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An Insight into Sulphide Removal from Waste Gases (Sulphides) with Emphasis on Carbon Disulphide

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ABSTRACT

Removal of selective gases from exhaust gas stream can be done by various gas liquid mass transfer operations. Gas absorption and adsorption are two important gas liquid separation operations. Gases like carbon dioxide, sulphur dioxide are products of combustion of fuel. Sulphide gases are the commonly existing gases in coal, natural gas and synthesis gas processing. CS_2 has detrimental effect on industrial heterogeneous catalysts. Methods like hydrogenation, oxidation, and hydrolysis can be used for removal of carbon disulphide. Current review is focused on removal of carbon disulphide from waste gaseous mixture. Also research on removal of other sulphide compounds is carried out.

Key words: Pressure, temperature, residence time, accumulation, bio filter.

INTRODUCTION

Air pollutants are classified into two types. Particulate matters are one class of air pollutants. These are mainly suspended particles present in emission gases. These pollutants can be removed from the exhaust gases by using various methods such as electrostatic separators, cyclone separators, fabric filters and other inertial separators. [1-5] Removal of gases like carbon dioxide, sulphur dioxide, hydrogen sulphide and carbon disulphide can be carried out by gas absorption or adsorption. [6-10] Biofiltration is also effective method for treatment of flue gases. [11-14] Various membrane separation techniques can also be used for removal of selective gases from the exhaust gas stream. Chemical processing gases from coal, natural gas and synthesis gas contains hydrogen sulphide and carbon disulphide. Carbon disulphide can have detrimental effect on industrial heterogeneous catalysts. Also it is a corrosive gas. It can cause atherosclerosis and coronary artery disease. Desulphurization of coal can minimize the sulphides in the exhaust gas streams. [15-20] The removal of sulphides can be carried out by various methods such as absorption, adsorption and bio filtration. Current review summarizes research and studies on sulphide removal from waste gases with emphasis on carbon disulphide.

AN INSIGHT INTO SULPHIDE REMOVAL FROM WASTE GASES WITH EMPHASIS ON CARBON DISULPHIDE

Wei et.al carried out investigation on biotrickling filtration for dimethyl sulfide removal. [21] They determined the optimal spray density, empty bed residence time (EBRT) and pH. The optimum values of these parameters were 100 $mL.min^{-1}$, 38 s and 6.0 respectively. Phylogenetic analysis carried out by them indicated that sequences of these bands were closest to sequences of species of the Bacillus sp, Rhodobacteraceae bacterium, proteobacterium, delta proteobacterium. Ohnuki et.al studied measurement of carbon disulfide anion diffusion in a time projection chamber. [22] In their investigation they used a negative ion time projection chamber, NITPC to measure the drift velocity, lateral diffusion and longitudinal diffusion in a variety of CS_2-Ar gas mixtures. Li et.al described a mathematical model for the rate of carbon disulfide (CS_2) removal. [23] They carried out kinetic studies in a fixed-bed reactor under atmospheric pressure and a range of temperatures (30–70^{O}C). Also they analyzed the effects of flow rate, CS_2 inlet concentration, temperature and relative humidity. Hosseini et.al carried out investigation on hydrogen sulphide production by hydrogen sulfide methane reformation. [24] In their investigations, they explored possibilities for efficient production of CS_2 from sour natural gas reformation (H_2SMR) ($2H_2S+CH_4 = CS_2 + 4H_2$). Also they studied the effect of H_2S to CH_4 feed ratio and reaction temperature on carbon disulfide production. According to these studies the major factor influencing CS_2 production is reactor temperature. They observed that the predicted CH_4 and H_2S conversion and yield of carbon disulfide were in good agreement with result of Huang and Traissi.

Rojo et.al studied influence of the accumulation of biodegradation products on biomass development in carbon disulfide bio-filtration. [25] They observed decrease in the initial high removal efficiency due to the excessive accumulation of sulfate and the reduction in the packing material's moisture content. In their investigations they used two laboratory-scale biofilters consisting of PVC columns. Morrison et. al. developed methods for assaying dimethyl sulfide (DMS) concentration in fermenter gas, activated carbon from the CO_2 purifier, and purified CO_2. [26] They characterized the pattern of DMS evolution during fermentation and removal during CO_2 purification. In fermentation, they observed that DMS evolution increased to a maximum during the first day. They also observed that the water scrubber was able to remove 72% of the DMS from the collected ferment or gas. Reminder was removed by carbon purifier. Sekhavatjou et.al developed a new method for sulfur components removal from sour gas. [27] They used zinc and iron oxides nanoparticles for the purpose. They used gas chromatography with a chemical luminescence sulfur detector for separation and identification processes of the sulfur components. They observed 9-16 percent increase in the removal of hydrogen sulfide, methyl and ethyl mercaptan by 33% reduction of zinc oxide particle size.

Smith carried out studies on hydrogen sulfide removal from industrial gases. [28] For this purpose they used modified Claus technology. Economics and technology are limiting factors for these processes. According to them, the new, advanced sour gas purification process fills the need for a robust and effective technology. It serves the purpose of removing reduced sulfur compounds from natural and industrial complex gases. A single adsorption and reaction vessel with significantly lower capital and operating costs can be used for the recovery and conversion of hydrogen sulfide to elemental sulfur. The decomposition of ethyl mercaptan to ethylene and hydrogen sulphide was studied by Boivinand MaCdonald. [29] They carried out experiments at various temperatures, with and without a catalyst. According to these studies, Metal sulphides (copper, nickel, and cadmium) are the most efficient catalysts for cracking ethyl mercaptan into unsaturated end products. Corresponding optimum temperature range was 500-600^{0}C. Carbon disulphide, carbonyl sulphide, methane, hydrogen, ethane, thiophene, diethyl sulphide, and free sulphur were other products in exit stream.

CONCLUSION

Gas absorption and adsorption are two important gas liquid separation operations. Gases like carbon dioxide, sulphur dioxide are products of combustion of fuel. CS_2 has detrimental effect on industrial heterogeneous catalysts. Methods like hydrogenation, oxidation, and hydrolysis can be used for removal of carbon disulphide. In a chemical process, major factor influencing CS_2 production is reactor temperature. A single adsorption and reaction vessel with significantly lower capital and operating costs can be used for the recovery and conversion of hydrogen sulfide to elemental sulfur. Zinc and iron oxides nanoparticles can be used for dimethyl sulfide (DMS) removal.

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