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A Review on Hydrogen Sulphide Removal From Waste Gases

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ABSTRACT*:* Treatment of waste water and waste gases is very important in the modern industrialization. Various methods (biological, chemical and physical) are available for removal of solute gases from waste gas streams. Hydrogen sulphide is one of the major pollutants in the off gases from many industries. It has very irritating odour, corrosive nature and is hazardous to human health. The present review aims at summarizing various methods for hydrogen sulphide removal. It was observed that the method for removal depends on the source of the pollutant, its concentration and economical aspects.

KEYWORDS*:* efficiency, removal, cost, adsorption, filtration.

I. INTRODUCTION

Treatment of waste streams from the chemical plants is major challenge to the technological advancements. While it is necessary to increase the yield of the product, the treatment of the waste streams in efficient way has also become very crucial problem. The organic matter and inorganic pollutants in the liquid streams can be treated by techniques like membrane separation, activated sludge processes and adsorption (1, 2, 3, 4). In case of gaseous pollutants, adsorption, oxidation, chemical treatments, biofiltration, membrane technology etc. can be used for treatment. The pollutants in the waste gas stream includes hydrogen sulphide, carbon dioxide, carbon monoxide, sulphur dioxide, other hydrocarbon gases etc. The present review aim at summarizing the research on these methods for removal of hydrogen sulphide and discussion on factors affecting the removal efficiency.

II. RESEARCH ON HYDROGEN SULPHIDE REMOVAL

An aqueous metal sulphate absorbent was used for hydrogen sulphide (H_2S) removal by Maat et.al [5]. They also carried out experimental study on regeneration of copper sulphide to copper oxide. Premkumar and Krishnamohan used biofilters for removal of H_2S from the waste gas stream [6]. They used compost and wood chips as filter bed material. They studied the effect of inlet air- H_2S vapour flow rate, inlet concentration, empty bed residence time, bed height and ratio of compost to wood chips on removal efficiency .The maximum removal efficiency was observed to be 99 percent.Wu et.al used selective catalytic oxidation for removal of H_2S[7]..They used laboratory-made activated carbon (ORNLB) along with commercial carbons. This carbon showed 100 percent selectivity during the test. Duranceau et.al. proposed new techniques for removal of H_2S [8]. They evaluated several alternative technologies at the desktop, bench, and pilot scales. They discussed techniques such as chlorination, aeration, packed tower aeration for H_2S removal. If chlorination alone is used, high iron content is a concern. In case of aeration excessive dissolved oxygen can cause corrosion. Moreover aeration has disadvantages like insufficient removal and turbidity formation. Low cost of the operation is the advantage. Oxidation by low cost oxidants like ozone, chlorine, hydrogen peroxide, potassium permanganate etc is also used. The processes by using this method are controllable and easy. Turbidity formation, safety in case of high dosage requirement, cost ineffectiveness for small amount of sulphide removal are few drawback of this method. Membrane filtration, biofiltration and ion exchange are effective bust costlier alternatives. Electrochemical membrane separation method was used for the removal of Hydrogen Sulphide from a fuel gas stream by Burke et.al [9]. According to them at higher H2S inlet concentrations or at higher operating temperatures, gaseous diffusion may become the limiting process. The diffusion rate can be increased by reducing membrane thickness or

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increasing its porosity, according to these investigations.. Effect of pore structure and surface chemistry on H_2S adsorption was studied by Feng et.al.[10].It was observed that the adsorbed and retained amount of H_2S increased with the factors such as surface area, pore volume, average pore size. Also desorbed amount decreased with the increase in serial number. Chenar et. al. carried out investigation on removal of hydrogen sulphide from methane by using commercial polyphenylene oxide and Cardo-type polyimide hollow fibre membranes [11]. They observed that the permeability of both components of the mixture increased with increasing temperature whereas the selectivity's remained constant. Clinoptilolite was used in a fixed bed adsorber by Yasyerli et.al. for removal of hydrogen sulphide [12]. Fixed-bed system at different temperatures between 100 and 600^0C at atmospheric pressure was used in the investigation. About 0.03 g S/g clinoptilolite was removed at 600^0 C. They also observed that the breakthrough curves from model prediction and experimental results were in agreement. A review was done on used of biological methods for H_2S removal by Syed et.al. [13]. According to them the preferred treatment method for removal depends on the source of the gas. For H_2S in biogas the anaerobic methods are suitable. Removal of H_2S from wastewater treatment plant off-gases can be done by biofiltration. Packed high specific surface area bed scrubber was used by Mousse et.al. [14]. They obtained removal efficiency of 97.5 percent during their investigation. They observed that the pH of the scrubbing liquid plays a vital role in H_2S removal by scrubbers .It was found that the removal efficiency of more than 99 % can be reached at high pH of at least 10. The results indicated that the change in the liquid flow rate had direct effect on the scrubber performance. With increase in the recycle liquid flow rate up to 4-5 l/min, the efficiency increased from 55 to 99 percent. Further increase in the flow rate doesn't have any effect on the removal efficiency. They concluded that, to achieve this high performance in the scrubber it is necessary to maintain minimum liquid flow rate and pH 5 L /min and 10, respectively.

