GAS ABSORPTION IN CO\_CURRENT FLOW

by

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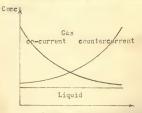
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### INTRODUCTION

Gas absorption is one of the numerous chemical engineering operations which involve transfer of material from one phase to another. Up to the present time nearly all industrial absorption equipment is operated under the countercurrent flow condition. However, evidence indicates that in certain cases this type of flow is not necessarily the best (17).

The main disadvantage of co-current flow is that generally a smaller driving force is established in the absorption equipment in comparison with the countercurrent flow. Such disadvantage will disappear when there is no appreciable vapor pressure of the transferring component in the liquid phase. For instance, in the absorption of  $CO_2$  into caustic solutions, it has been assumed by various investigators (17), that there is no  $CO_2$ pressure over the solution. Thus, the driving forces in both countercurrent and co-current flows will be the same, as shown by the following graph.



Distance from liquid inlet

On the other hand, operation under co-current flow has some advantages over that under countercurrent flow. The pressure drop is smaller in the former case, and correspondingly the power requirement will be lower. Besides, there is no limitation of high rates of flow due to flooding or loading.

Various apparatus have been proposed for laboratory scale absorption studies. Two of the frequently used apparatus are the disc column, which was introduced by Stephens and Morris (19), and the short wetted-wall column, which has been widely used during the last few years (4) (22). In both columns the surface areas are measurable, but the disc column provides a condition more like that in the packed absorber.

This investigation was to study the co-current flow absorption. The experiments were performed in both a disc and a packed column under cocurrent and counter-current flows for the sake of comparison. The CO<sub>2-H<sub>2</sub>O system was chosen for this study, not only for the well-known fact (16) that the liquid-film is the only controlling factor, but also for the extensive results of other investigators available for comparison (6).</sub>

### THEORY

In developing absorption theories, several models have been proposed to describe the absorption mechanism.

### Hatta's Film Theory (15)

The film concept pictures a stagnant fluid film at the interface, through which film the substance to be absorbed is transferred by stationary diffusion. The rest of the liquid is considered to be completely homogenized. 2

### Surface Renewal Theory (3)

This is the modified form of the Higble Penetration Theory due to Danckwerts. In this theory an element of the liquid present at the interface is changed by a transient diffusion process. After some time the element is replaced by another. The chance of the element being replaced within a given time is assumed to be a statistical distribution and independent of its age.

In both concepts use is made of a quantity which can not be directly measured. In the film theory this is the effective film thickness  $x_{f}$ , while in Danckwerts' theory it is the mean rate of production of fresh surface per unit surface F. According to these theories, the liquid film coefficient can be expressed as:

$$\begin{split} k_{\underline{L}} &= D/x_{\underline{f}} \text{ by Hatta's film theory, and} \\ k_{\underline{L}} &= \sqrt{DF} \text{ by surface renewal theory,} \end{split}$$

where  $k_{L}$  is the liquid film coefficient of physical mass transfer, and D is the diffusivity.

### Boundary Layer Theory (14)

In this theory the diffusion boundary layer is considered. The thickness of the layer is the distance measured normally from the interface in which the concentration changes from the interfacial value to the stream value. This theory differs from the film theory on the point that the boundary layer is moving while the film is assumed stagnant. This theory was developed only recently. Owing to mathematical difficulties, only some simple cases have been treated. However, the theory provided a more realistic physical picture than any other theory. The applicability of the boundary layer theory will likely be reduced considerably by the instability of a fluid-fluid interface, but the same is true of the stagnant film and Surface Renewal theories. Some important papers on this field are listed in the references (12) (14).

EXPERIMENTAL.

### Scope

Two types of columns, disc column and packed column, were used in the present investigation. In the disc column, the range of liquid flow was determined by the rates at which the column became unstable; that is, from the lowest rate which maintained nearly perfect wetting (cf. section under the heading 'De-wetting' on p.(4) of the disc surface, 10.0 lb./hr., to the highest rate which kept the water from spraying-out, 33.0 lb./hr. In the packed column, the liquid rate covered a range of 13.0-52.6 lb./hr. The gas rate waried from 1.55-10.6 cu.ft./hr. (the corresponding Reynolds numbers based on effective column diameter were 606 and 4150 respectively). The highest liquid temperature was 31.6°C, and the lowest was 21.0°C. The column pressures fluctuated between 722 - 755 mm. Hg. The experimental quantity determined was the liquid film coefficient at 25°C.

### Equipment

<u>Columns.</u> The disc column consisted of 35 ceramic discs, enclosed in a pyrex glass tube of 1-1/8 inch inside diameter. The discs were threaded edgewise on a vertical fiberglas cord in such a way that the successive ones were maintained at right angles by means of Duco cement. The general arrangement is shown on Plate I. The water was introduced at the top through a jet, and removed by a central tube and small funnel under the lowest disc. The liquid feed jet was placed 5 cm. above the uppermost disc, as recommended by Stephens and Morris (19).

The packed column was constructed with a 2 inch inside diameter pyrex glass pipe, packed with 8 mm. glass rasching rings. The bed was 5-1/4" in height and supported by a perforated plate. Water was distributed over the packings by a Tygon sprayer. Both ends of column were connected to glass tees, which formed the gas calming sections. Other constants for both columns are listed in Appendix I.

Accessories. A 1/8 hp. centrifugal pump was used to feed water (distilled water) from a 5 gal. carboy to the absorption columns. In the case of the disc column, a constant head tank was used.

A 1/4" needle valve was placed before a flowrator to regulate the liquid flow.

Another 1/4" needle valve was placed before a rotameter to regulate the gas flow from a CO<sub>2</sub> cylinder.

Gas leaving the rotameter passed through three saturation bottles. The difference between the inlet and outlet gas temperature was kept within 1°F to eliminate any effect due to vaporization of water. The guage pressure of the gas flow was measured by a manometer.

A sampling reservoir was used to stabilize the outlet liquid flow during sampling.

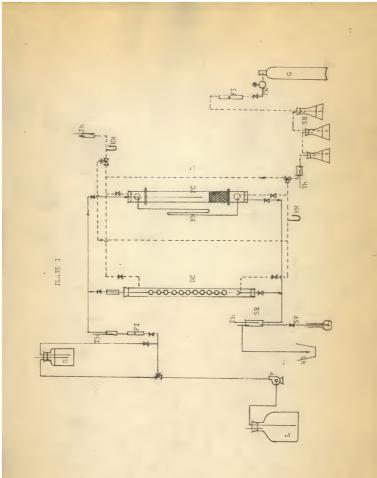
Thesemsters were provided at the inlets and outlets of both gas and liquid lines.

### EXPLANATION OF PLATE I

# Schematics Diagram of Experimental Layout

	SV: Sampling valve	SF: Sampling flash	DG: Dise celum	Mancmeter	Packed column	Saturation bottles	Pressure regulator
•	SV:	ST':	DG1	MM	PCs	SB:	PR:
	Lt Liquid feed tank	P: Feed pump	H: Constant head tank	WB: Weste bucket	Th: Thermometer	FI: Flow meter	SR: Sampling reservoir
	Lt	a.	Ha	-	Th	E	SR

G: CO2 cylinder



### Procedure

1.	Discharge remaining liquid from the column and sampling reservoir.
2.	Set gas rate G and liquid rate L.
3.	Adjust the height of the sampling reservoir to ensure liquid seal
	with minimum liquid level in the liquid collecting tube.
4.	Take the first sample at 10 min. for the disc column, or at 5 min.
	for the packed column after the start of the experiments.
5.	Sampling tube was dipped into the trapping solution (20 ml. of 0.1M
	BaCl2 and 40 ml. of 0.05W NaOH) in a 100 ml. measuring flask. The
	flask was plugged with rubber stopper before filtration.
6.	Drain off the liquid remaining in the sampling tube.
7.	Take the second sample at 16 min. for the disc column, or at 8-10
	min. for the packed column,
8.	Time of sampling was about 45".
	Chemical Analysis
Star	dard solutions. HCl was standardized against NagCO3. The effective

concentration of MaOH (OF ion only, CO<sub>3</sub> not considered) was standardized against the standard HGL solution, after excess BaCl<sub>2</sub> was added. <u>Inlet H<sub>2</sub>O</u>. The concentration of CO<sub>2</sub> in the inlet distilled water was analyzed every six runs. No appreciable content of CO<sub>2</sub> in H<sub>2</sub>O was found. <u>Purity of CO<sub>2</sub></u>. The purity of cylinder CO<sub>2</sub> was analyzed by volumetric method. The result showed that it contained CO<sub>2</sub> more than 99.2 percent. In calculation, 100 percent was assumed.

<u>Analysis of samples.</u> The absorbed GO<sub>2</sub> was precipitated as BaGO<sub>3</sub> in the trapping solution. After filtration the excess NaOH was determined by back titration against HCl solution with phenolphthalein as indicator.

A Magnetic stirrer was used in titration.

Filtration had no appreciable effect on the analytical results, as shown in Appendix II.

### Preliminary Experiments

A suspicion of errors introduced by the filtration of the sampling solution in the course of analysis led to the conduction of an auxiliary experiment. Its results are summarized in Appendix II. It was shown in this auxiliary experiment, that the results of analysis were practically unaffected by filtration, the variation of the height of funnel nozzle above filtrate surface, or the exposure time when it was less than 30 minutes.

The same experiment showed that the variation of sample obtained in the disc column was within experimental error for samples taken at longer than 8 minutes after start of the experiment, and another experiment showed that in the packed column it was 4 minutes after start (Appendix II).

### Design of Experiment

In the design of experiment letters P,Q, and R denote the co-current flow, and C,D, and E the counter-current flow operation.

A 2x3x3 factorial experiment, PC (2 types of flow, 3 levels of gas rate and 3 levels of liquid rate) was conducted for the disc column study. This experiment contained 2 replicates with total 36 runs and 72 observations.

Another 2x5 factorial experiment, QD (2 types of flow and 5 levels of liquid rate) with various repititions was conducted for the disc column af a fixed gas rate. A 2x3x4 factorial experiment, UE (2 types of flow, 3 levels of gas rate and 4 levels of liquid rate) with 2 replicates was conducted for the packed column study.

Randomized complete block designs were used for the experiments PG and RE, and completely randomized design was used for the experiment QD.

RESULT AND DISCUSSION OF EXPERIMENT

### Calculation of Liquid-Film Coefficients

For calculating liquid-film coefficients from the experimental data, the following equations were used;

$$k_{\rm L} = \frac{N/L}{(\Delta C)_{\rm L}m_{\rm c}}$$
(1)

for the packed column

$$k_{L}a = \frac{N/V}{(\triangle C)_{1,m}}$$
(2)

where

kL = liquid-film coefficient, lb./(hr.-sq.ft.)(lb./cu.ft.)

kja=liquid-film coefficient on a volume basis, lb./(hr.-cu.ft.)(lb./cu.ft.)

