Abstract

The objective of this project is to examine the removal of 1.0 % H_2S from 250 SCFM landfill gas stream by a NaOH solution using a pilot-scale gas absorption column. 0.05N aqueous solution of NaOH was used to separate CO_2 from air. The 4 feet pilot-scale gas absorption column is packed with ½-inch Raschig rings. For first section of lab, the gas flow rate kept as 1426.3 mL/s while the liquid flow rate was varied from 20,40 to 60 mL/s. The inlet of liquid flow rates effect on the gas absorption were put under investigation to determine the parameters that help in scrubbing the highest amount of H_2S that coming from a gas stream in a landfill. NaOH aqueous solution is used as a strong base that will react with CO_2 and H_2S to produce a solid. CO_2 was used in place of H_2S since they are similar in size, and they react with NaOH in a similar way. At a constant gas flow rate, K_ya increased with the increase of liquid flow rate. As the flow rate is increased, the trend of K_ya reaches 0.44 lbmole/ft^3*hr from 0.435 lbmole/ft^3*hr.

Background

The global warming caused by increasing emission of carbon dioxide is one of the most serious environmental problems.[1] Investigating effects of gas flow rate and carbon dioxide composition in chemical absorption of carbon dioxide in a packed bed using sodium hydroxide,[2] using a packed bed height of 1.2m, and diameter of the column is 10 cm, with 1cm of Rasching ring. to calculate the flux as shown in the following equation,

$$\frac{dG}{dZ} = -N_{co_2} \times a \qquad \text{[Eq (1)]} \qquad (1)$$

Where G is superficial molar velocity of gas,

N_{co_2} is mass transfer flux of ,

Z is the height of packed bed column, and it's the specific surface area of the packing.

In addition, a molecular balance in gas phase of gives the following differential equation.

$$\frac{dy_{co_2}}{dZ} = \frac{-[N_{CO_2}(1-y_{CO_2})]}{G} \times a \qquad \text{[Eq(2)]} \qquad (2)$$

y_{CO_2} is the mole fraction of at gas phase. With calculated mass transfer flux of CO_2 , mass transfer coefficient determined by using the following equations:

$$N_{CO_2} = k_L(CO_{2_I} - CO_{2_e}) \quad \textit{in liquid phase} \qquad \text{[Eq (3-A)]} \qquad (3a)$$

$$N_{CO_2} = k_g(P_{CO_2} - P_{CO_{2_I}}) \quad \textit{in gas phase} \qquad \text{[Eq ((3-B)]} \qquad (3b)$$

k_L = is the liquid phase mass transfer coefficient of carbon dioxide (CO_2)

CO_{2_I} = is the concentration of carbon dioxide at the interface

CO_{2_e} = is the equilibrium concentration of unreacted carbon dioxide in the bulk of liquid

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[1] Nair, P. S., & Selvi, P. P. (n.d.). Absorption of Carbon dioxide in Packed Column. International Journal of Scientific and Research Publications. Retrieved April 4, 2014, from http://www.ijsrp.org/research-paper-0414/ijsrp-p2885.pdf

[2] "ppm: parts-per million - RapidTables.com." https://www.rapidtables.com/math/number/PPM.html. Accessed 26 Jan. 2018

k_g =is the gas phase mass transfer coefficient of carbon dioxide,
$P_{CO_{2_I}}$ =is interface partial pressure of carbon dioxide.

From equation (3-A), they determined the overall mass transfer coefficient of carbon dioxide.

$N_{CO_2} = k_g(P_{CO_2} - P_{CO_{2e}})$ [Eq (3 – C)]

$P_{CO_{2e}}$ = is the partial pressure at equilibrium

Absorption processes can be divided into two groups, those in which the process is solely physical and the one accompanied by a chemical reaction. In gas absorption equipment design, intimate contact of the gas with the liquid is required.[3] For data collection, the liquid flow rate was fixed as (4L/min) and changed gas flow rate in the range of (50-90 L/min) increased by 10L/min. Moreover, they changed liquid flow rate for variation. Finally, they recorded the gas concentration at inlet and outlet, and analyzed the gas sample by gas chromatography. As a result, the amount of absorption increased because there is a higher partial pressure.

Materials and Methods