188b Removal of Hydrogen Sulfide in Coal Gases Using a Monolithic Catalyst Reactor

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Removal of hydrogen sulfide (H_2S) from coal gas and sulfur recovery as elemental sulfur are key steps in the development of advanced power plants that employ coal and natural gas, and produce electric power and clean transportation fuels. The conventional method of sulfur removal and recovery employing amine scrubbing, Claus, and tail-gas treatment involves a number of steps and is energy intensive. A novel process called Single-Step Sulfur Recovery Process (SSRP) is under development at various research groups. In this process, the H_2S in the coal gas is selectively oxidized in a single step to elemental sulfur using sulfur dioxide (SO_2) or oxygen (O_2) in the presence of alumina-or-carbon-based catalyst pellets in a packed/fluidized bed.

A monolithic catalyst reactor (MCR) for the development of a single-step sulfur recovery process is used to remove H_2S from a simulated coal gas in this study. Sulfur dioxide is used as an oxidizer to convert H_2S into liquid element sulfur at 125 to 155^oC. The monolith catalyst is wash-coated with gamma alumina oxide. A special flow regime (Taylor flow) in a monolithic catalyst channel removes the liquid elemental sulfur formed at the catalyst surface thereby regenerating the catalyst in-situ, whereas catalyst pellets deactivated with liquid sulfur in a packed/fluidized reactor are regenerated periodically.

The monolithic catalyst has the potential to convert selectively H_2S to elemental sulfur by wetting the interface between the solid catalyst surface and gas phase with a thin liquid sulfur film, which is developed with the aid of a special flow pattern (Taylor flow) in parallel catalyst channels. A performance of the monolithic catalyst is presented in terms of H_2S removal capacity, deactivation, and selectivity of COS with various catalyst promoters at various reactor operation conditions.