343d Deactivation of Catalysts in Removal of Hydrogen Sulfide in Coal Gases as Liquid Sulfur

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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 use coal, natural gas, and biomass as feed stocks, 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 organizations. In this process, the H_2S in the coal gas is selectively oxidized in a single step to liquid 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 reactor.

This heterogeneous catalytic reaction has gaseous reactants such as H_2S and SO_2. However, this heterogeneous catalytic reaction has heterogeneous products such as liquid elemental sulfur and steam. Pellet-type catalysts are used for a fluidized bubble reactor, whereas monolithic cataltysts are used for a monolithic catalyst reactor (MCR) for the development of a single-step sulfur recovery process 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 in this study. The monolithic catalyst is wash-coated with gamma alumina oxide, whereas the pellet-type gamma-alumina catalyst is used for a micro bubble reactor in this study. These catalysts are mainly deactivated with the reaction products such as liquid elemental sulfur and steam. A special flow regime (Taylor flow) in a monolithic catalyst channel removes the liquid elemental sulfur formed at the catalyst surface thereby partially regenerating the catalyst in-situ. Catalyst pellets surrounded with liquid sulfur in a packed/fluidized beds reactor are deactivated severely and regenerated periodically. A performance of the monolithic catalyst and the pellet catalyst will be presented in terms of deactivation, H_2S removal capacity, and selectivity of COS with various catalyst promoters at various reactor operation conditions.