483a Modeling the Kinetics of the Sulfation Reaction of a Copper-Based Regenerable Sorbent Used in Flue Gas Desulfurization

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Non-catalytic gas-solid reactions are encountered in a variety of chemical process industries. One of the major applications is found in the field of control of gaseous pollutants. The kinetic modeling of such systems is important to interpret the laboratory data on these systems and in design and scale-up. The kinetic model has to be reasonably sensitive to account for the transient nature of the problem and the effects of changes in solid properties with the course of reaction.

This paper discusses the kinetics of the reaction between SO_2 and a regenerable copper-based sorbent undergoing cyclic operation. The results obtained in a systematic study conducted in a Thermo Gravimetric Analyzer (TGA) are discussed in detail, which includes the effects of operating condition and cyclic sulfation/regeneration operation. An Expanding Grain Model was applied to describe and explain the reaction kinetics and the transport phenomena in the sorbent particle during the CuO-SO_2 reaction. The developed model incorporates the physical and chemical properties of the sorbent and relates the behavior of the sorbent particle in the reacting system to the changes in the physical and chemical properties of the sorbents. The model takes into account the pore-closure phenomena, and other structural changes (eg. Changes in surface area and porosity) during the reaction and is thus able to describe the kinetics of the sulfation reaction of the regenerable copper-based sorbent satisfactorily. Parameters such as the effective diffusivity of the gaseous reactant through the sorbent particle and the diffusivity of SO_2 through the product layer of the grains are also taken into account. The developed Expanding Grain Model can thus account for leveling-off of conversion-time data far below the complete conversion of the solid reactant.