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Oxidation and Heating Kinetics of Refinery Sludge

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Abstract: Refinery sludge is one of the major industrial wastes that needs to be handled and treated . Therefore, this study aim to investigate the Kinetics of devolatilization and oxidation of the refinery sludge collected from a typical petroleum refinery plant located in Malaysia . Thermo Gravimetric Analyzer (TGA) was used in this study for modeling of the devolatilization and oxidation processes in presence of nitrogen inert gas and oxygen. Two reaction models are proposed here to describe the devolatilization while the oxidation reactions can be adequately described by a three-parallel-reaction models. The results show that the significant devolatilization reactions occur in the range of 192.76 - 500 ^{o}C. After a temperature of 500 ^{o}C the oxidation reactions are predominant. The activation energy, reaction order and pre-exponential factor were determined using three heating rate 10, 20 and 30 ^{o}C min^{-1} and appropriate temperature are monitored to optimize the de-volatilization and oxidation reactions of the refinery sludge. The results show that, the heating rate has no significant effect of activation energy value. But Increasing the heating rate appeared to increase the start and end temperatures of each stage and shift DTG peaks to a higher temperature,. For all heating rates the third reaction of the three parallel oxidation reaction model has the highest activation energy ranged from 126.830- 472.277 kJ mol^{-1} with the lowest H/C ratio. The proposed reaction models could give useful information for treatment of refinery mixed sludge and design a proper system for oxidation and heating processes.

Keywords: TGA, Kinetics, oxidation, devolatilization, refinery sludge.