

Catalytic conversion of glucose to glycerol

A catalytic pathway was obtained in a two-stage sequence, starting from glucose to sorbitol to glycerol, to secure the full process to produce bio propane from lignocellulosic material.

A glycerol selectivity as high as 44 % was obtained with a Ni/ γ -Al₂O₃.

Glycerol has flooded the market through almost two decades, as the result of the large increase in the production of biodiesel, in which glycerol is a stoichiometric by-product. But with new research a pathway to produce bio based propane from glycerol has been developed. To keep the glycerol price low and as well to state an economically feasible process route, a pathway to produce glycerol from glucose (from lignocellulosic materials) has been proposed. By hydrogenation of glucose, obtained from processed lignocellulosic materials, sorbitol can be produced. This is done in large scale commercial processes and can be performed productively, with high selectivity towards sorbitol. Further hydrogenolysis of sorbitol has proven primarily one of the most suitable ways to end up with the requested product. The backbone carbon structure of six carbon atoms makes it easy to imagine a split between the two middle carbons resulting in two glycerol molecules. Though the fairly easy process route, large difficulties were found in acquiring an economically feasible product yield.

A wide range of catalyst were tested, in an autoclave batch reactor, to scout the activity of catalysts already proven active, according to previous literature, as well as catalysts not mentioned in literature for the specific reaction. Catalysts well known for both the hydrogenation of glucose and the hydrogenolysis of sorbitol are catalyst including either nickel or ruthenium as the active metal.

The just mentioned active metals supported on γ -Al₂O₃ was proven to have high conversion rates as well as high selectivity in the hydrogenation of glucose. With catalyst loadings of 0.5% in weight and active metal concentrations lower or comparable to literature, highly active hydrogenation systems were found with both types of catalysts. For the more unknown system of sorbitol hydrogenolysis, the case was different. The most active system was found to be Ni supported on γ -Al₂O₃ for which the selectivity was considerably high, 44%. This was though found after almost the triple operating time compared to certain literature with still low conversion rates of 36%.

Unexpected results were found in the addition of basic promoter which lowered the activity for the nickel catalyst which according to literature would increase the activity of the system. The increase in activity was only found for the catalyst using ruthenium as active metal. Other remarkable findings was the high conversion of sorbitol before the system was put to operating conditions. This together with the regenerating sorbitol concentration with the adding of hydrogen to the system, leads one to think that the start-up procedure before introducing hydrogen may be a crucial step for achieving a more sought for product distribution. This introduces further possibilities in the research area, studying tentatively the effect of hydro cracking derived from the high reactivity, specifically for the acidic catalyst, and if the retro-aldol is a crucial step, only obtained before the adding of hydrogen.