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# STUDYING ON EFFECTIVES PARAMETERS ON GAS ADSORPTION IN CHELATED IRON SOLUTION

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**Abstract**

As low sulfur regulations have been introduced, it's developed innovative ways to meet the reduced sulfur specifications at minimal cost. In recent decade, it is developed industrial plants based on chelated iron solution to convert $H_2S$ to innocuous elemental sulfur.
This paper describes effectiveness parameters on the effectiveness parameters on gas adsorption in chelated iron solution.
The result shows that it is possible to totally remove the $H_2S$ from the sour gas by this method. The reaction is quickly occurred when is used co-current pattern to contract gas and liquid phase.

***Keywords:*** Gas; Sweetening; Redox; Chelated iron; Adsorption.

## 1. Introduction

According to environmental rules that includes in various country, the hydrogen sulphide ($H_2S$) concentration of gas must be decreased 1% or less, therefore it's vital to develop processes with high efficiency.

In recent decade, iron-chelated solution is introduced as $H_2S$ absorption process, which has high efficiency, selectivity for $H_2S$ removal.

Because it's produced no hazardous waste byproducts or toxic chemicals; therefore it's expressed as a green process.

In the first step of $H_2S$ Adsorption processes based on iron chelating, $H_2S$ is physically absorbed into water undergoing the dissociation according on following reactions:

$$H_2S\ (g) + H_2O \quad \Leftrightarrow H_2S(aq) \qquad (1)$$

$$H_2S\ (aq) \quad \Leftrightarrow H^+ + HS^- \qquad (2)$$

$$HS^- \quad \Leftrightarrow H^+ + S^{-2} \qquad (3)$$

As it's presented in equation 4, Hydrogen sulphide is oxidized to innocuous elemental sulfur by the chelated iron:

$$H_2S + 2Fe^{+3} \quad \Leftrightarrow S + 2H^+ + Fe^{+2} \qquad (4)$$

The aqueous iron-chelated solution is regenerated to convert ferric ion ($Fe^{+3}$) by oxygen according the following equations:

$$\frac{1}{2}O_2\ (g) + H_2O\,(l) \quad \rightarrow \frac{1}{2}O_2(aq) \qquad (5)$$

$$\frac{1}{2}O_2\ (aq) + 2\,Fe^{+2} \rightarrow Fe^{+3} + 2OH \quad (6)$$

The overall reaction can be expressed as below:

$$H_2S\ (g) + \frac{1}{2}O_2(g) \rightarrow S + H_2O \quad (7)$$

However there are various several chelate agents which can be used for this process; but EDTA (Ethylene-diamine-tetra-acetate) is the most common chelate which have been studied in the literatures [1-7].

## 2. Material and method

Figure-1 shows the schematic of experimental facilities to investigate on operating condition for gas absorption in iron-chelate solution.

The gas stream is combined to make required composition and is introduced to absorption column where the chelated iron solution is sprayed from the top of column.

The upstream $H_2S$ free gas from absorption tower is conducted to analyzer.

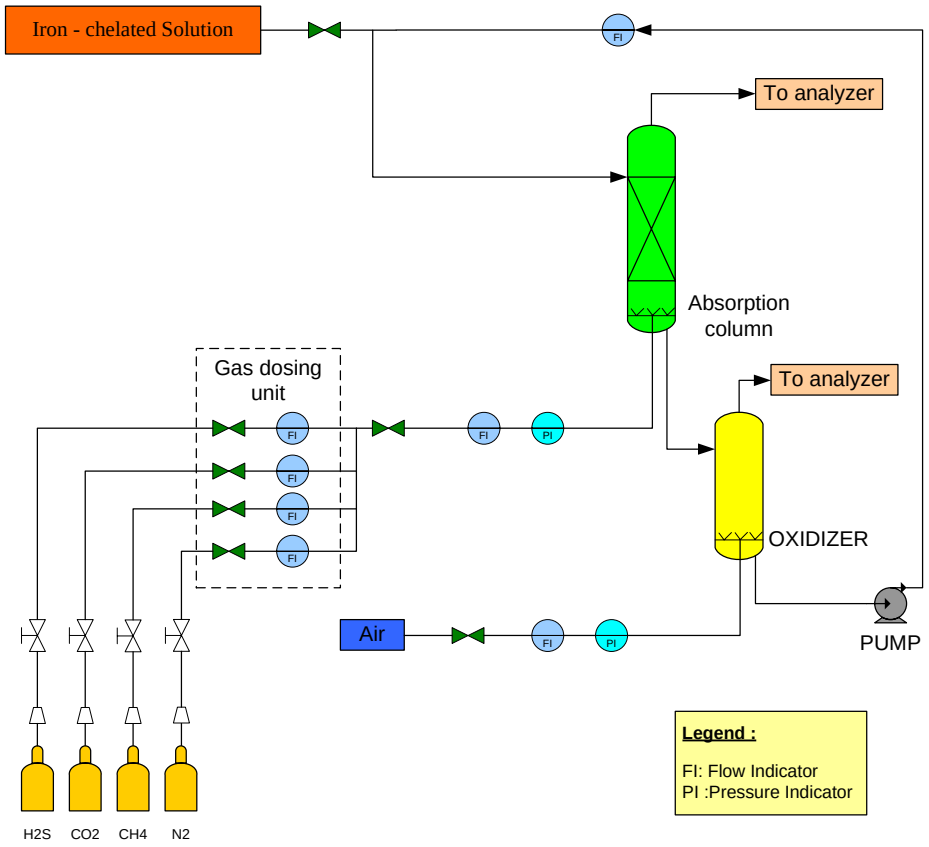


Figure 1 Schematic of laboratory set-up

The outlet solution is sent to oxidizer and regenerate by air stream.