N = rate of absorption, 1b./hr.

V = volume of the packed bed, cu.ft.

A = dry surface area of the discs, sq.ft.

(AC)<sub>1.m.</sub> = logarithmic mean of (C<sub>e</sub>-C) at inlet and outlet, lb./cu.ft.

 $C_e$  = liquid concentration in equilibrium with the gas phase, lb./cv.ft.

C = liquid concentration, 1b./du.ft.

The values of  $C_{0}$  were calculated from the Henry's law,  $C_{0} = p/E$ , where p is the partial pressure of CO<sub>2</sub>, and H the Henry constant (13). The reason for replacing the interfacial concentration with the equilibrium concentration C is based on the fact that the CO2-H2O absorption is controlled by the Hquid film, as verified by Sherwood and Holloway(16).

All mass transfer coefficients so obtained were corrected to 25% according to the following equation, (16):

$$k_{\rm L}^{25} = k_{\rm L} \cdot e^{0.023(25-t)}$$
 (3)

### Summary of Data

Data are summarized on Table 3 to 7 in Appendix III. Table 3 lists observed data for PC series experiments. Table 4 gives values of liquidfilm coefficients calculated from the data in Table 3. Table 5 contains both observed data and calculated liquid-film coefficients for QD series experiments. Table 6 contains observed data for RE series experiments and Table 7 lists the values of liquid-film coefficients calculated from the data in Table 6.

### Analysis of Data

Data obtained from experiments PC and RE were analyzed statistically. The results are given in Table 1 and 2 below. The detail can be found in Appendix IV (p. 62.). It is important to notice that the ordinarily assumed additive model in statistical analysis is not applicable to the  $k_L$  value, since multiplication is involved in the evaluation of  $k_L$ . Such operation will lead to serious error in standard deviation, and thus transformation is necessary before analysis. The logarithmic transformation was carried out for this purpose.

Source of Variation	d.f.	5.5.	M.S.
Replicate (R)	1	0.19995	0.19995
Treatment (T)	17	2.04449	0.12030
Flow type (F)	1	0.02467	0.02467
Liquid rate (L)	2	1.89697	0.94850
Gas rate (G)	2	0.02553	0.01276
FxL	2	0.00241	0.00121
FxG	2	0.01207	0.00604
LacG	4	0.00962	0.00240
FxLaG	4	0.07322	0.01830
Error	53	0.24888	0.00470
RgT	17	0.13487	0.00793
Obs'n : run	36	0.11401	0.00316
Total	71	2.49332	

Table 1. Analysis of variance; PC series.

Table 2. Analysis of variance; RE series.

Source of Variation	d.f.	5.8.	m.s.
Replicate (R)	1	0,00206	0.00206
Treatment (T)	23	3.65824	0.15905
Flow type (F)	1	0.00270	0,00270
Liquid rate (L)	3	3.62859	1.20963
Gas rate (G)	2	0.00079	0,00040
FxL	3	0.00403	0.00134
FxG	2	0.00552	0.00276
LarG	6	0.00472	0.00079
FxLarG	6	0.07189	0.00198
Error	69	0.06956	0.00101
RXT	23	0.04.227	0.00183
Obs'n : run	46	0.02729	0.000593
Total	93	3.72986	and the second

Since the m.s. of the main effects (F,L, and G) estimate error terms of very complicated forms (5), it is not suitable to use Snedecor's F to test the significance of those effects. However, comparing the main effects with interaction terms (FxL etc.), it is reasonable to believe that there is no difference between flow types, and only liquid rate has any effect on the liquid-film coefficient within the range of study. The significance of variation due to replicate in PC series (Table 1) indicates that some unnoticed error might be introduced in either of the two replicates. A discussion on this case is given in Appendix V under the heading, Selection of Data  $(p, \mathcal{L}q)$ .

The standard deviation is 13.8 percent for FG series, 4 percent for QD series, and 5.8 percent for NE series. The high deviation in FG series must result from a few seattered data.

### Experimental Error

<u>Error Due to Liquid Sampling</u>. In order to get better reading of sample volume, the sampling nozzle was immersed less than 1-1/2 inches below the surface of liquid in the measuring flash. But this could not ensure no loss of gas from samples. The magnitude of such error is not easy to estimate.

Error Due to Method of Analysis. The method of Emmert and Pigford (4) was used. An average error of 2 percent was supposed to be involved. As mentioned by Taylor and Roberts (20), this method was better than the barium hydroxide method, which generally results 3 percent in error, and the method of Hammerton and Garner, which gives results systematically high by about 10 percent.

Error Due to Liquid Temperature. Thermometers with scale graded to 0.1°C were used on liquid lines for QD and RE series, and with scale graded to  $0.5^{\circ}$ C were used for series PC. A misreading in 0.1°C would lead to an error in equilibrium constant of about 0.3 percent, and this would further be enlarged by the  $k_L$  computation formula to about 0.9 percent, as will be shown in a later section. In RE series experiments, the pump caused the inlet water temperature to continuously increase at a low flow rate. This complicated the absorption process by sensible heat transfer. This unsteadiness of the absorption condition would give rise to some deviation, and this was counted as experimental error. The total error contributed by liquid temperature deviation to the value of  $k_L$  is thus considered as 1.5 percent.

<u>De-wetting of the Liquid on the Disc</u>. The de-wetting phenomenon has been reported by a number of investigators, and in some cases the de-wetted areas have been quite extensive, even at liquid flow rates up to 200 lb./hr.-ft. (20). In this experiment, de-wetting was found at a liquid rate as high as 173 lb./hr.ft., e.g. run Q-9-4, and complete wetting was found at the liquid rate as low as 103 lb./hr.ft., e.g. run D-5-1. Generally, de-wetting rarely occurred at the rate higher than 120 lb./hr.ft., and complete wetting was hard to find at the rate below 129 lb./hr.ft. The largest de-wetted area observed visually was about 14 percent of the total area. Loss of absorption surface will cause low absorption coefficients, while the increased flow rate in the wetted areas will tend to offset this. It is possible that partial de-wetting might give rise to either high or low results.

It was found that, at high flow rate, liquid would sometimes drop from one disc to the next paralleled to it, without touching the neighboring one, which was at the right angle to it. This phenomenon would also decrease the contact surface area of liquid and gas, and resulted a relatively low coefficient.

Errors Amplified by Transfer Equation. Errors will be amplified 2 or 3 times by the transfer equation. This will be shown by the following illustration:

Illustration: Run POO-1 had the following observed data:

p.p. of CO<sub>2</sub> = column pressure - p.p. of H<sub>2</sub>O =-730-24 - 706 mm. Liquid temperature both at inlet and outlet = 24.5°C.
The Henry's Lew constant at 24.5°C is 8.10x16<sup>3</sup> mm.Hg/lb.CO<sub>2</sub>/ou.ft. The inlet concentration of CO<sub>2</sub> in H<sub>2</sub>O is zero, and that at the outlet is 0.0470 lb./ou.ft. k<sub>L</sub> was computed accouding to eq.(1), where N = CxL/62.4 (L is the liquid mass velocity in unit of lb./hr. per area of contact surface in sq.ft.). The value of k<sub>L</sub> = 0.566 at 24.5°C was obtained.
If a deviation of 5 percent less than the present value of C occurs, k<sub>L</sub> will be equal to 0.517, i.e. it causes an error of 9.15 percent, and if a deviation of 0.5 percent less than the present value of C<sub>0</sub> occurs, k<sub>L</sub> will become 0.574, and an error of 1.4 percent results. In the case of different C<sub>0</sub> at inlet and outlet the deviation will be even larger.

### DISCUSSION OF RESULTS

### Effect of Flow Type

It was expected that co-current flow and countercurrent flow would have some different effects on the mass transfer coefficient. According to the stagnant film concept, the liquid film should be thinned and the holding time should be much decreased by the co-current flow. According to the boundary layer theory, the relative velocity should play an important part in establishing the thickness of fluid layer. However, this investigation showed that there is no effect of using co-current flow or countercurrent flow on  $k_L$  within the range of investigation. In studying the  $GO_2$ -H<sub>2</sub>O absorption system in wetted-wall columns, Collins (2) found that the use of co-current flow, at Reynolds number of gas higher than 14,800, increased the transfer coefficient appreciably.

### Effect of Gas Rate

In this investigation, the gas rate range was too marrow to detect any influence on the liquid film coefficient. Hikits et al. (7) found that the liquid-film coefficient of  $CO_2$ -H<sub>2</sub>O system in a wetted-wall column was affected by gas rates at Reynolds number greater than 6000 in countercurrent flow, when the liquid rate was such that Re = 300 and also Re = 600. This seems contradictory to what might be expected by boundary layer theory for the simplest case (2-dimensional, co-current flow with horisontal interface), in which the relative velocity as well as the absolute velocity of gas is the determining factor for rate effect on transfer coefficient. It could be explained as that the effect of gas rate was due to ripple formation rather than the change in film thickness.

### Effect of Liquid Rate

Since there was no interaction between flow type and liquid rate, as shown by analysis (Table 1 and 2), a single correlation shall be provided for each column. Logerithmic plots of  $k_L$  vs. [] and  $k_L$  vs. L were constructed for the disc column and packed column respectively. [] is the wetting rate (equal to the liquid flow rate in lb./hr. divided by the mean perimeter for liquid flow in ft.) and L is the liquid flow rate in lb./hr.sq.ft. These lines can be represented in the following form:

$$k_{L} = bj^{n}$$
  
 $k_{L} = bL^{n}$ 

or

where b and n are the constants to be determined experimentally.

For the disc column the absorption data can be correlated in the following equation:

$$k_{L} = 0.0203 | 0.745$$
 at 20°C (4

The equation was based on 88 observations (Appendix V). The sample standard deviation from the equation is 0.0436 in logarithmic scale, or 10.5 percent of the value of  $k_{\rm L}$ . The sample standard deviation of the slope is 0.0298, or 4.0 percent.

For the packed column the absorption data can be correlated by the equation:

$$k_{La} = 0.655 L^{0.85}$$
 at 20°C (5)

The equation was based on 88 observations. The sample standard deviation from regression is 0.0284 in logarithmic scale, or 6.75 percent of the value of k<sub>L</sub>a. The sample standard deviation of the slope (the regression coefficient) is 0.0127, or 1.5 percent.

