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**GAS ABSORPTION IN A FLUIDIZED-BED COLUMN**



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ฟลูอิดเบดคอสมันน์เป็นอุปกรณ์ที่ใช้ดูดซึมก๊าซที่น่าสนใจ เนื่องจากสามารถนำมาใช้กับก๊าซและของเหลวที่มีความเร็วสูง โดยสูญเสียพลังความดันน้อย ฟลูอิดเบดประกอบด้วยอนุภาคกลมมีขนาดเท่ากันและน้ำหนักเบา ใช้หัวพ่นก๊าซและของเหลวที่ออกแบบโดยเฉพาะเพื่อให้เกิดฟลูอิดอย่างทั่วถึงที่ความเร็วของก๊าซและของเหลวต่าง ๆ กัน

ภาคแรกเป็นการศึกษาถึงภาวะทางจลนศาสตร์ต่าง ๆ ที่เกิดขึ้นในคอสมันน์ที่เกิดจากการไหลสวนทางกันของอากาศและน้ำในคอสมันน์ เช่นความต้านทานของเบด ความเร็วต่ำสุดของก๊าซที่ทำให้เกิดการฟลูอิด ปริมาณก๊าซคงค้างในเบด ปริมาณของเหลวคงค้างในเบด โดยมีตัวแปรต่าง ๆ คือ ความเร็วของเหลว ความเร็วของก๊าซ และความสูงของเบด จากผลการทดลองได้ศึกษาความสัมพันธ์ของตัวแปรต่าง ๆ ในฟลูอิดเบดคอสมันน์ และเปรียบเทียบกับผลงานที่ใกล้เคียงกัน

ภาคที่สองเป็นการศึกษาถึงการดูดซึมของก๊าซแอมโมเนียในน้ำ โดยมีตัวแปรต่าง ๆ คือ ความเร็วของของเหลว ความเร็วของก๊าซ ความสูงของเบด และความเข้มข้นของแอมโมเนีย ได้สรุปผลการทดลองและเปรียบเทียบกับผลการดูดซึมของก๊าซในแบบเบดคงที่ จากผลการศึกษานี้สามารถแสดงสมการสำหรับการดูดซึมของก๊าซในฟลูอิดเบดกับตัวแปรต่าง ๆ ดังนี้

$$Sh = 7.17 \times 10^9 \cdot Fr^{0.495} \cdot Re_L^{0.442} \cdot \left(\frac{D_c}{H_s}\right)^{0.621}$$

Thesis Title            Gas Absorption in a Fluidized-bed Column  
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#### ABSTRACT

Fluidized-bed column is an interesting technique in gas absorption process. It can be operated at high gas and liquid velocities with low pressure drop. In this work, the fluidized-bed composed of light weight spheres of uniform size, special types of gas distributor and liquid distributor were used to perform uniform fluidization at both high and low velocities of liquid and gas.

The first part of the experiment concerned with the study of hydrodynamic characteristics of column in which air and water flowed counter-currently. Hydraulic resistance of bed, minimum fluidization velocity, gas hold-up and liquid hold-up were determined. The variable parameters studied were liquid velocity, gas velocity, and bed height. Correlation of various variables in fluidized-bed column was compared with those in the literature.

In the second part, mass transfer coefficients of ammonia were studied. Liquid velocity, gas velocity, bed height, and

concentration of ammonia gas were used as variable parameters. The results were summarized and also compared with fixed bed absorbers. The values of mass transfer coefficient expressed in term of Sherwood number can be represented as follows:

$$Sh = 7.17 \times 10^9 \cdot Fr^{0.495} \cdot Re_L^{0.442} \cdot \left(\frac{D_c}{H_g}\right)^{0.621}$$



