

The Feasibility of Glycerol Steam Reforming in an Industrial Sized Fixed Bed Reactor Using Computational Fluid Dynamic (CFD) Simulations

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Abstract : For the past decade, the production of biodiesel has significantly increased along with its by-product, glycerol. Biodiesel-derived glycerol massive entry into the glycerol market has caused its value to plummet. Newer ways to utilize the glycerol by-product must be implemented or the biodiesel industry will face serious economic problems. The biodiesel industry should consider steam reforming glycerol to produce hydrogen gas. Steam reforming is the most efficient way of producing hydrogen and there is a lot of demand for it in the petroleum and chemical industries. This study investigates the feasibility of glycerol steam reforming in an industrial sized fixed bed reactor. In this paper, using computational fluid dynamic (CFD) simulations, the extent of the transport resistances that would occur in an industrial sized reactor can be visualized. An important parameter in reactor design is the size of the catalyst particle. The size of the catalyst cannot be too large where transport resistances are too high, but also not too small where an extraordinary amount of pressure drop occurs. The goal of this paper is to find the best catalyst size under various flow rates that will result in the highest conversion. Computational fluid dynamics simulated the transport resistances and a pseudo-homogenous reactor model was used to evaluate the pressure drop and conversion. CFD simulations showed that glycerol steam reforming has strong internal diffusion resistances resulting in extremely low effectiveness factors. In the pseudo-homogenous reactor model, the highest conversion obtained with a Reynolds number of 100 (29.5 kg/h) was 9.14% using a 1/6 inch catalyst diameter. Due to the low effectiveness factors and high carbon deposition rates, a fluidized bed is recommended as the appropriate reactor to carry out glycerol steam reforming.

Keywords : computational fluid dynamic, fixed bed reactor, glycerol, steam reforming, biodiesel

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