### Generalized Correlation

Sherwood and Holloway (16), investigated desorption of oxygen from water and they proposed the following generalized correlation for  $k_r$ :

$$\frac{\mathbf{k}_{\mathrm{L}}}{n} = d\left(\frac{4\pi}{\mu}\right)^{n} \left(\frac{\mu}{p}\right)^{0.5} \tag{6}$$

$$\frac{\mathbf{k}_{\mathbf{L}\mathbf{a}}}{\mathbf{D}} = d\left(\frac{\mathbf{L}}{\mu}\right)^{\mathbf{n}} \left(\frac{\mu}{2}\right)^{0.5}$$
(7)

where  $\not$  is the viscosity of the liquid, ( is the density of the liquid, and  $\sim$  and n are constants of a particular column. When the general equation is applied to the results of this experiment, the following equations are obtained:

OF

$$\frac{k_{\rm L}}{m} = \frac{7.44(\frac{4\Gamma}{M})^{0.745}(\frac{M}{C})^{0.5}}{(8)}$$

for the disc column

for the packed column

$$\frac{k_{L}a}{D} = \frac{84.0(\frac{L}{L})^{0.85}}{(\frac{M}{C})^{0.5}}$$
(9)

Comparison with Results of Previous Workers

<u>Disc column equation</u>. The liquid-film coefficients obtained are lower than all the published results. Stephens and Morris (19) have mentioned that the absorption coefficients obtained on different disc columns might vary by  $\pm$  10 percent. However, data with deviation about 50 percent lower than that given by Stephens and Morris have been found in the literature (6). The present result, though much lower, gives a line mearly parallel to Stephen and Morris'. Their data was represented by the equation:

In pletting their data for  $GO_2$  absorption in Doulton disc and pyrophyllite disc columns, Taylor and Roberts (20) observed the existance of a distinct change of slope in liquid film coefficient versus wetting rate plot. Their results for both columns were correlated into a single set of equations, viz:

For	1<1551b./hr.ft.	k_L	=	0.124 10.4
For	/>155 lb./hr.ft.	kz	H	0.0056 1.0

Chu (1), using the same column as that for the present study, also observed the break slopes in his data. He obtained the following set of equations:

For	73 < 11 < 200 1b./hr.ft.	k <sub>L</sub> = 0.0386 [70.644	(10)
For	16 < /1 < 73 lb./hr.ft.	kr = 0.123 / 0.37	

### EXPLANATION OF PLATE II

Experimental data of disc column plotted on k vs. 7 coordinates k\_ ---- Idquid-film coefficient, lb./(hr.msq.ft.)(lb./cu.ft.) at 2500

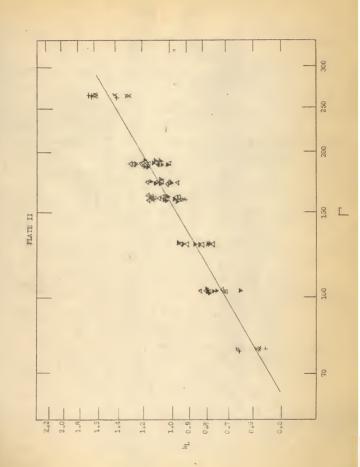
7 ---- wetting rate (liquid rate per mean wetting perimeter afdise), lb./hr.ft.

× ----- data from PC-l series for co-current flow

+ ----- data from PC--1 series for countercurrent flow

△ data form QD series for co-current flow

Y ----- data from QD warles for countervurrent flow



The difference in critical flow rates at which the break occurred has been reported by Taylor and Roberts (20) after the study of six different types of disc columns. However no such break was observed in this study, nor in Hwu's work (9). Hwu constructed the present column, and he suggested the equation

$$k_{\rm r} = 0.0075 \, \left[ \, \, ^{0.95} \, \, (11) \, \, \right]$$

for  $CO_2$  absorption in this column. The liquid-film coefficients found by Hwu were higher than those of Chu (1) and the present investigator. All the results just mentioned and some others are plotted on Plate III for comparison.

<u>Prediction of Correlation for  $Cl_2=H_2O$  System by the Present Result</u>. The absorption of chlorine is a typical liquid-film controlled system, as has been shown by Sherwood on the basis of  $CO_2$  and oxygen absorption and desorption data. It has also been recognized that in the tower with a small diameter the variation of gas rate has no effect on the transfer coefficient, as verified by Vivian and Whitney (23). Therefore, the result obtained from  $CO_2$  absorption study is expected to be applicable to the chlorine-water absorption data.

Using the general equation (6), or remembering that  $k_{\rm L}$  varies with  $D^{0.5}$  for the same absorbent at the same liquid rate, we can derive an equation for  ${\rm Cl_2-H_2O}$  system as:

$$k_{r} = 0.0178 \int^{-0.745} (12)$$

Similarly we have the corresponding equations derived from Chu's equation and Evu's equation. These are:

$$k_{\rm L} = 0.0338 | ^{0.644}$$
(13)  
$$k_{\rm L} = 0.00657 | ^{-0.95}$$
(14)

respectively. The three predicted equations are represented by lines II,

# EXPLANATION OF PLATE III

Comparison of the present result of  $00^{-41}_{-10}0$  Absorption with those of previous vorkers on a  $k_L$  ws.

kr ---- liquid-film coefficient, lb./(hr.-sq.ft.)(lb./cu.ft.) at 2000

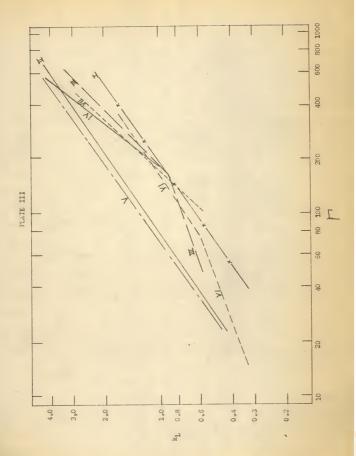
7 ---- wetting rate (liguid rate per meen wetting perimeter of disc), lb./hr.ft.

Curve I --- the present result Curve II --- result of Staphens and Morris (19) Curve III --- result of Taylor and Roberts (20) Curve IV --- result of Carner (6)

Curve V --- recult of Imperial Chemical Industries Ltd. (6)

Curve VI --- result of Chu (1)

Curve VII - result of Hwu (9)



III, and IV on Plate IV, and compared with the line directly drawn from the experimental data by Tion (21) in the same column. The corresponding equation for the experimental data is:

$$k_{\tau} = 0.0163 \Gamma^{0.81}$$

The agreement of equation (12) with that obtained by Tien within the range of experiment (180-400 lb./hr.ft.) is clearly shown by Plate IV. The predicted values of liquid film coefficient by use of Chu's equation (13) are little higher than the experimental values, and those predicted by Hwu's equation were even higher. The derivation of the equations, and their representative points are given in Appendix VII.

Prediction of Gas-film Coefficient of  $HH_2-H_2O$  system. By the combination of liquid-film coefficient data and overall mass-transfer coefficient,  $K_{\rm G}$ , data, we can calculate the gas-film coefficient from the following relationship:

$$\frac{1}{k_{\rm G}} = \frac{1}{k_{\rm G}} - \frac{\rm H}{k_{\rm L}}$$

where H is Henry constant.

Hwu has determined the overall mass transfer coefficient of  $NH_3-H_2O$ system, and calculated the gas-film coefficient by using his own equation for liquid-film coefficient. Since equation (12) predicts liquid film coefficients in the Cl\_2-H\_2O system better than Hwu's equation, an attempt was thus made to use equation (4) of the present investigation together with Hwu's experimental data of K<sub>0</sub> to calculate k<sub>0</sub> for  $NH_3-H_2O$  system. The detail of calculation are given in Appendix VII. The resulting equation is:

$$k_{\rm g} = 3.90 \, {\rm p}^{0.30}$$
 (15)

### EXPLANATION OF PLATE IV

### Chlorine-water absorption correlation $(k_L vs. f)$ in the disc column

k, -- liquid film coefficient, lb./(hr.-sq.ft.)(lb./cu.ft.) at 20°C

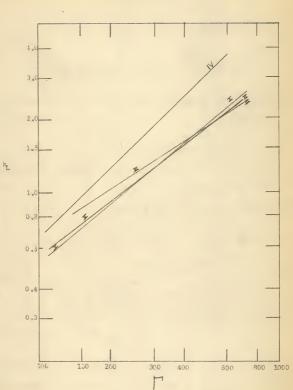
- wetting rate (liquid rate per mean wetting perimeter of disc), lb./hr.ft.

Curve I --- experimental result by Tien (21)

Curve II --- predicted by the present work on the basis of CO2-H2O system

Curve III --- predicted by the result of Chu's work on the basis of CO2-H20 system

Curve IV - predicted by the result of Hwu's work on the basis of CO2-H2O system





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EXPLANATION OF FLATE V

Correlation of ges-film coefficient with wetting rate of  $\rm RH_2^{-H}_2O$  system in disc column

Rg ---- gas-film coefficient, lb./(hr.sq.ft.atm.) at 20°C.

- wetting rate (liquid rate per mean wetting perimeter of disc), lb./hr.ft.

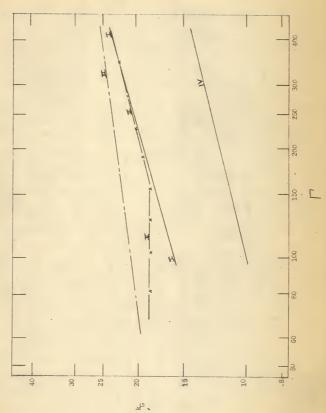
Curve I --- predicted by the experimental data of overall gas phase coefficient as obtained by Hau (9), and the liquid film coefficient versus wetting rate given by this investigation.