Roshani et. al. carried out studies on performance evaluation of biofiltration in the removal of hydrogen sulphide from flue gas [15].According to them, biofiltration is a low-cost and highly effective air pollution control technology and an environmentally amicable method. They evaluated the parameters like elimination capacity, removal efficiency; effects of sulphate accumulation, gas retention time, pressure drop, bed water content and pH. They obtained the removal efficiency of 98 percent. Vago et.al. studied removal of hydrogen sulphide from natural gas, a motor vehicle fuel [16]. Elkanzi carried out simulation of the process of biological removal of hydrogen sulphide from gas[17].It was observed that the biological process is safe, simple, and is cost competitive with respect to the Shell Claus Off-gas Treating (SCOT) process. Iron-chelate based process was used for oxidative absorption of hydrogen sulphide by Deshmukh et.al.[18]. The reaction appeared first order in Ferric chelate. They also studied effect of antioxidant using sodium thiosulphate. Gholami et.al investigated reactive absorption of hydrogen sulphide in aqueous ferric sulphate solution[19].According to them, A distinct advantage of the process is that the reaction of H_2S is so rapid and complete that there remains no danger of discharging toxic waste gas. Results showed that high temperature and low pressure were suitable for the process. At higher of $Fe_2(SO_4)_3$, the adsorption rate decreased. They also observed that at low $Fe_2(SO_4)_3$ concentration the absorption rate of H_2S increased with increasing the $Fe_2(SO_4)_3$ concentration. Mahdavian carried out simulation of CO_2 and H_2S removal process[20]. They used methanol in hollow fibres membrane gas absorber (HFMGA) for the purpose. They used a computational mass transfer (CMT) model for simulation. They observed that , even at low absorbent rate, the adsorption was complete at pressures above 10 atm. While at pressures at 1 atm, this value is about 30%.Abdehagh used a biotrickling filter(BTF)employing thiobacillus thioparus immobilized on polyurethane foam for hydrogen sulphide removal[21].They studied the effect of the parameters like Empty Bed Residence Times (EBRT) and initial H_2S concentration on the removal. They observed that with liquid recirculation rate (LRR), the H_2S removal increased up to certain value and then remained constant. Also decrease in EBRT results in more homogeneous removal of the pollutant in BTF. Amine absorption was used for removal of H_2S by Huertas et.al.[22].The removal efficiency of 98 percent was obtained by them. When amine was regenerated the removal efficiency reduced to 95 percent.

III. CONCLUSION

Hydrogen sulphide removal was reported by various researchers by methods like adsorption, biofiltration, membrane separation, chemical oxidation etc. The selection of the method depends on the source of pollutant and the concentration. It was important to maintain the operating parameters at optimum level for effective removal of hydrogen sulphide. By using adsorption, 99 percent removal was obtained. Amine absorption removed 98 percent of the hydrogen sulphide. Removal efficiency of 97.5 was obtained by packed high specific surface area bed scrubber

