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Desulphurization of Waste Tire Pyrolytic Oil (TPO) Using Photodegradation and Adsorption Techniques

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Abstract : The nature of tires makes them extremely challenging to recycle due to the available chemically cross-linked polymer and, therefore, they are neither fusible nor soluble and, consequently, cannot be remolded into other shapes without serious degradation. Open dumping of tires pollutes the soil, contaminates underground water and provides ideal breeding grounds for disease carrying vermins. The thermal decomposition of tires by pyrolysis produce char, gases and oil. The composition of oils derived from waste tires has common properties to commercial diesel fuel. The problem associated with the light oil derived from pyrolysis of waste tires is that it has a high sulfur content (> 1.0 wt.%) and therefore emits harmful sulfur oxide (SOx) gases to the atmosphere when combusted in diesel engines. Desulphurization of TPO is necessary due to the increasing stringent environmental regulations worldwide. Hydrodesulphurization (HDS) is the commonly practiced technique for the removal of sulfur species in liquid hydrocarbons. However, the HDS technique fails in the presence of complex sulfur species such as Dibenzothiopene (DBT) present in TPO. This study aims to investigate the viability of photodegradation (Photocatalytic oxidative desulphurization) and adsorptive desulphurization technologies for efficient removal of complex and non-complex sulfur species in TPO. This study focuses on optimizing the cleaning (removal of impurities and asphaltenes) process by varying process parameters; temperature, stirring speed, acid/oil ratio and time. The treated TPO will then be sent for vacuum distillation to attain the desired diesel like fuel. The effect of temperature, pressure and time will be determined for vacuum distillation of both raw TPO and the acid treated oil for comparison purposes. Polycyclic sulfides present in the distilled (diesel like) light oil will be oxidized dominantly to the corresponding sulfoxides and sulfone via a photo-catalyzed system using TiO_2 as a catalyst and hydrogen peroxide as an oxidizing agent and finally acetonitrile will be used as an extraction solvent. Adsorptive desulphurization will be used to adsorb traces of sulfurous compounds which remained during photocatalytic desulphurization step. This desulphurization convoy is expected to give high desulphurization efficiency with reasonable oil recovery.

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