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Production of Pure Hydrogen by Ethanol Dehydrogenation

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Abstract

Bioethanol production is growing in the world as a possible energy vector instead of gasoline. In Brasil ethanol produced from sugar cane residues is currently used as fuel for cars, directly or in mixture with gasoline. The use of ethanol as fuel increases the availability of this substance at low price. Therefore, ethanol can become a building block for producing other chemicals like: ethylene, ethyl ether, acetaldheyde and ethyl acetate. The two first mentioned reactions are dehydration, while, the third and fourth are dehydrogenation.

It is interesting to observe that together with acethaldeyde and ethyl acetate, that are very interesting chemicals, pure hydrogen can be obtained as by-product in both cases.

We have studied both the dehydrogenation to acetaldheyde and to ethyl acetate. More or less dispersed copper catalysts are active in these types of dehydrogenation. The presence of promoters, such as alumina, barium chromate, chromia, and the choice of the temperature pressure and contact time allows to obtain a good selectivity to respectively acetaldehyde or ethyl acetate. In any case, hydrogen is obtained that can be separated very easily from the effluents, being all liquids at room temperature. Hydrogen so obtained is, therefore, pure not containing in particular CO, as it occurs for the hydrogen deriving from syngas. This hydrogen is particularly useful for feeding Fuel Cells.

The mentioned copper catalysts, on the basis of the preparation methods, the presence of other components and the operative conditions, allow to obtain selectivities spanning from 98-99% of acethaldehyde to 95-98 % of ethyl acetate. In particular, the best results in the obtainment of ethyl acetate, have been found by using a commercial copper based catalyst, containing copper chromite (45%), barium chromate (11%), copper (13%), copper oxide (1%) and alumina (30%), operating at 220-240°C, 20 bar and 98 $ghmol^{-1}$ of contact time. In these conditions a conversion of 50-60% with selectivity to ethyl acetate of 97-98% has been obtained. On the contrary, at lower pressures and contact time and at higher temperatures, acetaldehyde becomes the main reaction product. At last also the copper dispersion and the presence of different promoters is very important in affecting the selectivity.

By concluding, in this work two different processes will be described, for producing respectively acethaldehyde and ethylacetate by using copper based catalysts with the aim of obtaining pure hydrogen as by-product. The type of catalysts used and the operative conditions will be described in details.