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REFERENCES

[1]Sunil J. Kulkarni, Dr.Jayant P. Kaware, "Adsorption for Cadmium Removal from Effluent- A Review", International Journal of Science, Engineering and Technology Research (IJSETR),vol. 2, no. 10, pp. 1840-1844,October 2013.
[2]Kulkarni Sunil J., Kaware Jayant P., "Batch and Column Studies for Phenol Removal from Wastewater Using Low Cost Adsorbent", Research in Chemistry and Environment, vol. 4, no. 3, pp.127-132,July 2014.
[3] Sunil J. Kulkarni and Dr. Jayant P. Kaware, "Removal of Cadmium from Wastewater by Groundnut Shell Adsorbent-Batch and Column Studies", International Journal of Chemical Engineering Research",vol. 6, no. 1 pp. 27-37,2014.
[4]Sunil J. Kulkarni, "Removal of phenol from Effluent in Fixed Bed: A Review", International Journal of Engineering Research and General Science,vol.2, no.5, pp.35-39,August – September 2014.
[5]H. ter Maata, J.A. Hogendoornb, G.F. Versteeg, "The removal of hydrogen sulfide from gas streams using an aqueous metal sulphate absorbent", Separation and Purification Technology ,vol.43 , pp.199–213, 2005.
[6]Premkumar. R and Krishnamohan. N, "Biological Elimination Of Volatile Hydrogen Sulphide Compounds In Biofilters", International Journal of ChemTech Research, vol.5, no.1, pp 56-64, Jan-Mar 2013.
[7]Xianxian Wu, Andrew K. Kercher, Viviane Schwartz, "Removing Hydrogen Sulfide From Hydrogen-Rich Gas Streams By Selective Catalytic Oxidation", Prepr. Pap.-Am. Chem. Soc., Div. Fuel Chem.,vol.49,no.2,pp.893-895, 2004.
[8]Steven J. Duranceau, Vito M. Trupiano, Mark Lowenstine,Steven Whidden, and Jason Hopp, "InnovativeHydrogenSulfideTreatmentMethods:MovingBeyondPackedTowerAeration", Florida Water Resources Journal,pp.,1-10,2010.
[9]Alan Burke,zJack Winnick, Changrong Xia,band Meilin Liu, "Removal of Hydrogen Sulfide from a Fuel Gas Stream by Electrochemical Membrane Separation", Journal of The Electrochemical Society, vol.149 ,no.11,pp. D160-D166,2002.
[10]Wenguo feng , Seokjoon Kwon ,Eric Borguet , Radisav Vidic, "Adsorption of Hydrogen Sulfide onto Activated Carbon Fibers: Effect of Pore Structure and Surface Chemistry", Environ. Sci. Technol.,vol.39, pp.9744-9749,2005.
[11]M.Pourafshari Chenara, H. Savojib, M. Soltaniehb, T. Matsuura, A. Tabe Mohammadi,"Removal of hydrogen sulfide from methane using commercial polyphenylene oxide and Cardo-type polyimide hollow fiber membranes",*https://pooya.um.ac.ir/ResearchDocuments/papers/1012602.pdf*
[12]Sena Yasyerlia, Irfan Ara, Guls ̧en Dogua, Timur Dogu, "Removal of hydrogen sulfide by clinoptilolite in a fixed bed adsorber", Chemical Engineering and Processing,vol. 41,pp.782-792 ,2002.
[13]M. Syed, G. Soreanu, P. Falletta and M. Béland, "Removal of hydrogen sulfide from gas streams using biological processes - A review", Canadian Biosystems Engineering, vol. 48, pp.1-14,2006
[14]G. Moussavi,K. Naddafi,A. Mesdaghinia,band M. Mohseni, Effectiveness of Hydrogen Peroxidein H2S Removal by a Packed High Specific Surface Area Bed Scrubber", Chem. Biochem. Eng. Q. 22 no.1,pp. 9–14,2008.
[15]Babak Roshani, Ayoob Torkian, Reza Dehghanzadeh and Mohammad Reza Shahmansori, "Performance evaluation of biofiltration in the removal of hydrogen sulfide from gas flue", *ruc.udc.es/bitstream/2183/11432/1/CC-79%20art%2016.pdf*
[16]A Vago, D. Ripell Pentho, G. Horwath, L. Toth, K. Olah, "Removal of Hydrogen Sulphide from Natural Gas, A motor Vehicle Fuel",Hungerian Journal of Industrial Chemistry, vol.39, no.2,pp.8282-287,2011.
[17]E.M. Elkanzi, "Simulation of the Process of Biological Removal of Hydrogen Sulfide from Gas", Proceedings of the 1st Annual Gas Processing Symposium,2009.
[18]Girish M Deshmukh, Aparna Shete and Deepali M Pawar, "Oxidative Absorption of Hydrogen Sulfide using Iron-chelate Based Process: Chelate Degradation", J Anal Bioanal Techniques,vol.3,no.3, pp.1-4,2012.
[19]Z. Gholami, M. Torabi Angaji, F. Gholami, and S. A. Razavi Alavi, "Reactive Absorption of Hydrogen Sulfide in Aqueous Ferric Sulfate Solution", World Academy of Science, Engineering and Technology,vol.3 pp.01-24,2009.
[20]Majid Mahdavian, Hossein Atashi, Morteza Zivdar, Mahmood Mousavi, "Simulation of CO2 and H2S Removal Using Methanol in Hollow Fiber Membrane Gas Absorber (HFMGA)", Advances in Chemical Engineering and Science, vol.2,pp. 50-61,2012.
[21]N. Abdehagh, M. Taghinejad Namini, S. M. Heydarian, B. Bonakdarpour,D. Zare, "Performance Of A Biotrickling Filter Employing Thiobacillus Thioparus Immobilized On Polyurethane Foam For Hydrogen Sulfide Removal", Iran. J. Environ. Health. Sci. Eng., vol. 8, no. 3, pp.245-254,2011.
[22]J.I. Huertas, N. Giraldo and S. Izquierdo, "Removal of H2S and CO2 from Biogas by Amine Absorption", http://www.intechopen.com,pp.133-151.