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Practical Investigation of Desulfurization Process Conditions as an Basic Experimental Phenomenon

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Abstract

The hydrogen Sulphide (H_2S) is an extremely dangerous substance and can cause fatalities if not managed properly. The H_2S is present in more of PDO's operations as existing fields begin to sour and as high sour developments are brought on stream. This procedure deals with the identification and assessment of the hazards and the management of the associated risk for "sour gas", or gas containing H_2S. The amount of Langmuir constant is increased with increasing the LPG operating temperature and flow rate. The variation interval of Langmuir constant is between 15.06 to 18.23. In addition, the experimental results show, increase in the amount of operation pressure from 3 atm to 6 atm at temperatures of 73°C to 82°C decreases the amount of sulphur compound removal factor, severely. The decreasing rate of sulphur compound removal factor in the temperature range of 82°C to 85°C is not severed and this change is linear, approximately. Also, the amount of Langmuir constant is increased with increasing the LPG operating temperature and flow rate. The variation interval of Langmuir constant is between 15.06 to 18.23.

Keywords

Catalytic Bed, Optimum Conditions, Dimensionless Group, Operating Conditions, Nano Bed

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1. Introduction

H_2S in the upstream oil and gas industry comes from: The original reservoir, as a result of the hydrocarbon source material and the conditions under which it was converted to oil and gas. If this is the case then H_2S will be produced with the fluids [1]. The reservoir after prolonged injection of water with oxygen (brackish or formation water) which may result in 'souring' of the fluids within it due to the action of sulphate reducing bacteria (SRB) introduced during the injection process [2]. Any H_2S will be subsequently produced with fluids. The H_2S detection is used to provide early warning to personnel to the presence of H_2S in a facility or workplace. Either of the following H_2S detection methods can be selected for the activity and hazards: Continuous gas monitoring in the immediate vicinity of the work using a properly calibrated and maintained H_2S monitoring device (personal, portable or fixed), Intermittent measurements taken before and periodically during the work using a properly calibrated and maintained electronic H_2S monitoring device or colorimetric detector tubes suitable for the range expected to be encountered [3]. This method is also typically used during turnarounds when multiple concurrent activities may be executed in an area without fixed H_2S detection [4].

1.1. Environment, Health and Safety

A) Assists departments in the development of safe work procedures, training and other matters related to the health & safety of University staff [5].

B) Provide current regulatory information updates necessary

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for compliance with Occupational Health & Safety legislation.

C) Review laboratory-specific safe work procedures

D) Review and update the Code of Practice for H_2S as necessary [6].

1.2. Hazards Identification, Assessment and Control

The hydrogen Sulphide has the chemical formula H_2S with the chemical structure H-S-H. Hydrogen sulphide is a colourless, poisonous and flammable gas with the smell of rotten eggs [7]. It can be detected by smell at very low concentrations ranging from 0.01 – 0.3 parts per million [8]. Detection by odour is not reliable because at high concentrations (e.g. 100 ppm), hydrogen sulphide deadens a person's sense of smell thus make it non-detectable [9]. The hydrogen sulphide is very quickly absorbed into the lungs. Short term exposure may cause irritation of nose, throat, eyes and lungs [10]. The Alberta Occupational Exposure Limit (O.E.L) is 10 parts per million (ppm) for 8 hours and 15 ppm as a ceiling limit [11]. The Immediately Dangerous to Life and Health concentration of 100 ppm has been established by the National Institute for Occupational Safety and Health (NIOSH) [12]. Alberta Workplace Health and Safety has published a bulletin, CH029 – Hydrogen Sulphide[1], which outlines the health effects. These effects are shown in Table 1: Health Affects from Short-Term Exposure to Hydrogen Sulphide [13].

The purpose of this procedure is to outlines the hazards associated with H_2S and the steps required assessing and managing the associated risk, and protecting personnel within Production Operations.

2. Materials and Methods

The H_2S is extremely toxic and can cause death at very low concentrations. The H_2S, also known as sour gas, is a colourless toxic, corrosive and flammable gas, which is heavier than air and tends to collect in low-lying areas such as trenches, sumps and confined spaces. The H_2S reacts with the internal surfaces of carbon steel vessels in the absence of oxygen to form pyrophoric iron sulphide. Pyrophoric iron sulphide can auto-ignite when exposed to air.

