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A REVIEW ON REMOVAL OF SULFUR DIOXIDE AND HYDROGEN SULFIDE GASES BY OPTIMIZING HYDROGEN PEROXIDE CONCENTRATION

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Abstract
In order to reduce SO2 emissions and achieve green utilization of sulfur resources, a desulfurization method of SO2 removal using peroxide (H2O2) in rotating packed bed (RPB) is proposed. It can't only achieve the efficient removal of SO2, but also cause the effective utilization of sulfur resources. A mathematic model was first developed to explain the reaction and mass transfer process between H2O2 and SO2 in RPB. The influences of various operating conditions including RPB rotating speed, H2O2 mass fraction, gas–liquid volumetric flow ratio, gas flux, and inlet SO2 concentration on desulfurization performance were studied. Under the optimized conditions, it clothed that the desulfurization efficiency was above 99% and the outlet SO2 concentration was ultra-low, below 35 mg/m3. The validity of the model was confirmed by the very fact that most of the predicted desulfurization efficiency agreed well with the experimental result with a deviation within 5%. the peak of mass transfer unit HTU for RPB is calculated to be 1.60–2.07 cm, which is one order of magnitude less than that of conventional reactors, indicating the investment of the desulfurization reactor are often greatly reduced by using RPB.

Keywords: *sulfer removal method,*

Introduction:

1. Emission of Sulfur Oxides and Hydrogen Sulfide

A prominent toxicant primarily found in various industrial processes and derived from industrial feedstocks such as natural gas, coal gas, synthesis gas.

2. Hydrogen Peroxide in Gases Removal

A versatile oxidizing and bleaching agent, used in a broad range of application particularly in advanced oxidation process to gaseous pollutants.

3. Wet scrubbing method

A promising method which proven to have higher reliability and greater removal efficiency.

PROBLEM STATEMENT

Wet Method by Hydrogen Peroxide	Conventional Wet Method Technologies
• Low capital costs maintenance costs • Environmental Friendly • Produces free radicals with strong oxidation such as OH, O and HO_2 • Safe chemical to store and would not cause secondary contamination	• Membrane separation Poor anti-corrosion ability and high cost • Biological Method Unable to treat high Concentration of hydrogen sulfide • Chlorine Produced a significant drawback by generating chlorinated by products: halomethanes • Fenton-Based Oxidation Method Narrow pH window, difficult to recovery ions and uncontrollable reaction rate

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Objective

- To investigate the optimum concentration of hydrogen peroxide to remove hydrogen sulfide and sulfur oxides from in gas emission.
- To study the efficiency of sulfides removal by using wet scrubbing method of advanced oxidation process.
- To study the stability of hydrogen peroxide as a chemical oxidant used in the wet scrubbing process.

Methodology

Step 1 - Sample preparation
10% of hydrogen peroxide is prepared with 5 different concentration (0.25 mol/L, 0.5 mol/L, 1.0 mol/L, 1.5 mol/L, and 2.0 mol/L).
Step 2 - Hydrogen Sulfide and Sulfur Dioxide
Hydrogen sulfide gas (20 ppm) and sulfur dioxide gas (1000 ppm) is injected into the wet scrubber.
Step 3 - Wet Scrubbing
Gases are then passed through the scrubber whereby it was absorbed in the scrubbing liquid and oxidized by hydrogen peroxide solution.
Step 4 - Gas Chromatography
The outlet gas was collected at the output of the scrubber and was kept before being analyze in the gas chromatography.
Step 5 - Chromatogram
The chromatogram is used to analyze the component in the injected gas.

Results and discussion

1) Effect of hydrogen peroxide concentration

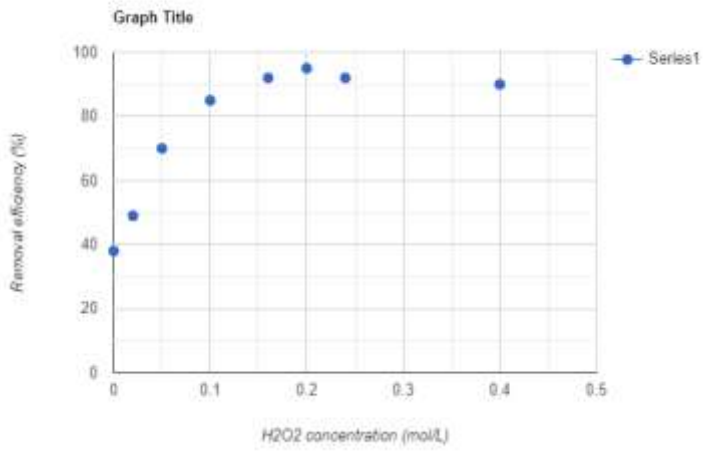

Fig 1 : Effect of hydrogen peroxide concentration on removal Efficiency of Hydrogen Sulfide

