

γ -Al₂O₃ catalysts synthesis with different aluminum sources for methanol dehydration to dimethyl ether

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Dimethyl ether (DME) is a versatile multi-source multi-purpose chemical being projected to become one of the main chemical feedstocks in the 21st century. It is a non-toxic, eco-friendly and easily condensable gas that can be used both as a fuel or as a chemical feedstock [1]. DME can be produced by methanol dehydration. In this study, three γ -Al₂O₃ catalysts for methanol dehydration to DME were synthesized by the precipitation method using different aluminum sources (Table 1). The activity of the catalysts was compared with a commercially available γ -alumina catalyst.

The result showed that the Al precursor strongly affected the structural properties and catalytic performance with the catalyst produced from aluminum nitrate had the highest catalytic performance under the same reaction conditions, being comparable with the commercial γ -Al₂O₃. As a general trend, catalytic performance improved significantly with increasing specific surface area and pore volume of the catalysts, which are in turn a function of the textural properties and crystallinity of the sample. These characteristics favor the availability and accessibility of acidic active sites to methanol reactant. In contrast, samples with low porosity and/or smaller crystallite size are less active, most probably due to their predominant amorphous nature [2].

Table 1. Textural properties and activity of catalyst samples.

Sample name	Aluminum source	BET surface area (m ² /g)	Pore volume (cm ³ /g)	Pore diameter (nm)	Methanol conversion (%) ^a	
					T=260 °C, WHSV=3h ⁻¹	T=300 °C, WHSV=20 h ⁻¹
S1	Sodium aluminate	357	0.88	49.6	79	80
S2	Aluminum nitrate	353	0.80	45.5	79	82
S3	Aluminum foil	204	0.30	29.4	14	17
Commercial	-	246	0.74	62.0	80	81

^a The catalyst activity measurements were carried out in an isothermal fixed-bed stainless steel reactor (i.d. 10 mm) at temperatures of 260 and 300 °C under atmospheric pressure. Feed: pure methanol, WHSV= Weight Hourly Space Velocity.

Keywords: γ -Al₂O₃ synthesis, Methanol dehydration, Dimethyl ether, Catalytic performance.

References

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