## 3. Result and discussion

In figure 2 shows the $CH_4$, $N_2$ and $CO_2$ absorption versus time, which the flow rate of inlet gas (free $H_2S$) was 2 liter per minute with P=1.1 $bar_a$, T=24°C and the gas composition (%volumetric) was CH4 (84.4%), CO2 (3.3%) and N2 (12.25 %).

It's illustrated that the compositions (without $H_2S$) of gases other than $H_2S$ are maintained constant, except for the component $CO_2$, which is slightly absorbed at the

beginning of bubbling, thus increasing the outlet composition of the $CH_4$. After the saturation of the catalyst solution with the absorbed $CO_2$ the outlet composition is restored to the inlet value.

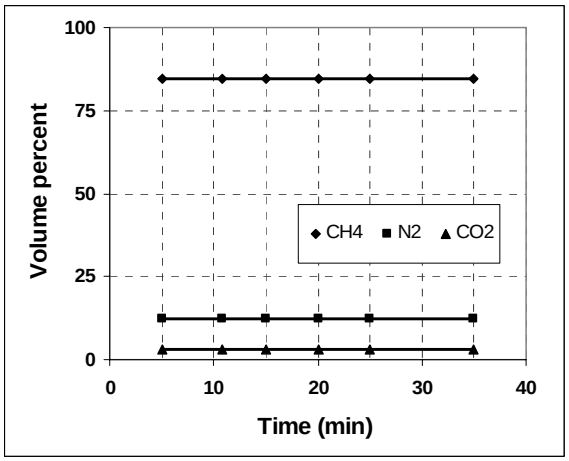


Figure 2 Gas composition versus time in batch system

The $H_2S$, $CO_2$ adsorption is investigated in continuous mode in next step. The inlet gas flow rate was 2 lit / min which its composition was $CH_4$ (84.36%), $H_2S$ (0.1), $CO_2$ (3.3%) and $N_2$ (12.24 %) based on volumetric percent.

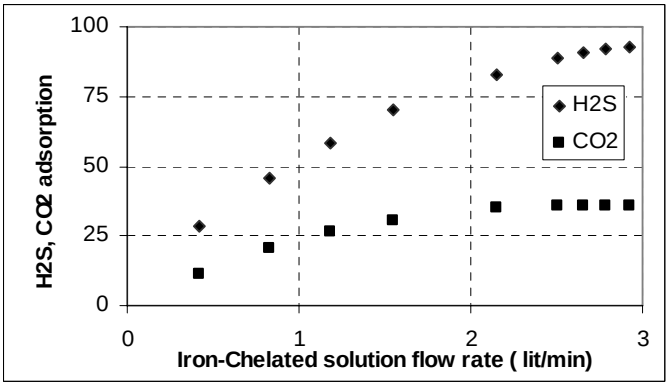


Figure 3 H2S, CO2 removal versus Fe-EDTA solution flow rate

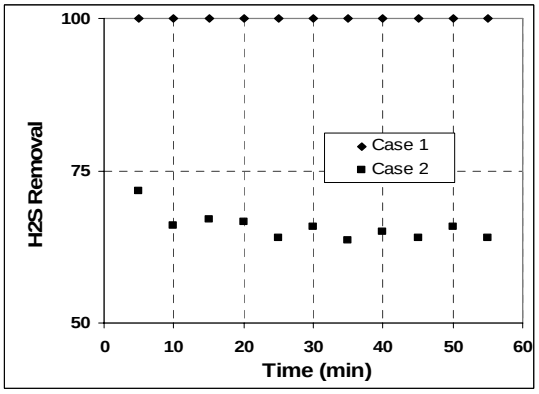


Figure 4 The pressure effect for H2S adsorption by Fe-EDTA solution

As it's clear, the adsorption rate is boosted when the flow rate of iron-chelated solution is increased. This means that above determined flow-rate with an appropriate ratio of gas contacting phases, it is possible to achieve total removal of $H_2S$.

Figure-4 shows the pressure effect on $H_2S$ removal, where the gas flow rate and EDTA catalyst solution is 1, 0.063 l/min, respectively.

The pressure is set in 0.1 for case 1 and then it will be increased to 1.1 $bar_g$ for case 2.

It can be seen; when the gas inlet pressure is increased, then $H_2S$ adsorption is decreased As it's stated before, $CO_2$ and $H_2S$ were continuously absorbed into the catalytic solution, while no absorption was observed for other gases such as $CH_4$ or $N_2$.

## 4. Conclusions

The results show the iron-chelated has high efficiency to remove $H_2S$ from gas stream. The adsorption rate is decreased when the pressure is increased.

Because only The $CO_2$ and $H_2S$ were continuously absorbed into the catalytic solution, while no absorption was observed for other gases such as $CH_4$ or $N_2$, Therefore this process has high selectivity for $H_2S$ adsorption.

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