Hydrogen production by aqueous-phase reforming of glycerol on supported metal catalysts

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Introduction

The full environmental benefit of power generation from hydrogen fuel cells is only achievable if hydrogen is produced from sustainable resources such as biomass. Glycerol is the main biomass-derived product formed during bio-diesel production. Nowadays the worldwide trend of increasing production of bio-fuels results in an overproduction of glycerol. The hydrogen production from glycerol by the aqueous-phase reforming process at low temperatures and high pressures on various supported catalysts including Pt/Al_2O_3, Pd/Al_2O_3, Ni/Al_2O_3, Ru/Al_2O_3 and Rh/Al_2O_3 was studied.

Materials and Methods

The catalysts Pd/Al_2O_3, Pt/Al_2O_3, Ru/Al_2O_3, Rh/Al_2O_3 and Ni/Al_2O_3 were prepared by incipient wetness impregnation. The activity and selectivity of the catalysts for the aqueous-phase reforming of glycerol were studied in a laboratory reactor at 498 K 26.5bar and 513 K and 34.5bar, the concentration of glycerol was 1 - 10%wt.

Results and Discussion

The selectivities to hydrogen and alkanes at 489 K and 26.5 bar are shown in the figure 1.

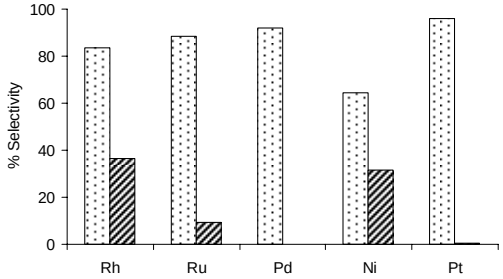

Figure 1. Hydrogen and alkane selectivity of the catalysts at 489 K and 26.5 bar. The hashed bar represents alkane selectivity and the white bars present hydrogen selectivity

The hydrogen selectivities of various metals supported on γ-Al_2O_3 were in the order Pt > Pd > Ru > Rh > Ni. The H_2 selectivities of Pt and Pd supported on γ -Al_2O_3 were above 90% with a low alkane selectivity. The apparent activation energies of the metals supported on γ-alumina were in the order Pt < Pd < Ru < Ni < Rh.

The activity of the Pt/Al_2O_3 catalyst was studied for 2 weeks at 498 K and 29 bar, during this time the activity of the catalysts was almost constant as shown in Figure 2. The conversion of glycerol was close to 100% and less than 1000 ppm of CO were produced. Intermediate compounds such as methanol, ethanol, 1-propanol, propylene glycol, propanoic acid, acetol, acetic acid ethylene glycol, and small traces of untreated glycerol were present in the in the liquid phase.

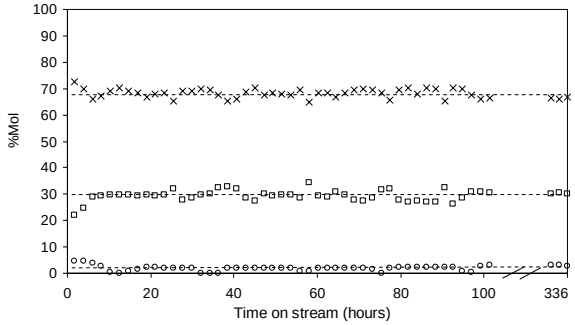

Figure 2. Concentration of gas products versus time H_2 (×); CO_2; (□); CH_4 (○)

Significance

The H_2 selectivity of Pt and Pd of more than 80% at 489 K and 513K together with the low alkane selectivity and the high long term stability indicates that Pt and Pd supported on gamma alumina could be a potential catalysts for the aqueous phase reforming of glycerol.

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