- Concentration of hydrogen peroxide imposes OH free radical that will be generated during the reaction.
- As the hydrogen peroxide concentration increases from 0 to 0.2 mol/L, hydrogen sulfide removal efficiency increases from 38.7% to 98.2% and reduces to from 98.2% to 90.1% respectively (Y.Wang et al. 2020).
- Owing to its strong oxidizing property, the OH produced able to oxidize hydrogen sulfide to sulfate through few series of reaction.

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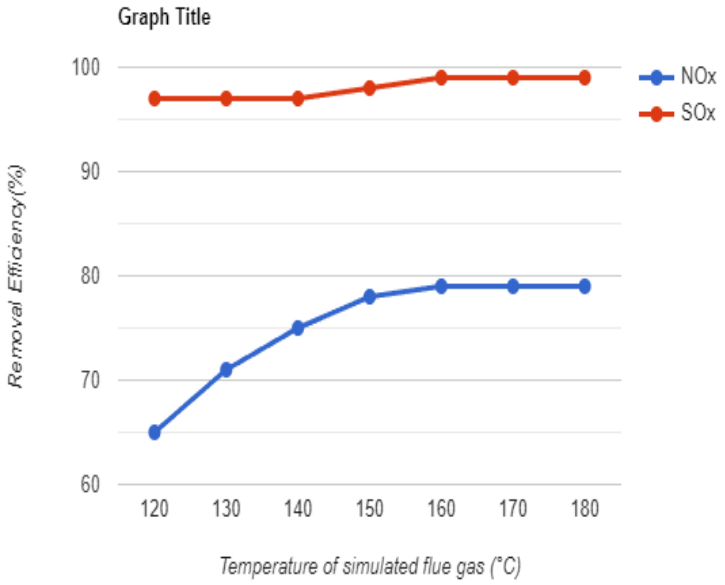
2) Effect of Solution pH
   - The solution pH is varied from 1.51 to 9.82 thus showing an increase in hydrogen sulfide removal efficiency. This is due to the fact that the enhancement of alkalinity which is solution pH will effectively improve the ionization process.
   - The removal process of the gas generates a large number of H+ in the solution. Consequently, when OH- is added into the solution, via an acid-base neutralization reaction, it can effectively absorb the substance H+, thereby improving the gas oxidation-absorption.

3) Effect of Volume Gas Ratio and Gas Flow Rate
   - In the situation where the diameter kept constant, an increase in gas flow rate will effectively increase the velocity of the gas passing the equipment used which is scrubber.
   - Increasing the gas velocity would decrease the hydrogen sulfide residence time in the reaction region. Subsequently, make it deleterious to the hydrogen sulfide removal.
   - Raising the L/G ratio will improve the transfer of gas-liquid mass by improving the disturbance in two-phase gas-liquid, thereby further supporting the removal of gases.

4) Effect of Flue Gas Temperature



   - OH radicals, hydrogen peroxide and oxygen are accelerated in the oxidation reactor with the temperature of simulated flue gas increasing, resulting in an increase in the oxidation rate.
   - The reaction activation energy of oxidation with hydrogen peroxide or oxygen is much greater than that of oxidation with OH radicals because of the lower oxidizing ability of hydrogen peroxide and oxygen.

Conclusion

1. The most promising method of removing hydrogen sulfide and sulfur dioxide is by using wet scrubbing with 1% of hydrogen peroxide.
2. From economical aspect, this method is proved to be viable as lower volume of hydrogen peroxide (378 mL) removed 2500 ppm of hydrogen sulfide with 98.7% efficiency.
3. The most preferable pH is estimated between the range of 3.2 to 11.56 for the wet scrubbing process with hydrogen peroxide.

Recommendation

- Conducting the experiment by using different parameters to study the removal efficiency trend from various aspects.
- Perform the gas analyzer analysis by using UV-VIS to compare the accuracy of the result with gas chromatography.
- Perform the gas analysis for a longer time in order to obtain the most accurate composition of gases.

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