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## NOMENCLATURE

- $a$  = interfacial area per unit volume,  $\text{cm}^2/\text{cm}^3$   
 $A$  = cross-sectional area of column,  $\text{cm}^2$   
 $b, \beta$  = packing constant, dimensionless  
 $C$  = concentration,  $\text{gm-mol}/\text{cm}^3$   
 $d$  = equivalent diameter of slot, cm  
 $D$  = equivalent diameter for free sectional area, cm  
 $D_f$  = Diffusivity of solute at infinite dilution,  $\text{cm}^2/\text{sec}$   
 $D_c$  = diameter of column, cm  
 $D_p$  = packing diameter, cm  
 $e_1-e_4$  = constants  
 $f$  = free opening of supporting grid  
 $g$  = acceleration due to gravity,  $\text{cm}/\text{sec}^2$   
 $G$  = gas mass velocity,  $\text{gm}/\text{sec cm}^2$   
 $G_M$  = molar flow rate of gas,  $\text{gm-mol}/\text{sec cm}^2$   
 $G_{mf}$  = minimum fluidization velocity,  $\text{gm}/\text{sec-cm}^2$   
 $H$  = expanded bed height, cm  
 $H_L$  = height of clear liquid, cm  
 $H_p$  = net static packing height, cm  
 $H_{og}$  = height of transfer unit, cm  
 $H_G$  =  $V_G/A$ , cm  
 $\mathcal{H}$  = Henry's constant  
 $K_G$  = over-all gas phase mass transfer coefficient,  $\text{gm-mol}/\text{sec cm}^2 \text{atm}$   
 $K_L$  = over-all liquid phase mass transfer coefficient,  $\text{gm-mol}/\text{sec cm}^2$



- $L$  = liquid mass velocity, gm/sec cm<sup>2</sup>  
 $L_M$  = Molar flow rate of liquid, gm-mol/sec cm<sup>2</sup>  
 $M$  = solvent molecular weight  
 $m$  = constant  
 $N_1$  = concentration, normal  
 $N$  = rate of mass transfer, gm-mol/sec cm<sup>2</sup>  
 $p$  = partial pressure, atm  
 $P$  = total pressure, atm  
 $Q_L$  = volumetric flow rate of liquid, cm<sup>3</sup>/sec  
 $\Delta P_b$  = hydraulic resistance of bed, mm.H<sub>2</sub>O  
 $R$  = gas constant,  $\frac{\text{atm cm}^3}{\text{gm-mol } ^\circ\text{K}}$   
 $T$  = absolute temperature, <sup>o</sup>K  
 $U$  = superficial velocity, cm/sec  
 $V_o$  = molar volume of solute at normal boiling point  
cm<sup>3</sup>/gm-mol  
 $V_1$  = amount of HCl that used to titrate with the  
solution, cm<sup>3</sup>  
 $V_G$  = gas volume in aerated bed, cm<sup>3</sup>  
 $X$  = association parameter  
 $x$  = mole fraction of solute gas in liquid phase  
 $y$  = mole fraction of solute gas in gas phase  
 $\Delta y_{LM}$  = logarithmic mean of  $\Delta y_1$  and  $\Delta y_2$   
 $\epsilon_L$  = liquid hold-up,  $H_L/H$   
 $\epsilon_G$  = gas hold-up,  $H_G/H$   
 $\epsilon_{SL}$  = liquid hold-up base on static bed,  $H_L/H_S$

$E_{sp}$	=	void fraction in a dry packed bed
$E$	=	void fraction
$\rho$	=	density, gm/cm <sup>3</sup>
$\rho_M$	=	liquid density, gm-mol/cm <sup>3</sup>
$\sigma$	=	surface tension, dyn/cm
Fr	=	Froude number, $U_G / (g D_c)^{0.5}$
Re <sub>L</sub>	=	Reynolds number, $D_c U_L \rho_L / \mu_L$
Sh	=	Sherwood number, $(K_G a D_c^2) RT / D_f$

Subscripts

A	=	gas A
1,2	=	bottom and top
*	=	equilibrium
G	=	gas
L,f	=	liquid, fluid
i	=	air
g	=	ammonia

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