol and DME by hydrogenation of CO_2

D. J. Escalante[1], A. Chocho[1], L. A. González[1], A. Brito[1]

[(1)]Chemical Engineering Department, University of La Laguna; Avda. Astrofísico Fco. Sánchez s/n, La Laguna, Tenerife, Canary Island, 38200, Spain. 922318001,descalan@ull.edu.es

1. Introduction – It is well known that CO_2 is the most important greenhouse gas, and its accumulation in the atmosphere contributes to global warming, which could be a great threat to the environment and to the mankind. Consequently, the catalytic routes of CO_2 utilization as carbon source for the production of fuels like methanol or dimethyl ether (DME) have gained significant attention in the recent years [1-3]. The present work focuses on preparing and testing different polymetallic and hydrotalcites catalysts to obtain MeOH and DME by hydrogenation of CO_2 at low pressure.

2. Results and Discussion - A reaction system to obtain MeOH from the hydrogenation of carbon dioxide has been designed. The system contains a continuous fixed bed tubular reactor, which operates in a pressure range from 1 to 8 bar and high temperatures. Different polymetallic catalysts Cu-Mg-Al, Cu-Mn-Al, Cu-Zn-Al, all with the same molar ratio of 2:4:0.5, and hydrotalcites catalysts Cu:Mg:Al, Cu:Mn:Al, Cu:Zn:Al with molar ration of 2:1:1, were used to test the reaction system. The reaction conditions used were 6 bar and 265 °C, with a H_2/CO_2 flow relation of 5 and a space velocity of 1860 mL/(g_{cat} h).

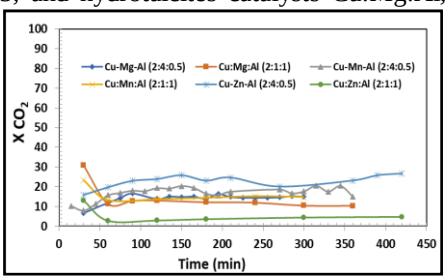

Figure 1.CO_2 conversión

For the polymetallic and hydrotalcites catalysts, the conversion of CO_2 was determined, as well as the selectivity of the catalysts to MeOH. As can be seen in Figure 1, the polymetallic catalyst that shows the highest conversion for CO_2 is Cu-Zn-Al (2:4:0.5) (25%), while for the hydrotalcite catalyst is Cu:Mn:Al (2:1:1), although the one with the highest selectivity to MeOH is the hydrotalcite catalyst Cu:Mg:Al (2:1:1), with a value of 40%, while its selectivity to CO is 60%, with a CO_2 conversion of 10%.

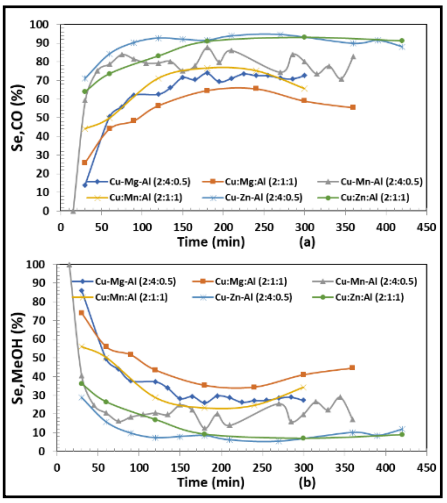

Figure 2. a) CO selectivity, b) MeOH Selectivity

3. Conclusions - In general, the polymetallic catalysts give higher conversions, but the hydrotalcites give a greater selectivity to MeOH. In the two types of catalysts those with Mg in their composition are the ones that give the highest selectivity, followed by those with Mn. The next step will be studding the influence of the different reaction variables in the process, as well as to varying the proportion of metals in the composition of the catalyst.

4. References

[1] Centi G, Perathoner S. Opportunities and prospects in the chemical recycling of carbon dioxide to fuels. Catal Today 2009;148:191-205.

[2] Khozema AA, Ahmad AZ, Abdul MR. Recent development in catalytic technologies for methanol synthesis from renewable sources: a critical review. Renew Sustain Energy Rev 2015;44:508-18.

[3] Frusteri F, Bonura G, Cannilla C, Drago Ferrante G, Aloise A, Catizzone E, et al. Stepwise tuning of metal-oxide and acid sites of CuZnZr-MFI hybrid catalysts for the direct DME synthesis by CO_2 hydrogenation. Appl Catal B Environ 2015;176e177:522-31.

Acknowledgment: ENERMAC project (MAC/1.1a/117), INTERREG MAC 2014-2020