Curve II - result obtained by Taylor and Roberts (20)

Curve III --- result obtained by Stephens and Morris (19)

Curve IV - result obtained by Hwu (9)





or in the general form

$$\frac{k_{\rm g}^{\rm P}}{\nabla f a} = \frac{0.0326}{0.0326} \int_{-0.30}^{0.30} \left(\frac{Vd_{\rm P}}{M}\right)^{-0.33} \left(\frac{M}{f_{\rm PD}}\right)^{-.56} \int_{-0.50}^{0.30} \left(\frac{Vd_{\rm PD}}{M}\right)^{-0.33} \left(\frac{M}{f_{\rm PD}}\right)^{-.56} \int_{-0.50}^{0.30} \left(\frac{Vd_{\rm PD}}{M}\right)^{-0.33} \left(\frac{M}{f_{\rm PD}}\right)^{-.56} \int_{-0.50}^{0.30} \left(\frac{Vd_{\rm PD}}{M}\right)^{-0.33} \left(\frac{M}{f_{\rm PD}}\right)^{-.56} \int_{-0.30}^{0.30} \left(\frac{Vd_{\rm PD}}{M}\right)^{-0.33} \left(\frac{M}{f_{\rm PD}}\right)^{-0.33} \left$$

The equation (15) was corrected to a relative velocity of 8.4 ft./sec. for the convenience of comparison with published data (Hwu corrected his data to the relative velocity 5.84 ft./sec.). Plate V shows the comparison of the results from various sources. It may be noted that, over the range of studied by Hwu (  $[^{-1}=155-395$  lb./hr.ft.), equation (15) is quite consistent with the experiment data of Taylor and Roberts. Hwu's equation corrected to 8.4 ft./sec. gives relatively low gas-film coefficients. The equations of the curves are:

S. and M. (19)	kg = 11.17 0.23
T. and R. (20)	kg = 5.3 p 0.25
Hwu (9)	kg = 2.99 -0.26

Packed Column Equation. Koch et al. (10) studied GO2 absorption in 6- and 30-inch towers with a considerable variety of packing rings. He correlated all his data by the equation.

$$K_{L}^{a} = 0.015 L^{0.96}$$
, or  
 $H_{oL} = 1.05 L^{0.04}$ 

where the result of the present investigation, equation (5) and the corresponding equation:

$$H_{ol} = 0.103 L^{0.15}$$
 (17)

 $(H_{oL} = L/K_La)$  is the height of transfer unit give much higher liquid-film coefficients at the low liquid rate range then Koch's.

Since the diffusivity of  $CO_2$  and  $O_2$  are 6.8-7.0 x10<sup>-5</sup> sq.ft./hr. at 20<sup>o</sup>C (11) (17), equation (5) should directly be applicable to  $O_2$ -H<sub>2</sub>O

## EXPLANATION OF PLATE VI

Experimental data of  ${\rm CO}_{\rm o-E_2O}$  system in the packed column plotted on  $K_{\rm L}e$  vs. 1 coordinates

kra --- liquid-film woefficient, lb./(hr.-cu.ft.)(lb./cu.ft.) at 2500

L ---- liquid mass velocity, lb./hr.-sq.ft.

o ---- data for co-current flow

+ ---- data for countercurrent flow

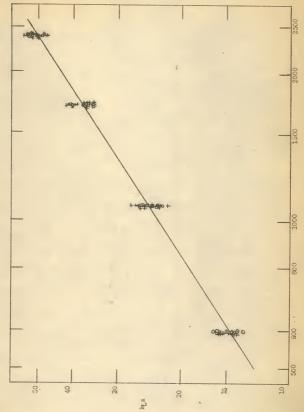


PLATE VI

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system. A comparison with  $0_2$ -H<sub>2</sub>O absorption data by Sherwood and Holloway (16) is shown on Plate VIII. The present results give higher H<sub>0</sub>L values.

Chu (1) worked with the same  $\operatorname{CO}_2-\operatorname{H}_2O$  system in the same packed column. The values of  $k_{\mathrm{L}}a$  obtained by Chu are 18 percent higher than those obtained in this investigation. A comparison plot is given on Plate VII.

### CONCLUSION

The results of the present investigation lead to the following conclusions:

(1) This investigation fails to show any different effect of flow types, commercurrent and co-current, on the value of liquid-film coefficient within the range of study. The significantly higher liquidfilm coefficient found by Collins (2) in wetted-wall column for the co-current flow did not appear in the present investigation.

(2) Discrepancies between the present results in disc column and those quoted in the literature have been found. This inconsistency also exists among other investigator's work.

(3) Though the performance is quite different from one disc column to another, the data from the same column are likely self-consistant, as justified by the agreement of the predicted correlation for Cl<sub>2</sub>-H<sub>2</sub>O system with the experimental results.

(4) The empirical correlation for liquid film coefficient in the disc column was found to be:

$$k_{T} = 0.0203 | 0.745$$

This correlation is better than both Hwu's and Ghu's correlations in view of the successfulness in predicting  $Gl_2-H_2O$  system data.

# EXPLANATION OF PLATE VII

Comparison of  $k_{\rm FA}$  ws. L plot with results obtained by previous workers on  ${\rm GO}_{2^{\rm od}}{\rm H}_2{\rm O}$  system in packed column

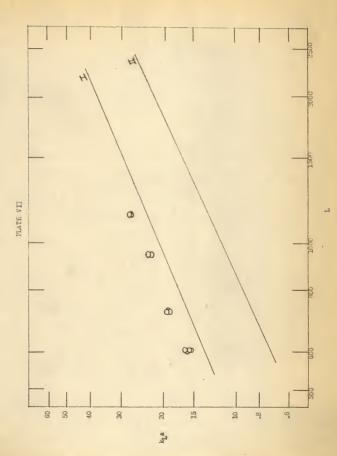
kra --- liquid-film coefficient, lb./(hr.-cu.ft.)(lb./cu.ft.) at 20°C

L - liquid mass velocity, Ib./ hr.-sq.ft.

Curve I --- result of the present work

Curve II --- result of Koch et al. (10)

0 --- experimental data of Chuis work (1)



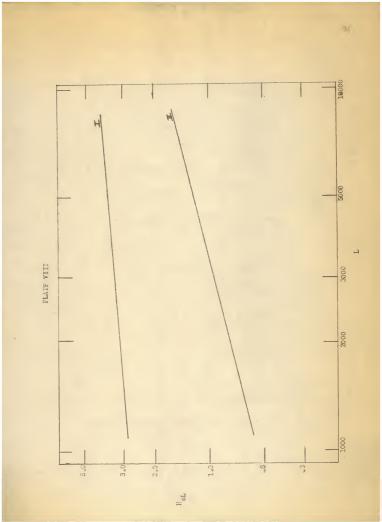
EXPLANATION OF PLATE VIII

HoL vs. I plot for oxygen-water system in packed column

 $H_{oL}$  ---- transfer unit ( = L/K\_La )

I --- liquid mas velocity, lb./hr.-sq.ft.

Curve I- predicted by the present work on the basis of 60 dig0 absorption data Curve II - result obtained by Sherwood and Holloway (16)



kL = 0.0178 - 0.745

or the generalized equation can be represented by:

$$\frac{k_{L}}{D} = 7.44 \left(\frac{4}{2}\right)^{0.745} \left(\frac{4}{2}\right)^{0.5}$$

(6) The gas-film coefficient for NH3-H20 system in the disc column can be represented by:

(7) The liquid film coefficient for the packed column is given by:

$$k_{ra} = 0.0655 L^{0.85}$$

or by the general form:

$$\frac{\mathbf{k_{L}e}}{\mathbf{k_{L}e}} = \frac{84.0 \ \left(\frac{1}{2\pi}\right)^{0.85} \ \left(\frac{\pi}{2}\right)^{0.5}}{\left(\frac{\pi}{2}\right)^{0.5}}$$

or expressed in transfer unit as:

$$H_{oL} = 0.103 L^{0.15}$$

(8) The satisfactory interpretation of  $Cl_2-H_2O$  system data justifies the relation given by the Penetration Theory, that  $k_L$  is proportional to  $D^{0.5}$  rather than D. The latter is predicted by Hatta's film theory.

# ACKNOWLEDGMENT

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# I. Principal Constants of Columns

(a) Disc column

Number of discs	35
Disc diameter	1.5 cm. (0.0492 ft.)
Disc thickness	0.48 cm. (0.0304 ft.)
Dry surface area of discs	0.218 sq. ft.
Mean perimeter for liquid flow	0.127 ft.
Tube internal diameter	0.0938 ft.

# (b) Packed column

Size of packing	8 mm.
Height of bed	5-1/2 inches
Tube internal diameter	2 inches
Cross section area	0.0218 sq. ft.
Volume of bed	0.00954 cu. ft.

## II. Preliminary Experiments

#### Test for filtration effect.

A test run was performed in the disc column under countercurrent flow condition. The recorded data are given as follows:

PC .
5 6
5 18
-
,
LO
LO

# CO2 absorbed 1b./cu.ft.

0.0431 0.0438 0.0445 0.0408 0.0434 0.0431

Sampling flasks were rubber-stopped before filtration. The various factors indicated above were so combined that all the effects in a single sample were additive and easy to detect. The result favors the statement that there is no effect of filtration on CO<sub>2</sub> absorbed. Test for Effect of Exposure Time on the Trapped Sampling Solution.

Three samples were used for this test. Each sample contained 40ml.

0.051 N NaOH and 20 ml. 0.1N BaCl, solutions, and was put in a 400 ml. beaker. Then the following data were obtained:

Sample No.	1	2	3
Exposure time, min.	0	15	30
CO2 absorbed mole/initial mole of NaSH, x104	O#	0.865	1.37

\*The effective concentration of NaOH was determined under this assumption.

Ho correction for CO, so absorbed has been made in evaluating ki. Test for Time for Reaching Steady State in The Packed Column.

A test run for this purpose was performed under co-current flow condition. Observed data and results are given below:

	Baromet	tric pressure		752.8 mm.	Hg. Room	Temp. 93°F
	Gas Rai	te		5.42 cu. 1	rt./hr.	
	Gas ter	perature, i	inlet	83°F	outlet 8	13°F
	Liquid	rate		42.9 1b./1	ır.	
	Liquid	temperature,	inlet	27.800	outlet 2	7.900
Sample	No.	1	2	3	4	5
min. at run sta		.4	6	8	10	12
CO2 abs 1b./cu	sorbed	0.0218	0.0236	0.0233	0.0221	0.0236

Sa mi ru CO

The result of this run, though quite inconsistent with other runs, shows that the data taken from the 4th min. deviate from the mean within 5 percent. It may also be noted that the small standard deviation of the result of HE series (for the packed column) leads to the same conclusion.

## III. Experimental Data

# Sample Calculation.

(a) Observed data for Run ROO-1A,	co-current flow, packed column,
Barometric pressure	744.8 mm. Hg at 750F
Gas rate	1.55 cu.ft./hr.
Gas temperature, inlet	78°F outlet 78°F
Column gauge pressure	2.2 cm. water
Liquid rate	13.0 lb./hr.
Liquid temperature, inlet	30.8°C outlet 28.2°C
CO2 concentration in water	, at inlet 0.0000 at outlet 0.0397 lb./cu.ft.

(b) Published data

Correction factor for 800 mm. brass scale barometer (13)=0.130 mm./°C Vapor pressure of H<sub>2</sub>0 at 78°F, from Keenan's Thermodynamical Properties of Steam p.28, = 0.9666 in. Hg, or 24 mm. Hg Henry constant (13) at 30.8 = 9.44 x 10<sup>3</sup> mm. Hg/(1b. C0<sub>2</sub>/cu.ft.) at 28.2°C = 8.88 x 10<sup>3</sup> mm. Hg/(1b.C0<sub>2</sub>/cu.ft.)

