# Performance of manganese-based solid sorbents for $H_2S$ removal: Particle size and promoter effects on sorbent capacity

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The increasing environmental concerns due to the climate change and carbon dioxide emissions over the past decades have led to many research activities on developing renewable energy resources, such as biofuels. Gasification of the solid biomass produces syngas (mainly contains $H_2$, CO $CO_2$, $CH_4$, $C_2H_4$ and $H_2O$), which can be used for electricity production and biofuel synthesis [1]. However, a number of undesired chemical species, such as tars, alkali metals, chlorine, nitrogen compounds, and sulfur species, are also part of the gas matrix. These contaminants have severe detrimental effects on downstream equipment and catalysts [2], especially sulfur species which are important catalyst poisons. Therefore, high temperature gas cleaning –operating between the gasification temperature (700 °C or higher) and the synthesis temperature of subsequent catalytic conversion (300 °C for methane synthesis) – is desired, in terms of costs and energy efficiency.
Manganese (Mn)-based solid sorbents have promising performance at high temperatures, due to their high thermal stability, resistance to reduction and volatilization [3]. For example, the metallic Mn cannot be formed below 1200 °C, hence the volatilization of metal does not occur as observed for Cu and Zn [4,5]. In this work, we study the removal process of $H_2S$ from a simulated syngas of biomass gasification using high temperature Mn-based solid sorbents. Molybdenum (Mo) oxide is used as a promoter in this study to further improve the stability of sorbents and enrich their desulphurization capacity [6]. A series of Mo-promoted manganese oxide sorbents (15 wt%) supported on alumina are prepared by the incipient wetness impregnation method. Different loadings of Mo promoters are made (i.e. 2wt%, 5wt% and 8wt%) using co-impregnation. More details about the chemicals and preparation procedures can be found in Ref. [7]. We also report on the preparation and characterization of eggshell and uniform pellets of Mn-based sorbents. The evaluation of the eggshell catalysts performance, along with corresponding uniform catalysts, for $H_2S$ removal capacity is also performed.
The performance test is done using 10 sorption – regeneration cycles. The sorption process is carried out on pre-reduced samples at 600°C. A gas mixture of 0.4 vol% $H_2S$, and 40% $H_2$, with balance inert gases of Ar, and $N_2$ are used. A gas mixture containing 25 vol% air is supplied for regeneration process at 650°C and ambient pressure. The residual $H_2S$ level is monitored with a specific sulfur analyzer (Thermo-Fisher 450i) at various Mo loading, different sorption temperatures, and for different particles sizes of solid sorbents. It is found that the addition of Mo to the Mn-based sorbents is beneficial, in terms of capacity, stability, and residual $H_2S$ concentration. However, by increasing the particle size, the sorbent capacity for $H_2S$ removal was decreased substantially.

**References**
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