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Determination of optimum blend of bioethanol-petrol mixture using utrasonication for environmental friendly fuel

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ABSTRACT

Increasing global energy demand as well as air quality concerns have in recent years led to the search for alternative clean fuels to replace fossil fuels. One such alternative is the blending of petrol (gasoline) with ethanol, which has numerous advantages such as ethanol's ability to act as oxygenate thus reducing the carbon monoxide emissions from the exhaust of internal combustion engines of vehicles. However, the hygroscopic nature of ethanol is a major concern in obtaining a perfectly homogenized petrol-ethanol fuel. This problem has led to the study of ways of homogenizing the petrol-ethanol mixtures. Therefore, this thesis aimed at enhancing the homogenization of petrol-ethanol mixture.

Ethanol concentration in ethanol-water mixture plays a key role in enhancing the homogenization of the fuel, thus the bioethanol employed in this study was dehydrated with silica gel using ultrasonication-enhanced adsorption. Afterwards, the dehydrated ethanol was used in studying the homogenization of the fuel blend.

Water removal from the bioethanol using ultrasonication-enhanced adsorption shows a 28% increase when compared to the water removal using magnetic-stirring-enhanced adsorption, During ultrasonication-enhanced adsorption, the estimated adsorption enthalpy was –1 592.82 J/mol (exothermic) and the entropy was -5.44 J/ K mol, indicating a non-ordered loading of water molecules in the adsorption site. In addition, a modified pseudo second order kinetic model given by $\frac{d\,q_t}{(q_t - q_e)^2} = \frac{1}{q_e}[\,cos\,(K-t) - t\sin(K-t)]\,dt$ was proposed for the ultrasonication-enhanced adsorption process. Effect of temperature during ultrasonication-enhanced adsorption was found to be directly proportional to the amplitude and the pulse rate. However, increase in the amplitudes at lower pulse rates resulted in better cavitation, and hence better adsorption.

Furthermore, during phase behavior of ethanol-petrol blend, volume fractions of ethanol and petrol were studied with respect to t the depth within the storage container to confirm homogenization of the blend and time of storage. The binodal curve of the ternary diagram shows an increase of homogeneous region indicating an improved interaction between water and petrol. Therefore, the interesting results regarding the homogenization of the fuel blends

resulted from using ultrasonication-enhanced blending were very promising, and could be a platform upon which further research efforts could be built on.

The concentration distribution in the reactor showed proof of cavitation formation since in both directions, the variation of concentration with both time and distance was found to be oscillatory. On comparing the profiles in both directions, the concentration gradient, diffusion flux, and energy and diffusion rates were found to be higher in the vertical direction compared to the horizontal direction. It was therefore concluded that ultrasonication creates cavitation in the mixture which enhances mass transfer and mixing of ethanol and petrol. The horizontal direction was found to be the diffusion rate limiting step which proposed that the blender should have a larger height to diameter ratio. It is however recommended that further studies be done on the rate-limiting step so as to have actual dimensions of the reactor.

Testing of the blended fuel in internal combustion engine showed an optimal performance of this fuel at 60 % volume ethanol content with higher fuel power. The results of fuel consumption and emissions (such as CO_2 and CO) trends confirm various reports in literature on the performance of ethanol/petrol blended fuel.