(c) Calculation

p.p. of  $CO_2$  in the column = 718 mm.Hg  $C_e = P_{cO2} / H = 0.0761 lb./cu.ft. at inlet, and$ <math>= 0.0809 lb./cu.ft. at outlet  $\Delta G = (G_e-G)_{in} - (G_e-G)_{out} = 0.0397 lb./cu.ft.$   $ln(G_e-G)_{in} - ln(G_e-G)_{out} = 0.615$   $(\Delta G)_{1.m.} = \Delta G / ln(G_e-G)_{in} - ln(G_e-G)_{out} = 0.0568 lb./cu.ft.$   $N = (G_{out} - G_{in}) \times Liquid rate / 62.4 = 8.41 \times 10^{-3} lb/hr.$ A = 0.0218 eq. ft. Substitute the above values into equation (1), and obtain the value of  $k_{L}a$  at average temperature 29.5°C, 15.5. Correct this value to 25°C with equation (3) on page 11, and the resulting  $k_{L}a$  will be 14.1 (1b./hr.-cu.ft.)(1b./cu.ft.).

Data Experimental data are listed in the following tables:

- Table 3. Absorption data of CO2-H2O system in the disc column (PC).
- Table 4. Liquid film coefficient for GO2-H2O absorption in the disc column (PC).
- Table 5. Absorption data of GO2-H2O system in the disc column at gas rate of 5.42 cu.ft./br. (QD).
- Table 6. Absorption data of CO2-H2O system in the packed column (RE).
- Table 7. Liquid film coefficeint for CO2-H2O absorption in the packed column (RE).

In recording gas rate the effect of variation of temperature and pressure was ignored. This would introduce a maximum error of less than 3 percent (ef. Catalog 92-A, Fisher & Porter Company).

The differences between gas inlet and outlet temperatures were kept within 19F , and therefore only the inlet temperature was listed in the tables.

Since the operating liquid temperatures fluctuated around 25°C, all observed data of liquid film coefficient were corrected to 25°C rather than 20°C, in order to reduce effect of any error associated with the correction equation (3). However, for comparison with published data, equations drawn from data at 25°C were corrected to 20°C with equation (3). Table 3. Absorption data of CO. - H.O system in the disc column

0.64	5533	: Pressure : mm. Hg. 730 722	Rate 10.0 10.0 10.0	: Metting : Rate : 1b./hr.ft.: 78.7 78.7	Idquid Inlet oc 24.5 24.5 24.5 24.5 29.0	Temp. Outlet oc	t 100, absorbed 100, cu.ft. x102 4.70 4.77 4.77
	78 78 85	661 221	10.0 10.0 10.0	7.87 7.87 7.87	25.5 25.5 29.0	25.4 25.4 25.4	668 5-63 5-63 5-68
	828EE	727 967 767 767	10.0 10.0 10.0	78.7 78.7 78.7 78.7 78.7 78.7	29.0 24.5 24.5 24.5	24.5 24.5 24.5 24.5	5-35 4-45 5-94 5-68
	229351	737 725 725 730	22.00	159.0 159.0 159.0	24.0 24.0 29.0 24.5	24.0 24.0 29.0 29.0	4-96 5-02 4-83 4-83
	£3322288	728 7728 7738 7738 7738 7738 7738	8.2.000 8.2.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.00 8.5.000 8.5.000 8.5.000 8.5.000 8.5.000 8.5.000 8.5.000 8.5.000 8.5.000 8.5.0000 8.5.0000 8.5.0000000000	159.0 159.0 159.0 159.0 159.0	57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-20000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-2000 57-20000 57-20000 57-2000000000000000000000000000000000000	25.0 29.0 24.0 25.0 25.0	4-86 4-87 4-89 4-89 4-74 8-74 8-74 8-74 8-74 8-74 8-74 8-74

Run	: Gas Rate	: Gas Temp.	: 00	alumn	* Liquid	: Wetting :	Liquid	Temp. : (	0. absorbe
Mo.	: cu. ft./hr.	. or.		Pressure m. Hg.	: Rate : 1b./hr.	: Rate :	Inlet	Outlet:	15./eu.ft. x102
20-14	0.64	64	14	80	33.0	260	25.0	25.0	4.25
<b>A</b>	0.64	64	5	88	33.0	260	25.0	25.0	4.96
-24	0.64	84	12	52	33.0	260	29.0	29.0	3.82
20	0.64	84	11	52	33.0	260	29.0	29.0	3.48
AL-12	5.42	78	1	32	33.0	260	23.5	23.5	3.56
-		78	2	32	33.0	260	23.5	23.5	3.62
-24		85	2	80	33.0	260	30.0	30.0	4.38
-		85	12	88	33.0	260	30.0	30.0	4.42
22-1A		78	12	3	33.0	260	25.0	25.0	3.59
-		78	712	2	33.0	260	25.0	25.0	3.67
-24	10.60	84	1	1	33.0	260	29.5	29.5	5.60
89	10.60	8¢	2	734	33.0	260	29.5	29.5	6.24
AL-00	0.64	62	2	60	10.0	78.7	26.0	26.0	5.27
-	0.64	64	22	729	10.01	78.7	26.0	26.0	4.44
-2A	0.64	85	7	52	10.01	78.7	30.0	30.0	5.14
2	0.64	85	7	52	10.0	78.7	30.0	30.0	5.04
COL-1A	5.42	11	12	22	10.0	78.7	25.0	25.0	5.15
20	5.42	44.	22	35	10.0	78.7	25.0	25.0	5.18
-2A	5.42	85	2Lo	8	10.0	78.7	29.0	29.0	6.82
2	5.42	85	2L	8	10.0	78.7	29.0	29.0	5.50
02-JA	10.60	7/8	74	8	10.0	78.7	25.0	25.0	4.67
2	10.60	7/8	72	9	10.0	78.7	25.0	25.0	4.30
-24	10.60	80	24	8	10.0	78.7	25.5	25.5	5.65
2	10 60	90							

02 absorb b./cu.ft.	44884444444444444444444444444444444444
Temp. : C Outlet: 1 oc :	รัฐสัสส์ชุมส์ส์ชุมส์ส์ชุมส์ส์ชุมส์ส์ชุมส์ส์ชุมส์ส์ชุมส์ส์ชุมส์ส์ชุมส์ส์ชุมส์ส์ชุมส์ส์ชุมส์ส์ชุมส์ส์ชุมส์ส์ชุมส สารารารารารารารารารารารารารารารารารารา
Idquid Inlet oc	ราสสรรรรรรรรรรรรรรรรรรรรรรรรรรรรรรรรรร
Wetting : Rate : Ib./hr.ft.:	8611466511466558888888888888888888888888
: Liquid : Rete : : lb./hr.	800 800 800 800 800 800 800 800 800 800
Column Pressure mm. Hg.	728 7729 7729 7729 7729 7722 7722 7722 7
Gas Temp. : or. :	***************************************
: Gas Rate : : ou. ft./hr. :	
Run No.	CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA CIOLIA

	: log (K <sub>L</sub> x 10)	0.7852 0.7852 0.8129 0.8129 0.6697 0.6697 0.8976 0.9426 0.9426 0.9426 0.9426 0.9426 0.9426 0.9468 0.9468 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.0588 1.05888 1.05888 1.05888 1.05888 1.05888 1.05888 1.05888 1.05888 1.05888 1.05888 1.05888 1.05888 1.05888 1.05888 1.05888 1.05888 1.05888 1.05888 1.05888 1.058888 1.058888 1.05888 1.05888 1.058888 1.0
LAquid film coefficient for $00_2 = H_2^0$ absorption in the disc column.	k <sub>L</sub> at 25°C 110. (hraq.ft.)(lb./ou.ft.)	0.573 0.573 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659000 0.65900000000000000000000000000000000000
- H20 absorption	: (AC) <sub>1.m.</sub> : 1b./en.ft. : x102	
costicient for 602	Absorption Rate per area 1b./hrsq.ft.	eurere 44resser 2000 2000 2000 2000 2000 2000 2000 20
	Wetting Rate 1b./hr.ft.	78.7 78.7 78.7 78.7 78.7 78.7 78.7 78.7
• • 97027	Run : No. :	F00-14 -24 -24 -24 -24 -24 -24 -24 -2

Table 4. Limit film

-	: 10g (k <sub>L</sub> x 10)	1.2021 1.2181 1.2181 1.2181 1.2712 1.2712 1.2712 1.2712 1.2712 1.2712 1.2712 1.2712 1.2722	0, 8465 0, 8345 0, 8573 0, 8573 0, 8573 0, 8573 0, 8573 0, 8573 0, 8620 0, 8630 0, 8630
and and a second se	k <sub>L</sub> at 25°C Ib. (hrsq.ft.)(Ib./cu.ft.	487444444444888 882838888888888888888888888	0.702 0.644 0.644 0.720 0.720 0.720 0.723 0.723 0.723 0.723 0.723 0.723
	: (40) <sub>1,m.</sub> : : 1b./ov.ft. : : x10 <sup>2</sup> :		44444449944 4558555555555555555555555555
	: Absorption Rate : per area : 1b./nrsq.ft.	0.22 9.82 8.85 9.65 8.65 8.65 8.65 8.65 8.65 8.65 8.65 8	
(p. tuon)	Wetting Rete 1b./hr.ft.	260 260 260 260 260 260 260 260 260 260	78.7 78.7 78.7 78.7 78.7 78.7 78.7 78.7
Table 4.	Run : No. :	F20-14 -24 -24 -24 -24 -24 -24 -24	COOLIA B -24 -24 -24 -24 -24 -24 -24 -24 -24 -24

(n-++2.2

Table /

: log (K <sub>L</sub> x 10)	L. 0730 L. 0730 L. 0590 L. 11959 L. 11959 L. 11959 0. 9865 L. 12655 L. 12655 L. 12655 L. 2032 L. 2022 L. 2022
K <sub>L</sub> at 25°C 1b. (hrsq.ft.)(1b./cu.ft.	1.1133 1.1370 1.1370 0.922 0.923 0.923 0.923 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.133 1.1
: (AC) <sub>1.m.</sub> : : 1b./cu.ft. : : x102	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
: Absorption Rate : per area : lb./hrsg.ft.	, , , , , , , , , , , , , , , , , , ,
Wetting Rate lb./hr.ft.	1129 1129 256 256 256 256 256 256 256 256 256 256
Run : No. :	C10-11 - 1 - 1 - 2 - 2 - 2 - 2 - 2 - 2 - 2 - 2

