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Witted Wall Column

Experiment Number (6)

Short Report

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1. Abstract

This experiment was conducted as one of a series of experiments for separation processes. In this experiment, wetted wall columns were studied because they play an essential role in the study of mass transfer in chemical and process engineering and industry, where they are employed in mass transfers involving rapid heat transfer. The experiment aimed to determine the power-law relationship between the liquid film mass transfer coefficient and the mass flow rate of water and then to compare the results with theoretical predictions and to use a constant water flow rate and variable air flow rates to calculate the Sherwood number for the mass transfer from the wetted wall into the turbulent flow of water. The result shows that as air and water flow water increased the Reynolds number, Sherwood number, and liquid film mass transfer coefficient were increasing. Also, the power-law relationship between the liquid film mass transfer coefficient is 0.429.

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2. RESULTS

Table 1 : Data Required for Calculation.

Area (m^2)	0.0893016
Density of water (kg/m^3)	997
Viscosity of water (mPa.s)	0.89
diffusivity of oxygen in water (m^2/s)	2.1*10^-9
length of column (m)	0.9

Table 2: Data obtained for 1000cm3/min of air.

air flow rate = 1000 cm^3/min		
water flow rate (cm^3/min)	%sat O2 in	%sat O2 out
60	4	78
100	4	78
120	4	79
150	5	77
200	5	75
250	4	72
280	6	71

Table 3: Calculation of Sherwood's no., Reynold's no., and the mass transfer coefficient.

j (kg/s)	LMCD (kg/m^3)	KL	Mass flow of water per length (kg/s.m)	Re	Sh	logRe	logSh
6.64002E-06	0.004520447	0.016448595	0.001106667	4.973782772	7.05E+06	0.696686814	-0.156962409
1.10667E-05	0.004520447	0.027414324	0.001844444	8.289637953	1.17E+07	0.918535563	-0.036904024
1.34595E-05	0.004441299	0.033935927	0.002213333	9.947565543	1.45E+07	0.997716809	-0.000992711
1.61514E-05	0.004568584	0.039588527	0.002766667	12.43445693	1.70E+07	1.094626822	0.039266086
0.000020937	0.004719097	0.04968168	0.003688889	16.57927591	2.13E+07	1.219565559	0.086205151
2.54235E-05	0.004966953	0.05731734	0.004611111	20.72409488	2.46E+07	1.316475572	0.119412805
2.72181E-05	0.004974494	0.061270247	0.005164444	23.21098627	2.63E+07	1.365693595	0.135353272

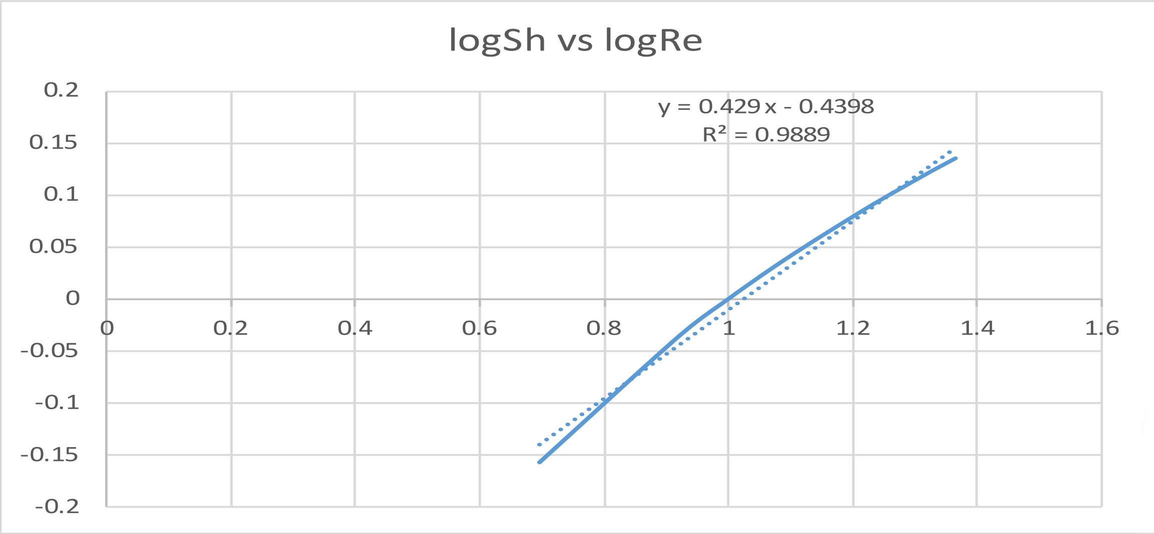

Figure 1 : LogSh vs. LogRe at 1000cm3/min.

3. DISCUSSION

As shown in table 3, J increased as water flow rate increased at constant flow rate of air because the contact area increased so large amount of oxygen transfer from gas phase to liquid phase. The result also shows that the Re number increased with water flow rate due to the turbulence.

Sh number increased with increased liquid film mass transfer coefficient a higher mass transfer coefficient implies more effective transfer of the solute from the gas phase to the liquid phase. This increased efficiency is reflected in a higher Sherwood number. From figure 1 the relation between log Sh and log Re is directly proportional, a higher Reynolds number is associated with increased turbulence in the fluid flow. Turbulence enhances mixing, leading to improved mass transfer. This result in a higher Sherwood number.

The power-law relationship between the liquid film mass transfer coefficient is an empirical correlation and may vary for different systems or experimental conditions in this experiment the value is 0.429.

4. CONCLUSION & RECOMMENDATION

The wetted wall column experiment aimed to investigate the relationship between the liquid film mass transfer coefficient and the mass flow rate of water. By analyzing the data collected at various water flow rates, the following conclusions were obtained:

- Reynolds number increases as the water flow rate increases.
- Sherwood number increases as Reynolds number increases, and this confirms the positive correlation between these two parameters.

5. REFERENCES

1. Geankoplis, Christie, Transport Processes and Unit Operations, 3rd edition, Prentice-Hall International, Inc.
2. Study of Mass transfer Coefficient in a Wetted Wall column, Al-Margib University, Libya, 2016.
3. Wetted Wall Gas Absorption Column, Armfield, Chemical Engineering Basic Process Principles – CE Series

6. Appendix

6.1. Sample of calculation

Area of Mass Transfer

$$A = \pi \mathrm{DL} = \pi * 0.0316 * 0.9 = 0.0893 \mathrm{~m}^2$$

Log Mean Concentration Difference

$$\Delta C_{LM} = \frac{Cin-Cout}{Ln\frac{100-Cin}{100-Cout}} = \frac{78-4}{Ln\frac{100-4}{100-78}} * 0.0910^{-3} = 0.00452 \mathrm{~Kg/m}^3$$

J = Change in O_2 Concentration * Volumetric Flow Rate

$$= \frac{(78-4)*60}{60* 100^3*997*0.09*10^{-3}} = 6.64 * 10^{-6} \mathrm{~kg/s}$$

$$K_L = \frac{j}{A* \Delta Clm} = \frac{6.64* 10^{-6}}{0.0893*0.00452044} = 0.016448 \mathrm{~m/s}$$

$$Re = \frac{4*\Gamma}{\mu} = \frac{4*\frac{60}{0.9*1.66*10^{-5}}}{8.9*10^{-4}} = 4.973$$

$$Sh = \frac{Kl*Z}{Dl} = \frac{0.016448*0.9}{2.1* 10^{-9}} = 7.05 * 10^6$$

<u>So</u>

Log(Re)=Log(4.973)=0.69668

Log(Sh)=Log($7.05* 10^6$)=-0.1569