Gasification of crude glycerine: experimental and theoretical study

Q. Follador[1], D.M.G. Leite[1], A. Essiptchouk[2]

[1] *Instituto Tecnológico de Aeronáutica (ITA), São José dos Campos, SP, Brazil*
[2] *Instituto de Ciência e Tecnologia, São Paulo State University (UNESP), São José dos Campos, Brazil*

Biofuels industry produces demethylated crude glycerine on a large scale, which presents a potential raw material for the production of several high-benefit by-products. The aim of this work is to study the production of synthesis gas from crude glycerine via thermal plasma processing. The experiments were carried out at the plasma-chemical reactor operated at 33 kW. The mean operating temperature was ~1000K and the feedstock flow rate – 5 g/s. The concentration of H_2 and CO on the final gas were 34% and 24%, respectively, as measured by chromatography. The experimental results were compared with numerical simulation of the process, assuming the thermodinamical equilibrium conditions. This study shows that synthesis gas could be effectively produced from crude glycerol through the thermal plasma treatment.

The looking up for alternative energy sources has been proving, over the last years, that reducing the harmful effects, caused by the fossil fuels use, is a right way for improving of the human life quality. A plasma-chemical experimental system is used in this work for the study of biofuel plasma reforming. The system consists of a compact, water-cooled, plasma-chemical reactor working with a transferred arc at atmospheric pressure, a DC power supply, a glycerol supply system, a gas scrubber, and an exhaust fun for controlling of the inside reactor pressure. A mass-spectrometer and a gas chromatograph were used to quantify the components of the produced gases. In order to eliminate moisture before the quantitative analysis the sampling gas was conducted through condenser immersed in a thermostatic bath with the temperature -5°C.

In experiments, the crude glycerine with 15,5% of water and 1.9% of sulphur was used. The flow rate of feedstock was calibrated for 5×10^{-3} kg/s of crude glycerol. The arc current and interelectrode distance were adjusted to operate at power of 33 kW to maintain an average temperature inside the reactor at 1000±50 K during the tests. Small quantity of air, gasification agent, was added. Under these conditions, the sample of produced gas contained 34% of H_2 and 24% of CO with remainder compounds like carbon dioxide, methane, and lights hydrocarbons. In order to evaluate the reforming performance of the experimental system, it was quantified in terms of energy conversion efficiency (relation between the lower heating value of the synthesis gas and sum of the lower heating value of glycerine and the plasma torch power), which attains approximately 36%.

A numerical simulation of the process was carried out in a thermodynamic equilibrium approximation. The obtained experimental data corroborate well with the theoretical results and confirm the potential available in the plasma gasification process of crude glycerine.

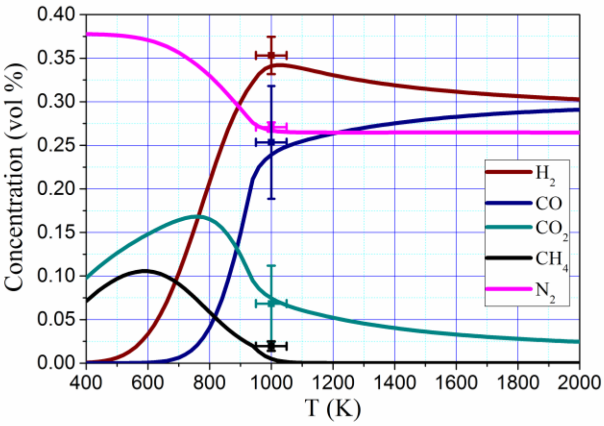

Figure. Numerical simulation (solid lines) versus experimental data (points)

A comparison with experimental works of different authors and methods, [1]-[3], indicates that the reforming process may be improved that requires more detailed studies together with a kinetic modelling.

We acknowledge FAPESP and CAPES for financial support of work.

[1] Tamošiūnas, A., Valatkevičius P., Grigaitienė V., Valinčius V., Striūgas N. J. Cleaner Production 130 (2016) 187

[2] Yoon S.J., Yun, Y.M., Seo M.W., Kim, Y.K., Ra, H.W., Lee, J.G., Int. J. Hydrogen Energy, 38 (2013) 14559.

[3] Zhu X., Hoang T., Lobban L.L., Mallison R.G., Chem Commun (2009) 2908