Table 4. (Cont'd)

1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1	No.	Temp.	: Column : Press. : mm.Hg.	: Wetting : Rate : Ib./hr.ft.	: Liquid : Inlet .: oC	Temp. Outlet	: CO2 absorbed : 1b./cu.ft. : x102	: X <sub>L</sub> at 25°C : : (hr-aq.ft)(lb/cu.ft.):	log(KL = 10)
8       773       773       103       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       21.7       2	15-1A	80	730	103	27.2	27.3	4.86	CE8 0	2010 0
76     77     10     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     21,7     2	24	80	730	103	27.2	27.3	4-67	0.784	0 8010
37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37       37 <td< td=""><td>-24</td><td>20</td><td>727</td><td>103</td><td>21.7</td><td>21.7</td><td>1.73</td><td>20.0</td><td>0 2613</td></td<>	-24	20	727	103	21.7	21.7	1.73	20.0	0 2613
73     73     73     73     73     73       73     733     733     733     733     733     733       73     733     733     733     733     733     733       73     733     733     733     733     733     733       73     733     733     733     733     733     133       73     733     733     733     733     733     133       73     733     733     733     733     133     133       73     733     733     733     733     133     133       73     733     733     733     733     1413     0.733       73     733     733     733     743     743     0.733       73     743     743     744     143     0.443       74     743     744     744     0.443       743     743     744     744     0.443       743     744     744     1.143     0.443       744     744     744     1.143     0.443       744     744     744     744     1.143       744     744     744     744     1.143 <td>2</td> <td>22</td> <td>727</td> <td>103</td> <td>21.7</td> <td>21.7</td> <td>1.75</td> <td>6LL-0</td> <td>Caller O</td>	2	22	727	103	21.7	21.7	1.75	6LL-0	Caller O
8.8       737       103       24,0       24,3         8.8       737       103       24,0       24,3         737       739       129       25,0       0,073         737       739       129       24,3       25,0         737       739       129       24,3       24,3         737       739       129       24,3       24,3         737       739       129       24,3       24,3         737       739       129       24,3       24,3         737       739       129       24,4       4,43         737       739       129       24,4       4,43         737       733       24,4       4,43       0,435         737       733       24,4       4,43       0,435         737       733       24,4       4,43       0,443         737       74       74,3       74,4       0,443         737       74,4       74,4       74,4       0,444         738       74,4       74,4       74,4       0,444         733       74,4       74,4       74,4       0,444         74,4       74,4 </td <td>-3A</td> <td>78</td> <td>737</td> <td>103</td> <td>24.0</td> <td>24.3</td> <td>4.60</td> <td>0.705</td> <td>CCC0-0</td>	-3A	78	737	103	24.0	24.3	4.60	0.705	CCC0-0
88     730     129     86.9     77.9     5.91       733     739     129     86.9     77.9     5.91       733     739     129     22.5     5.91       733     739     129     22.5     5.91       733     739     129     22.5     5.91       733     739     129     22.5     5.91       734     739     129     22.5     5.91       735     739     129     22.5     5.91       735     739     129     22.5     5.91       735     739     129     23.0     23.1       736     737     1199     23.0     23.1       737     738     23.0     23.1     1.109       737     1199     23.0     23.1     1.139       737     1199     23.0     23.1     1.139       738     23.0     23.1     1.139     0.133       737     1199     23.0     23.1     1.139       738     23.0     23.1     1.139     0.133       738     23.0     23.3     1.139     1.139       738     23.0     23.3     1.139     1.139       744     1.139	2	78	737	103	24.0	24.3	5.04	0.810	0 Onder
8       730       129       25,9       7,9       1,15         733       739       129       25,9       1,15       0,25         733       739       129       25,1       1,15       0,25         733       739       129       25,2       2,13       0,25         733       739       129       25,2       2,13       0,25         734       739       129       25,2       2,13       0,25         735       72,3       21,9       22,5       2,11       0,25         736       737       1199       23,3       24,4       1,12       0,25         737       732       21,9       23,3       24,1       1,13       0,25       0,25         737       733       21,9       23,3       24,1       1,19       0,25         733       74,2       14,3       1,19       24,1       1,19       0,26         733       119       25,0       25,0       25,0       1,19       0,26         733       119       25,0       25,1       1,19       0,29       1,19         733       219       25,0       25,0       1,19       1,1	A1-0	80	730	129	26.9	27.9	3.91	0.735	0.8663
737       129       21,5       21,6       4,25         733       739       129       21,5       21,6       4,25         733       739       129       21,5       21,6       4,25         733       129       21,8       21,9       21,6       4,25         733       129       21,8       21,9       21,6       4,25         733       21,9       21,9       21,9       21,1       0,25         733       21,9       21,9       21,3       21,5       1,1         733       734       73,9       21,9       21,1       0,25         733       734       73,3       21,1       1,1       0,25         733       74,4       119       23,0       24,1       1,1       0,25         733       74,4       119       23,0       24,1       1,1       0,25         733       74,1       1,1       1,1       1,1       0,25       1,1       1,1       0,25         733       21,1       1,1       1,1       1,1       1,1       0,25       1,1       0,25         733       21,1       1,1       1,1       1,1       1,1	A	80	730	129	26.9	27.9	4-15	ACR.O	00100
73     73     73     73       73     73     73     73       73     73     73     73       73     73     73     21,5       74     73     73     21,5       74     73     123     21,5       74     73     123     21,5       74     73     11,9     21,4       74     74     11,9     21,5       74     74     11,9     21,5       74     74     11,9     21,5       74     74     11,9     21,5       74     74     11,9     21,1       74     74     11,9     21,1       75     74,1     1,4     11,09       74     74     74     11,9       75     74,1     1,4     11,09       74     74     1,9     21,1       75     74,1     1,4     1,19       75     74,1     1,4     1,19       75     74,1     1,4     1,19       75     74,1     1,4     1,19       75     74,1     1,4     1,19       75     74,1     1,4     1,19       75     74,2     1,4     <	-24	20	727	129	21.5	21.6	4.25	0.771	0. 4471
73     73     73     23     23     24     24       73     73     123     24,0     44,0     0,05       73     73     143     24,0     44,0     0,05       73     73     143     24,0     44,0     0,05       73     73     143     24,0     44,0     0,05       73     73     143     24,0     44,0     0,05       73     74     149     23,0     24,1     0,05       73     74     149     24,0     44,0     0,05       73     74     149     24,1     1,05       74     74     149     24,1     1,05       74     74     74     14,1     0,05       75     74     14,1     1,15     1,13       75     74     1,13     1,13       75     74     1,13     1,13       75     74     74     1,13       75     74     1,13     1,13       75     74     1,13     1,13       75     74     74     1,13       75     74     1,13     1,13       75     74     74     1,13       75     74	-34	73	739	129	22.3	22.5	2.91	0.295	10000
733     129     24.8     24.9     4.13       733     129     24.8     24.9     4.13       735     732     1193     23.8     24.9     4.13       735     732     1193     23.8     24.9     4.13       737     737     1193     23.8     24.9     4.13       737     737     1193     23.0     23.3     4.11       737     741     1193     23.0     23.3     4.12       737     741     1193     23.0     23.3     4.12       737     732     1193     23.0     23.3     4.12       737     1193     23.0     23.3     4.12     11.09       737     1193     23.0     23.3     4.12     11.09       738     23.0     23.3     4.12     11.09       738     23.0     23.3     4.12     11.19       738     23.0     23.3     4.12     11.19       739     1193     23.6     23.0     4.28       738     23.0     23.3     4.12     11.19       744     744     14.28     11.19     11.19       745     74.11     14.28     11.19       746	-	5	139	129	22.3	22.5	3.11	0.516	0.712K
733     129     24.8     24.9     4.8       733     129     24.8     24.9     4.8       734     735     159     23.8     24.0       735     739     23.8     24.0     4.6       737     1199     23.3     4.42     1.099       737     733     23.0     23.3     4.42     1.099       737     743     733     24.0     4.43     1.099       737     743     733     24.1     4.44     1.099       737     732     1199     25.0     25.1     4.42     1.096       737     732     1199     25.3     4.42     1.096       733     1199     25.6     25.0     4.45     1.199       733     139     25.6     25.0     4.45     1.199       733     139     25.6     25.0     4.45     1.199       733     139     25.6     25.0     4.45     1.199       733     139     25.6     25.0     4.45     1.199	-44	2	739	129	24.8	24.9	4.13	0.945	0.9751
742     199     2.8     24.0     4.66     1.165       742     732     199     2.8     24.0     4.66     1.165       743     737     199     2.9     2.1     4.66     1.165       743     737     199     2.3     2.3     4.1     1.165       743     737     199     2.3     2.1     4.65     1.165       743     737     199     2.3     2.1     4.12     1.006       743     732     1199     2.5     1.42     1.006       743     732     1199     2.5     4.12     1.106       743     732     1199     2.5     4.12     1.106       743     732     1199     2.5     4.12     1.106       743     732     1199     2.5     4.12     1.106       743     732     1199     2.5     4.12     1.133       743     733     1.19     4.12     1.133       744     733     1.19     4.12     1.133       744     733     1.19     4.12     1.133       745     743     743     743     1.133       744     744     745     744     1.133 </td <td>1</td> <td>27</td> <td>139</td> <td>129</td> <td>24.8</td> <td>24.9</td> <td>4+27</td> <td>0.905</td> <td>0.9566</td>	1	27	139	129	24.8	24.9	4+27	0.905	0.9566
772     159     23.8     24.0     4.65       773     773     159     23.3     24.0     4.65       773     773     1199     23.3     4.41     1.099       773     741     1199     23.3     4.42     1.099       773     741     1199     23.1     4.42     1.099       773     743     732     24.1     4.42     1.099       773     732     1199     25.3     4.42     1.099       773     732     1199     25.3     4.42     1.099       773     732     1199     25.3     4.42     1.193       773     733     23.0     23.3     4.43     1.193       773     733     139     23.5     4.45     1.133       773     139     23.6     23.0     4.43     1.133       773     139     23.6     23.0     4.43     1.119       773     73     23.6     23.0     4.43     1.119	N-14	2	742	159	23.8	24.0	4.66	1.163	1.06%
772         159         33.0         33.3         4.11           772         159         33.0         33.3         4.11           773         159         33.0         33.3         4.11           773         159         33.0         33.3         4.11           773         159         33.0         33.3         4.12         1.000           773         159         23.0         24.1         4.12         1.000           773         159         25.1         4.12         1.006           773         159         25.1         4.12         1.006           773         159         25.0         25.1         4.12         1.006           773         732         159         25.3         4.12         1.133           773         159         25.3         4.12         1.133           773         159         25.3         4.12         1.116           773         159         25.3         4.12         1.116           773         159         25.3         4.12         1.116           773         159         25.3         4.12         1.116	-	2	742	159	23.8	24.0	4.65	1.154	1.0622
722         159         23.0         23.3         4.42         1.050           777         159         23.0         24.1         4.42         1.050           777         159         23.0         24.1         4.43         0.096           777         159         23.0         24.1         4.43         0.096           777         159         25.0         25.1         3.45         0.096           777         159         25.0         25.1         4.43         0.096           76         777         159         25.0         25.1         4.43         0.193           76         772         159         25.0         25.1         4.42         1.193           77         772         159         25.0         25.3         4.42         1.193           77         773         159         25.0         4.42         1.119           77         773         159         25.0         4.42         1.119           77         773         159         25.0         4.42         1.119           77         73         159         25.0         4.42         1.119           77         73	-24	2	722	159	23.0	23.3	11.4	0.953	10791
77         159         23.9         24.1         4.34         1.000           77         747         159         23.0         24.1         4.34         1.000           77         747         159         25.0         25.1         4.34         1.006           76         747         159         25.0         25.1         4.48         1.096           76         742         159         25.5         4.465         1.133           77         722         189         25.5         4.465         1.133           77         722         189         25.3         4.455         1.133           77         773         189         25.6         2.3.0         4.455         1.110           77         773         189         22.6         23.0         4.455         1.110           77         773         189         22.6         23.0         4.455         1.110	-	21	722	159	23.0	23.3	4.42	1.050	0100.1
77         7.71         1.99         239         241         418         0.998           77         7.11         1.99         250         25.11         418         0.998           77         7.11         1.99         250         25.11         418         1098           76         7.77         1.89         250         25.11         428         1098           76         7.72         1.89         250         251         480         1332           77         722         1.89         250         253         417         1132           77         772         1.89         230         233         417         1193           77         773         1.89         226         230         428         1117           77         773         1.89         226         230         428         1117	-34	22	737	159	23.9	24.1	4.34	1.010	1.00.3
741 199 25.0 25.1 3.85 1.098 777 189 25.0 25.1 3.85 1.098 772 189 25.0 25.1 4.80 1.332 722 189 25.9 25.9 4.45 1.332 722 189 23.0 23.3 4.17 1.122 773 189 23.6 23.0 4.25 1.172 773 189 22.6 23.0 4.26 1.126	-	2	737	159	23.9	24.1	4.18	0.958	7186-0
741         159         25.0         25.1         4.21         1.050           737         189         25.0         25.3         4.61         1.050           742         189         25.0         25.9         4.65         1.332           722         189         25.0         23.3         4.17         1.132           722         189         23.0         23.3         4.17         1.142           723         189         22.6         23.3         4.17         1.143           723         189         22.6         23.3         4.17         1.143           723         189         22.6         23.0         4.25         1.143           723         189         22.6         23.0         4.25         1.143	-	FI	1712	159	25.0	25.1	3.85	1.098	1.0407
777         189         26.0         26.1         4.80         1.332           722         189         25.9         4.15         1.1352           722         189         25.0         23.3         4.12         1.142           722         189         23.0         23.3         4.17         1.142           773         189         22.6         23.0         4.25         1.150           773         189         22.6         23.0         4.25         1.150           723         189         22.6         23.0         4.25         1.150		FI	1712	159	25.0	25.1	4.21	1.050	1.0212
742 189 25.9 25.9 4.65 1.952 722 189 25.0 23.3 4.112 1.142 723 189 22.6 23.0 4.23 4.17 723 189 22.6 23.0 4.25 1.170 723 189 22.6 23.0 4.25 1.170	AL-D	27	737	189	26.0	26.1	4.80	1.332	1.1245
722 189 23.0 23.3 4.12 1.142 723 189 23.0 23.3 4.17 1.190 723 189 22.6 23.0 4.25 1.172 723 189 22.6 23.0 4.20 1.160		2	2712	189	25.9	25.9	4.65	1.352	1.1309
722 189 23.0 23.3 4.17 1.150 723 189 22.6 23.0 4.25 1.172 723 189 22.6 23.0 4.20 1.360	- 34	E	722	189	23.0	23.3	4.12	1.142	7-0577
723 189 22.6 23.0 4.25 1.172 723 189 22.6 23.0 4.20 1.160	a :	F	722	189	23.0	23.3	4.17	1.150	1.0607
723 189 22.6 23.0 4.20 1.160	-44	FI	723	189	22.6	23.0	4.25	1.172	1.0690
	-	11	723	189	22.6	23.0	4.20	1.160	1.0645

