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Developing Environmental Engineering Alternatives for Deep Desulphurization of Transportation Fuels

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Abstract : Deep desulphurization of transportation fuels is a major environmental concern all over the world and recently prescribed norms for the sulphur content require below 10 ppm sulphur concentrations in fuels such as diesel and gasoline. The existing technologies largely based on catalytic processes such as hydrodesulphurization, oxidation require newer catalysts and demand high cost of deep desulphurization whereas adsorption based processes have limitations due to lower capacity of sulphur removal. The present work is an attempt to provide alternatives for the existing methodologies using a newer non-catalytic process based on hydrodynamic cavitation. The developed process requires appropriate combining of organic and aqueous phases under ambient conditions and passing through a cavitating device such as orifice, venturi or vortex diode. The implosion of vapour cavities formed in the cavitating device generates (in-situ) oxidizing species which react with the sulphur moiety resulting in the removal of sulphur from the organic phase. In this work, orifice was used as a cavitating device and deep desulphurization was demonstrated for removal of thiophene as a model sulphur compound from synthetic fuel of n-octane, toluene and n-octanol. The effect of concentration of sulphur (up to 300 ppm), nature of organic phase and effect of pressure drop (0.5 to 10 bar) was discussed. A very high removal of sulphur content of more than 90% was demonstrated. The process is easy to operate, essentially works at ambient conditions and the ratio of aqueous to organic phase can be easily adjusted to maximise sulphur removal. Experimental studies were also carried out using commercial diesel as a solvent and the results substantiate similar high sulphur removal. A comparison of the two cavitating devices- one with a linear flow and one using vortex flow for effecting pressure drop and cavitation indicates similar trends in terms of sulphur removal behaviour. The developed process is expected to provide an attractive environmental engineering alternative for deep desulphurization of transportation fuels.

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