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A Thermodynamic Approach of the Aqueous-Phase Glucose Reforming Reaction for Hydrogen Production: A comparative study with glycerol and ethylene glycol

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ABSTRACT

In the present work is reported for the first time the thermodynamic analysis of aqueous-phase glucose reforming. The reaction has been studied at low temperature values (298-338K) and at atmospheric pressure with the reactants to be in liquid phase and the products in gas phase. According to the results temperature increase affects positively the conversion of glucose to hydrogen. Comparable with glycerol and ethylene glycol which are also considered being among the most promising sources for hydrogen production, glucose gives the highest conversion.

Keywords: *aqueous-phase, glucose reforming, ethylene glycol reforming, glycerol reforming, thermodynamic analysis, hydrogen production*

Introduction

Glucose is a major component of biomass and has emerged as the best candidate for biomass derived hydrocarbon processing for hydrogen [1]. Herein in order to take information about the theoretical hydrogen yield of the aqueous-phase glucose reforming reaction the thermodynamic analysis is studied at low temperature (298-338 K) and at atmospheric pressure. The temperature range is restricted as in the literature there are no further data for glucose's solution at higher temperature. The results are compared with those of glycerol and ethylene glycol.

Results & Discussion

The aqueous-phase glucose reforming is described by the following reaction:

$C_6H_{12}O_6$ (l) + $6H_2O$ (l) —> $6CO_2$ (g) + $12H_2$ (g), considering glucose and water in liquid phase. This chemical equation represents a heterogeneous chemical system. The two major assumptions that were made for the calculations are: (i) the two phases are in equilibrium [2], (ii) due to the lack of information of the water's and glucose's activity coefficients values in an aqueous glucose solution at different temperature values, these are kept constant Additionally, the Van't Hoff's equation was used for calculating the equilibrium constant as a temperature function. Numerical values for the standard enthalpy of the reactions were computed from tabulated formation data which were obtained from chemical engineers' handbooks [3]. The above calculations were accomplished by using a simple mathematical model which was developed in Matlab environment. As it can be seen from Fig.1 temperature affects positively the hydrogen production under mild conditions.

More precisely at atmospheric pressure and at 298K it is observed almost 50% glucose conversion and at 338K is almost succeeded the complete glucose conversion to carbon dioxide and hydrogen.

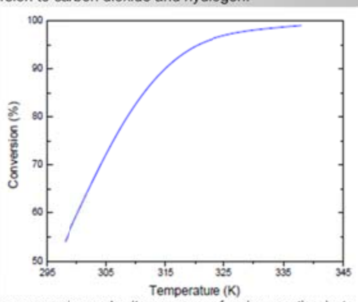

Figure 1: Glucose conversion under its aqueous reforming reaction in temperature range 298-338 K and at atmospheric total pressure.

Conclusions

As it can be concluded, the aqueous glucose reforming reaction can be conducted under mild conditions and thus glucose can be also a good fuel candidate for fuel cells. The same behaviour with glucose was observed for the glycerol and ethylene glycol. However, the conversion of those is found to be 3% and 6% lower than glucose's.

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