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Hydrolysis of cellulose and glucose onto silica-pyridine sulfonic acid

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Abstract

In this study, silica was extracted from rice husk by washing rice husk many times with distilled water, and then treated with 1.0 M of Nitric acid; finally, it was burned in an oven at 800 ^{o}C. Using method Sol-gel the resulting silica was converted into sodium silicate after dissolving it with a solution (1.0M) of sodium hydroxide, then it was reacted with CPTES to produce a silica with the functional group CH_2-Cl and the symbol RHACCl.

Loading pyridine sulfonic acid on the surface of silica in two ways: the direct method, where pyridine sulfonic acid, CPTES, and sodium silicate were added to the aqueous solution, then the mixture was titrated against HNO_3 (3.0N), and the reflux method, where RHACCl and pyridine sulfonic acid were added to the toluene solvent and at a temperature of 120°C for 48 hours to form a heterogeneous catalyst symbol, RHAPSA@Dir and RHAPSA@Ref, respectively.

The prepared catalyst was identified by several techniques, including elemental analysis (CHNS), where the percentages of nitrogen and sulphur appeared, and thermal decomposition (TGA/DSC), where the thermal stability of both catalysts was proven up to 250 ^{o}C. According to the nitrogen adsorption analysis, the surface area of the catalyst was found to be 50,416 m^2/gm for both the direct and reflux methods, respectively. FT-IR spectroscopy showed that the SO_2 and CH aromatics and aliphatic were clearly shown in FT-IR. As well as the scanning electron microscope (SEM) and the transmission electron microscope (TEM), which show the topography, size, and arrangement of the particles of the catalyst. The X-ray diffraction results for both catalysts showed the appearance of a wide band at an angle of 22^{o}, which proves that the surface is amorphous.

Cellulose and glucose decomposition were carried out over the prepared catalyst. Pyridine sulfonic acid homogeneous catalyst needed only 6 h to decompose 98% of cellulose to glucose. RHAPSA@Dir needs 9 hours to decompose 55% of cellulose. About 86% of glucose was decomposed in 4 h over RHAPSA@Dir. RHAPSA@Ref needs 10 h to decompose 41% of cellulose and 4 h to decompose 80% of glucose. According to our results the catalytic activity of the catalysts used in the decomposition of cellulose and glucose was followed the sequence below:

Pyridine sulfonic acid > RHAPSA@Dir > RHAPSA@Ref