Run No.	Temp.	Press. : Press. : nm.Hg. :	Wetting Rate 1b./hr.ft.	: Inlet	d Temp. Outlet	: CO2 absorbed : lb./ou.ft.	: KL at 25°C : :(hr-sq.ft)(lb/ou.ft.)	; log(KL x 10)
8-5A	74	684	189	1.00	29.3	1 06	1 146	- 0000
-	74	664	189	22.1	5.00	4.05	870 L	1 0000 T
-64	E.	739	189	21.0	21.2	76.6	0.908	0.0001
8	17	739	189	21.0	21.2	4.50	1.190	1.0744
-7A	74	739	189	22.6	22.8	4.18	671-1	LUCIO+T
8	74	739	189	22.6	22.8	7.06	1.092	1.0380
-84	14	141	189	24.3	24.5	3.96	1.270	1.1038
8	44	141	189	24.3	24.5	3.88	1.290	Solt L
A-14	2	737	173	24.7	24.8	4.25	1.016	1.0068
<b>m</b> ;	26	737	173	24.7	24.8	4.08	310°T	1.0076
-24	22	723	173	22.7	23.9	4.19	1.056	1.0237
m ;	75	723	173	22.7	23.9	4.28	1.095	1.0395
-3A	75	737	173	23.3	23.5	4.56	1,161	1.0653
-44	2	739	173	21.2	21.4	4.20	0.952	0.9786
N-1-N	18	737	103	25.8	25.9	4.90	0.800	0.9031
-	18	737	103	25.8	25.9	4.83	0.780	0.8921
-24	E	723	103	22.9	23.4	4.95	164.0	0.8962
-	F	723	103	22.9	23.4	4.78	0.750	0.8751
-34	F	737	103	24.1	24.04	4.58	0.795	7006 0
	11.	137	103	24.1	24.4	4.86	0.766	0.8342
4.	20	141	103	24.1	24.04	5.05	0.642	0.8075
2	21	1712	103	24.1	24.04	4.19	0.636	0.8036
NI-	FI	737	129	24.9	25.1	4.16	0.785	6763.0
A	11	131	129	24.9	25.1	4.23	0.795	1006-0
-44	21	123	621	22.5	22.8	4++7	0,865	0.9370
4 40	22	621	129	22.5	22.8	436	0.828	0.9180
1	25	601	677P	24.2	22.5	3.22	0.534	0.7275
47-	24	661.	621	22.2	22.5	3.00	0.490	0.6937
B	26	730	677	1.42	24.03	4.65	0.950	0.97777
	2	201	101	Cho L	14+03	4.04	0° 442	1716.0

Table 5. (Cont'd)

 Press.	Rate : Ib./hr.ft.t	Inlet oc	Temp. Outlet	: CO_ absorbed : lb./cu.ft. : xlO <sup>2</sup>	: KL at 2500 : [hr-sq.ft](lb/cu.ft.)	-: 10g(K <sub>L</sub> x 10)
735	159	25.0	25.3	4.17	0.979	0.9908
735	159	25.0	25.3	4.36	1.040	1.0170
723	159	23.2	23.5	3.90	0.830	1616.0
723	159	23.2	23.5	4.15	0.955	0°9795
737	159	23.1	23.4	4.45	1.030	1.0128
737	159	23.1	23.4	4.046	1.030	1.0128
739	189	22.5	22.7	3.83	0.966	0.9827
739	189	22.5	22.7	3.90	1.010	1.0043
6EL	189	22.5	22.7	3.66	0.928	0.9675
664	189	22.5	22.7	3.78	0,960	0.9823
664	189	21.4	21.5	4.22	1.084	1.0351
739	189	22.4	21.5	4.11	1.056	1.0237
742	189	24al	24.5	4.50	1.248	1.0958
742	189	24.4	24.5	4.033	1.180	1.0719
737	189	25.4	25.5	3.60	0.942	1716-0
137	189	25.4	25.5	4.22	1.170	1.0682
722	189	23.1	23.3	3.90	1.045	10101
722	189	23.1	23.3	4.24	1.130	1.0531
722	189	22.3	22.6	4.10	1.105	1.0433
722	189	22.3	22.6	4.30	1.180	1.0719
730	173	27.0	27.1	10.4	1.048	1.0203
730	173	27.0	27.1	4.25	060"1 .	1.0374
727	173	22.0	22.0	4.052	1.130	1.0531
127	173	22.0	22.0	4.13	1.000	1.0000

Table 5. (Cont'd)

