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Photocatalytic oxidation of SO_2 on TiO_2 and the catalyst deactivation: a kinetic study

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Abstract

Kinetics for the photocatalytic oxidation (PCO) of SO_2 on TiO_2 surface considering catalyst deactivation were investigated in this study. Different deactivation rate models as a function of SO_2 concentration and the catalyst residual activity were studied. The kinetic parameters of the overall reactions were obtained and discussed for different water contents, oxygen contents, and reaction temperatures. The addition of water and oxygen into the flue gas both benefited the PCO performance of TiO_2. According to the model, however, the water-related radicals appeared to be more reactive than the oxygen-related radicals on UV-irradiated TiO_2 surface. In addition, the presence of water significantly reduced the residual activity of the deactivated catalyst from ~7% to ~1%, while the influences of oxygen and temperature can be negligible. The model prediction in the temperature range of 60-100 ℃ reveals that the apparent activation energy of the photocatalytic reaction was about 29.0 kJ/mol under the UV intensity of 3 mW/cm^2. This indicates that SO_2 can be oxidized by photocatalysis much easier when compared with other oxidation approaches. The thermodynamic analysis of the kinetic parameters shows that the adsorption of SO_2 on TiO_2 surface was spontaneous physisorption with the adsorption enthalpy of −17.5 kJ/mol.

Keywords: Sulfur dioxide; Titanium dioxide; Photocatalysis; Deactivation; Kinetics