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SO2 abatement using gold catalysts

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ABSTRACT

Common species that are found in the flue gas of many coal burning industries are sulphur dioxide (SO_2) and carbon monoxide (CO). The current flue gas desulphurisation techniques used in practice are undesirable as they are uneconomical (they have high capital and operating costs) and they generate waste.

Many results in the literature show that if gold (Au) is finely divided and supported on metal oxide, it is effective as a catalyst for oxidising CO. However, there have not been many studies involving the reduction of SO_2 by CO over a gold catalyst. The main objective of this research project was to determine whether a gold catalyst supported on titania would be suitable for the reduction of SO_2 by CO.

Titania (TiO_2) was used as the metal oxide support and the gold catalysts were prepared by the deposition-precipitation method. Other gold catalysts were prepared by impregnating promoter ions (K^+, Na^+, SO_4^{2-}, PO_4^{3-}) onto the TiO_2 before the gold was added. The effect of TiO_2 calcined at 400°C without the addition of gold was also investigated for this reaction.

Since this work is novel, as the reduction of SO_2 by CO has hardly been performed over this type of catalyst before, the experimental method required screening several catalysts over a range of temperatures. The method used for screening the catalysts was the temperature "stepping method" where the reaction temperature was stepped in equal intervals of 25°C from a minimum temperature of 50°C to a maximum of 200°C. The results were analysed by integrating the SO_2 adsorption peaks.

It was found that a gold catalyst is in fact suitable for this application. TiO_2 without gold was effective at adsorbing SO_2, although it was not as effective as the gold catalysts supported on titania.

A catalyst time on stream experiment using the 0.8wt% Au/TiO_2 catalyst was used to understand the chemistry of the full reaction. It was observed that initially the SO_2

blocks the active sites at the interface between the gold and the titania. The SO_2 gets adsorbed onto the surface of the catalyst and after some time the SO_2 molecule dissociates. After the S-O bond has been broken the active sites at the Au – TiO_2 perimeter are no longer blocked and SO_2 reduction occurs and CO oxidation decreases with time which suggests irreversible desorption of SO_2 reduction products on CO oxidation sites.