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Multistep Thermal Degradation Kinetics: Pyrolysis of $CaSO_4$-Complex Obtained by Antiscaling Effect of Maleic-Anhydride Polymer

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Abstract : This work evaluates the thermal degradation kinetic parameters of $CaSO_4$-complex isolated after the inhibition effect of maleic-anhydride based polymer (YMR-polymers). Pyrolysis experiments were carried out at four heating rates (5, 10, 15 and 20°C/min). Several analytical model-free methods were used to determine the kinetic parameters, including Friedman, Coats and Redfern, Kissinger, Flynn-Wall-Ozawa and Kissinger-Akahira–Sunose methods. The Criado model fitting method based on real mechanism followed in thermal degradation of the complex has been applied to explain the degradation mechanism of $CaSO_4$-complex. In addition, a simple dynamic model was proposed over two temperature ranges for successive decomposition of $CaSO_4$-complex which has a combination of organic and inorganic part (adsorbed polymer + $CaSO_4.2H_2O$ scale). The model developed enabled the assessment of pre-exponential factor (A) and apparent activation-energy (E_a) for both stages independently using a mathematical developed expression based on an integral solution. The unique reaction mechanism approach applied in this study showed that (E_{a1}-160.5 kJ/mole) for organic decomposition (adsorbed polymer stage-I) has been lower than E_{a2}-388 kJ/mole for the $CaSO_4$ decomposition (inorganic stage-II). Further adsorbed YMR-antiscalant not only reduced the decomposition temperature of $CaSO_4$-complex compared to $CaSO_4$-blank ($CaSO_4.2H_2O$ scales in the absence of YMR-polymer) but also distorted the crystal lattice of the organic complex of $CaSO_4$ precipitates, destroying their compact and regular crystal structures observed from XRD and SEM studies.

Keywords : $CaSO_4$-complex, maleic-anhydride polymers, thermal degradation kinetics and mechanism, XRD and SEM studies
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