

A study of the influence of acidity on the production of THFA from furfural using clay supported nickel catalysts

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1. Introduction – Furfural is a platform chemical obtained from biomass that can be catalytically hydrogenated to obtain different products of interest. The conversion to tetrahydrofurfuryl alcohol (THFA) proceeds via furfuryl alcohol (FOL). This process is catalysed by metals such as Ni [1]. The presence of acid sites can suppose secondary reactions that compete with the expected reaction [2]. To study the influence of acidity we propose the use of nickel catalysts supported on mineral clays (montmorillonite, saponite) with different acid properties.

2. Experimental – Commercial montmorillonite MK-10 (M), was used along with mesoporous delaminated H-saponite (S), synthesised using a previously described method [3]. The acidity of these supports was 0.7 and 1.02 CHA meq/g for M and S, respectively. This acidity was modified for M with different amounts of MgO (M-MgO10% and M-MgO30%) named M1 and M2, respectively. The modification of saponite was performed by exchange to obtain the Na form (S1) and by the presence of MgO30% (S2). The nickel catalysts with a 40% loading were prepared via impregnation, calcination and reduction at 450°C. An aqueous solution of furfural was added to a stainless-steel autoclave along with the reduced catalyst. The reaction was performed at 140°C, 40 bars of hydrogen and 600 rpm stirring for 4 hours. The reaction products were analysed by gas chromatography. All samples were characterised using mainly thermogravimetric analysis (TPR, CHA-desorption) and X-ray diffraction.

3. Results and Discussion – The acidity in supports M2 and S2 was negligible and in M1 and S1 was lower than in M and S. With respect to the amount of metal phase, important differences were observed between the catalysts. The highest amounts were obtained for catalysts Ni/M2 and Ni/S and the minimum amount for Ni/M and Ni/S2. A total conversion and 100% selectivity to THFA was obtained using Ni/M2. This catalyst presented a negligible acidity and a total reduction of Ni. The higher acidity of Ni/M and Ni/S can be correlated with the presence of cyclopentanone (CPO), produced by acid catalysis. The lower activity of Ni/S and Ni/S1 can be explained by catalyst deactivation.

Fig. 1. Catalytic results. Blue line: conversion; orange column: selectivity to THFA; blue column: selectivity to FOL; grey column: selectivity to CPO.

4. Conclusions – The yield to THFA can be improved by decreasing the acidity of the support whilst maintaining a good reduction degree of the metallic nickel phase.

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6. References

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