2.1. Setup Description

One laboratory cylindrical vessel equipped with the nano-sized aluminium oxide catalytic fixed bed is applied for sulphur adsorption process, in this work. The process temperature is adjusted by one heat coil in the entrance of stream. The sour liquefied petroleum gas stream from a tank reservoir is fed into the bed containing aluminium oxide nano particles.

2.2. Study of Operating Variables

The operating conditions, such as operating pressure and operating temperature and also, dimensionless temperature and dimensionless pressure are evaluated in this study. In addition, the geometry of catalytic bed is investigated in this work.

2.3. Study of Langmuir Parameters

The Langmuir parameters in the optimum conditions are evaluated in this paper. The slope and intercept of Langmuir, maximum capacity for adsorption process, absorbed enthalpy are evaluated in this research.

2.4. Evaluation Langmuir Isotherm Parameters

The quality and efficiency of adsorption process can calculate according to the experimental results. The concentration of sulphur compounds in the exit stream of LPG from catalytic bed influence on the capacity, energy, thermal and hydrodynamics of flow, finally. The equation 1 shows the concentration of sulphur compound.

$$\frac{C}{q_e} = \frac{1}{q_m.K} + \frac{C}{q_m} \quad (1)$$

The q_e is defined as equilibrium state of adsorption process or the removed pollutant from LPG by catalytic bed with the mgr per gr unit. Also, C is concentration of sulphur compound (ppm) in the outlet stream of LPG. The values of q_m and K are considered as Langmuir isotherm constants. The q_m is introduced as maximum adsorption capacity and K is adsorbed energy or adsorption enthalpy. The Langmuir constants can calculate with plotting the $\frac{C}{q_e}$ versus C as slope and intercept of plotted curve. Therefore, the slope is $\frac{1}{q_m}$ and the slope is $\frac{1}{q_m.K}$.

3. Results and Discussion

The most common place H_2S gas found on campus is in calibration gas canisters for multi-gas detectors. The gas canisters contain 25ppm per canister and pose very little hazard to the user. More concentrated H_2S gas cylinders can

1 Work Safe Alberta (August, 2010), Workplace Health and Safety Bulletin - Hydrogen Sulphide at the Work Site. Retrieved from https://work.alberta.ca/documents/WHS-PUB-CH029.pdf.

be found in analytical labs, especially environmental labs, which conduct analysis of metal ions. You may discover other sources of H_2S gas on campus that are used for organic synthesis or precursors to metal sulphides, but most laboratories will choose to work with a less dangerous alternative. These concentrated cylinders of H_2S are stored in their own enclosures with an independent exhaust and fire suppression system.

3.1. Effect of Operating Temperature and Operating Pressure

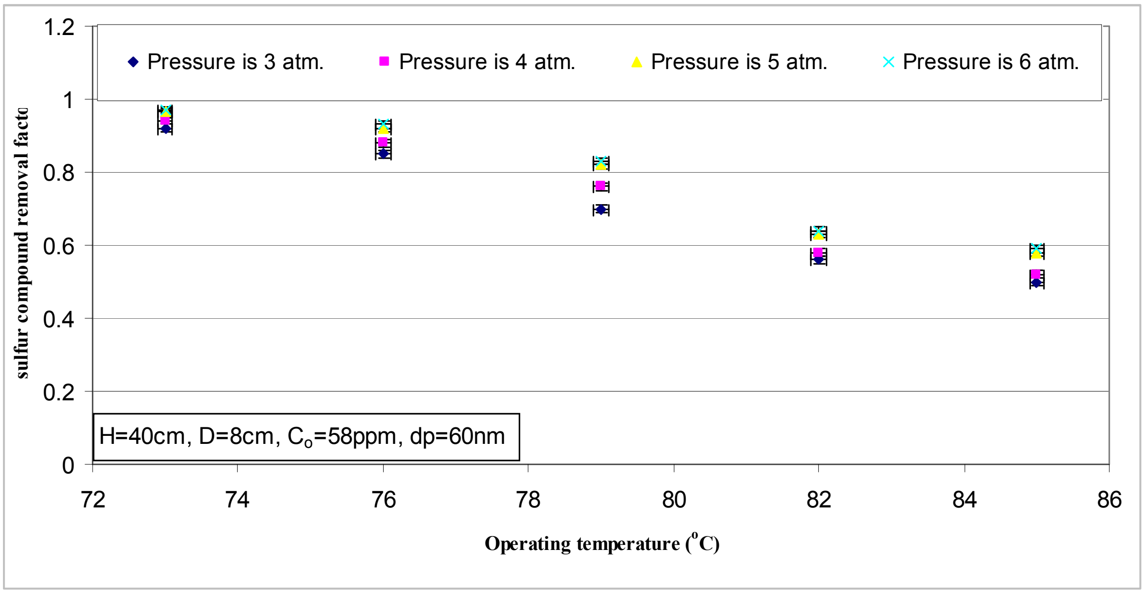

Figure 1. Effect of operating conditions on sulphur compound removal factor.

The increase in the amount of operation pressure from 3 atm to 6 atm at temperatures of 73°C to 82°C decreases the amount of sulphur compound removal factor, severely. The decreasing rate of sulphur compound removal factor in the temperature range of 82°C to 85°C is not severed and this change is linear, approximately. The Figure 1 shows the changes in the amount of sulfur compound removal factor due to the changes in temperatures and pressures.

3.2. Evaluation of Langmuir Constant

The effect of changing in the flow rate and operating temperature of LPG is evaluated in this part. The results show, the relation between Langmuir constant and LPG flow rate and operating temperature are positive. It means, the amount of Langmuir constant is increased with increasing the LPG operating temperature and flow rate.

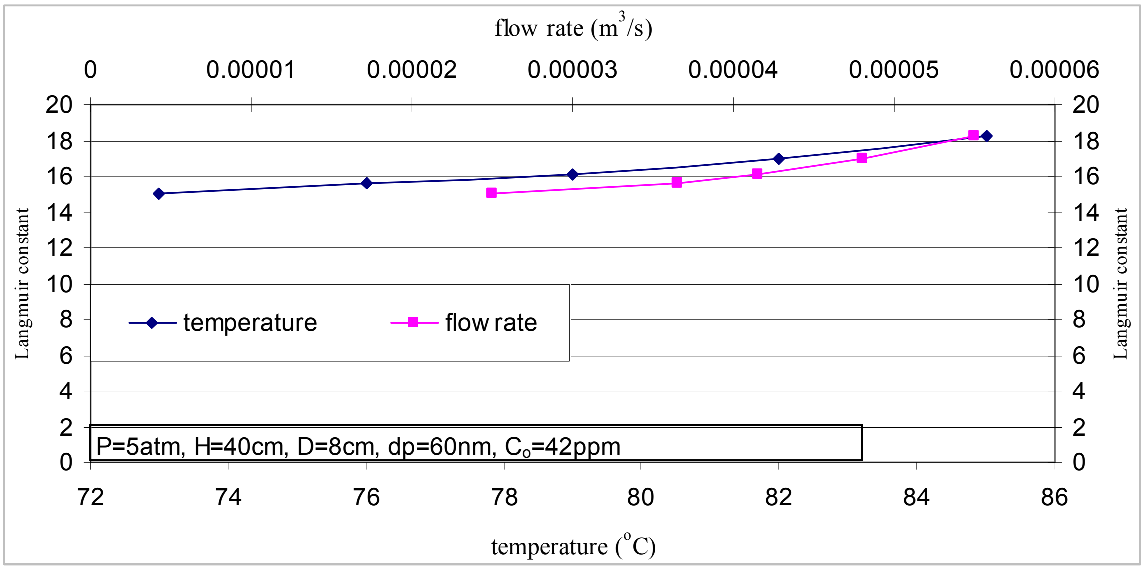

Figure 2. Relation of LPG flow rate and operating temperature and Langmuir constant.

4. Conclusions

The nano catalyst development in various areas proposes to perform many processes economically and efficiently. The optimum operating conditions and reactor characteristics for sulphur removal with aluminium oxide nano catalyst are investigated experimentally in this work. The ratio of sulphur concentration in the product stream on the initial concentration in the input stream (C/C_0) represents the process performance. Finally, the sulphur removal factor as X is defined according to the ($X = 1 - C/C_0$), in this paper. Totally, the purpose of the experiments is to decrease the amount of sulphide compounds below the 4 ppm in the outlet stream. The experimental results are presented in the following notes;

1 The amount of pressure 5 atm, bed height 48 cm, temperature 73 centigrade degree, initial sulphur content 42ppm as the optimum basic properties.

2 The increase in the amount of operation pressure from 3 atm to 6 atm at temperatures of 73°C to 82°C decreases the amount of sulphur compound removal factor, severely. The decreasing rate of sulphur compound removal factor in the temperature range of 82°C to 85°C is not severed and this change is linear, approximately.

3 The amount of Langmuir constant is increased with increasing the LPG operating temperature and flow rate. The variation interval of Langmuir constant is between 15.06 to 18.23.

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