MO-LI         1.55         73         743         13.0         556         30.8         28.2         3.9           B         1.55         75         74         743         13.0         556         30.8         28.2         3.9           B         1.55         75         75         745         13.0         556         30.1         28.7         4.06           B         5.42         75         745         13.0         556         30.1         28.7         4.06           B         5.42         75         747         13.0         556         30.1         28.7         4.06           B         5.42         75         741         13.0         556         30.2         28.7         4.06           B         10.66         743         13.0         556         30.2         28.7         4.06           B         10.66         741         13.0         556         30.2         28.7         4.06           B         10.66         743         745         13.0         556         30.2         28.7         4.05           B         10.66         743         13.0         556         30.2 <td< th=""><th>4 4 4 4 4 4 4 4 4 4 4 4 4 4</th><th>t rressure t nuckg.</th><th>: Rate : : Ib./hr.:l</th><th>Mass Velu : b./hr-aqft:</th><th>Inlet oc</th><th>Outlet</th><th>10, co, absorbed 10, cu, ft.</th></td<>	4 4 4 4 4 4 4 4 4 4 4 4 4 4	t rressure t nuckg.	: Rate : : Ib./hr.:l	Mass Velu : b./hr-aqft:	Inlet oc	Outlet	10, co, absorbed 10, cu, ft.
1455     75     75     75     13,0     956     31,6     25,2       1,55     5,4,2     75     73     13,0     956     30,1     28,7       5,4,2     75     73     13,0     956     30,1     28,7       5,4,2     75     73     13,0     956     30,1     28,7       5,4,2     73     13,0     956     30,1     28,7       5,4,2     73     13,0     956     30,1     28,7       10,6     73     13,0     956     30,2     28,1       11,5     76     73     13,0     956     30,2     28,1       11,5     76     73     24,0     1100     956     30,2     28,1       11,5     76     73     24,0     1100     35,4     28,1     28,1       11,5     74     73     24,0     1100     26,4     28,2     28,0       11,5     74     73     24,0     1100     26,4     28,2     28,1       11,5     74     74     24,0     1100     26,4     28,2       11,5     74     73     24,0     1100     26,4     28,2       11,5     74     24,0     1100<	++++++ %%%&&%%%%%%%%%%%%%%%%%%%%%%%%%%%		13.0	596	30.8	28.2	3.07
1.155     7.3     7.36     13.0     956     27.5       5.42     7.8     7.0     13.0     956     30.0     27.5       5.42     7.8     7.9     13.0     956     30.0     27.5       5.42     7.8     7.9     13.0     956     30.0     27.5       10.6     7.9     13.0     956     30.0     27.8       10.6     7.9     13.0     956     30.0     27.8       10.6     7.9     13.0     956     30.0     27.8       10.6     7.9     13.0     956     30.0     27.8       10.6     7.9     13.0     956     30.7     28.4       10.6     7.1     13.0     956     29.5     28.7       10.6     7.4     13.0     956     29.5     28.7       10.6     7.4     13.0     956     29.5     28.7       11.5     80     7.4     13.0     956     27.2       5.42     10.0     956     29.4     1100     27.4       5.43     7.4     10.00     27.4     28.4     27.4       10.6     7.4     24.0     1100     27.4     28.4       5.42     10.0     24.	୳୳୶୶୶୶ୠୠୠୠୠ୳୳୲୳୲୳୶୶୶୶୶ୠୠୠୠୠ୲ ଽଽଽୡଌଌ୕ଌୠଡ଼୶୶୶ <i>ଽଽଽଽ</i> ଽଽୡଌୡୡଡ଼୶୶୶ଽଽଽ		13.0	596	31.6	29.2	4.000
5.22         7.47         7.47         13.0         956         90.1         23.7           5.42         73         7.47         13.0         956         90.2         23.4           5.42         73         739         13.0         956         90.2         23.4           5.42         73         739         13.0         956         90.2         23.4           10.6         73         741         13.0         956         90.7         23.4           10.6         73         745         13.0         956         90.7         23.4           10.6         73         745         13.0         956         90.7         23.4           10.6         73         745         13.0         956         90.7         23.4           11.55         80         743         24.0         1100         77.4         27.4         24.7           11.55         54.4         73         24.0         1100         77.4         27.4         27.4           11.55         54.4         74.5         24.0         1100         77.4         27.4         27.4           11.55         54.4         74.5         24.0	៹៹៷៷៷៷៰៰៰៰៰ ៹៹៹៹៹៹៹៹៹៹៹៹៹៹៹៹៹៹៹៹៹៹៹៹៹៹៹	962	13.0	596	29.6	27.5	4.28
State         Tot         Tate         Tate <th< td=""><td>44440000111111222200000000 444400000222224444446000022</td><td></td><td>13.0</td><td>596</td><td>30.1</td><td>28.7</td><td>4.06</td></th<>	44440000111111222200000000 444400000222224444446000022		13.0	596	30.1	28.7	4.06
5.42         73         13.0         556         30.7         23.8           10.6         73         13.0         556         30.7         23.8           10.6         73         13.0         556         30.7         23.8           10.6         73         13.0         556         30.7         23.8           10.6         73         743         13.0         556         30.7         23.1           11.55         80         741         13.0         556         30.7         23.1           11.55         80         743         13.0         556         30.7         23.1           11.55         80         743         24.0         1100         57.6         20.7         23.7           11.55         80         743         24.0         1100         27.6         27.2         23.7           5.42         74         24.0         1100         27.6         27.8         27.2           5.43         74         74         24.0         1100         27.4         28.4           5.45         74         24.0         1100         27.4         28.4         27.4           5.45         74<	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	147	0.61	596	30.2	27.5	4.16
5,52         73         741         13.0         995         90.0         25.1           10.6         73         745         13.0         996         90.0         25.1           10.6         73         745         13.0         996         20.0         25.2           11.65         80         745         13.0         996         20.0         25.1           11.55         76         733         74.0         110.0         996         20.0         25.1           11.55         76         733         24.0         1100         996         29.2         28.1           11.55         76         733         24.0         1100         27.6         28.1           5.42         745         24.0         1100         27.6         28.1         28.1           5.42         74         733         24.0         1100         27.6         28.1           5.43         74         73         24.0         1100         27.6         28.1           5.43         74         74         73         24.0         1100         27.4         28.1           5.44         10.00         26.4         28.6         2		720	13.0	596	30.7	28.8	4.00
IO.6         75         741         IO.0         956         20.5         77.5           IO.6         73         745         13.0         956         20.5         27.5           IO.6         73         745         13.0         956         20.5         27.5           I.55         80         745         13.0         956         20.5         27.5           I.55         80         745         13.0         956         20.5         27.5         27.5           I.55         80         745         13.0         956         20.5         22.5         27.6         22.5           I.55         5.45         745         24.0         1100         27.6         22.6         23.6         23.6           S.45         5.45         24.0         1100         27.6         20.6         20.7         24.6         24.6         24.6         24.6         24.6         24.6         24.6         24.6         24.6         24.6         24.6         24.6         24.6         24.6         24.6         24.6         24.6         24.6         24.6         24.6         24.6         24.6         24.6         24.6         24.6         24.6         2	000011111122220000000 0000822225444446000022	101	13.0	NON NON	20.00	1.02	4.35
10.6         73         745         13.0         956         90.7         28.7           10.6         73         745         13.0         956         29.5         28.7           1.55         60         741         24.0         1100         29.6         29.5         28.7           1.55         76         733         24.0         1100         27.6         28.7         28.7           1.55         76         733         24.0         1100         27.6         28.4         28.7           5.42         74         733         24.0         1100         27.4         28.4         28.4           5.42         74         733         24.0         1100         27.4         28.4           5.43         74         733         24.0         1100         27.4         28.4           5.43         74         73         24.0         1100         27.4         28.4           10.6         74         73         24.0         1100         26.6         20.3           10.6         74         24.0         1100         26.6         20.7         28.4           10.6         74         24.0         1100	ਗ਼ਗ਼ਗ਼ ਗ਼ਗ਼ਗ਼ਗ਼ਗ਼ਗ਼ਗ਼ਗ਼ਗ਼ਗ਼ਗ਼ਗ਼ਗ਼ਗ਼ਗ਼ਗ਼ਗ਼ਗ਼ ਗ਼ਗ਼ਗ਼ਗ਼ਗ਼ਗ਼ਗ਼ਗ਼ਗ਼ਗ਼ਗ਼ਗ਼ਗ਼ਗ਼ਗ਼	11/1	13.0	280	29.5	27.2	4.12
10.6         73         745         13.0         976         23.1         27.1           1.55         80         7.1         13.0         976         23.2         23.1           1.155         80         7.1         24.0         1100         976         23.2         23.1           1.155         76         733         24.0         1100         27.6         23.2         23.2           1.155         76         733         24.0         1100         27.6         23.2         23.2           5.42         80         7.45         24.0         1100         27.6         23.2         23.2           5.42         7.4         733         24.0         1100         27.6         23.2         23.2           5.42         80         7.45         24.0         1100         27.6         23.2         23.2           10.66         78         74.0         1100         26.6         26.5         26.7         26.1           10.66         74         24.0         1100         26.6         26.3         26.6         26.7           10.66         74         74         24.0         11000         26.6         26.7	9644444 <i>4444</i> 469669444 6 <i>6888884444</i> 6666888		13.0	596	30.7	28.7	3.82
1.05         1.05         20.5         22.0         1.05         20.5         22.0           1.155         10         1.0         1.00         1000         20.5         22.6           1.155         76         733         24.0         1100         20.4         22.6           1.155         80         7.45         24.0         1100         20.4         22.6           5.42         7.43         24.0         1100         27.6         22.6         22.6           5.42         80         7.45         24.0         1100         27.6         22.6           5.42         80         7.5         24.0         1100         27.6         22.6         23.2           5.43         80         7.45         24.0         1100         27.6         23.6         23.2           10.66         74         739         24.0         1100         20.6         20.3         20.7           10.66         74         24.0         1100         26.2         28.0         27.1           10.66         74         27.4         1100         20.6         20.3         20.7           10.66         74         27.4         1100<		745	13.0	596	29.1	27.1	4.72
1.955         80         74.1         24.0         1100         29.4         28.7           1.155         76         733         24.0         1100         27.8         27.8           1.155         76         733         24.0         1100         27.4         28.4           5.45         80         745         24.0         1100         27.4         28.4           5.42         74         733         24.0         1100         27.4         28.4           5.42         74         739         24.0         1100         27.4         28.4           5.42         74         739         24.0         1100         27.4         28.4           5.42         74         739         24.0         1100         27.4         28.4           10.6         745         24.0         1100         26.5         26.5         26.5           10.6         745         24.0         1100         28.2         28.0         28.5           10.6         741         71.3         71.4         27.0         28.2         28.0           10.6         741         71.3         71.4         27.4         28.3         28.0	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		13.0	5%	29.5	28.0	67.7
1.233         76         733         24.0         1100         27.6         27.3           1.155         5.42         100         27.0         1100         27.4         27.4           5.42         80         745         24.0         1100         27.4         27.4           5.42         80         745         24.0         1100         27.4         27.4           5.42         74         739         24.0         1100         27.4         27.8         27.4           5.42         74         739         24.0         1100         27.6         27.8         27.4           10.6         78         27.0         1100         26.9         26.9         26.9           10.6         74         739         24.0         1100         30.6         30.3           10.6         74         24.0         1100         30.6         30.3           10.6         74         24.0         1100         30.5         28.0           10.6         74         24.0         1100         30.3         28.1           10.6         74         27.4         170         36.3         28.1           1.5 <t< td=""><td>,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,</td><td>1712</td><td>24.0</td><td>0011</td><td>29.4</td><td>28.7</td><td>3.66</td></t<>	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	1712	24.0	0011	29.4	28.7	3.66
1.33         7.3         2.4.0         1100         27.8         27.8           5.42         80         7.45         2.4.0         1100         27.9         27.4           5.42         80         7.45         2.4.0         1100         27.4         28.6           5.42         7.4         739         2.4.0         1100         27.4         28.6           5.42         7.4         739         2.4.0         1100         27.4         28.6           5.42         80         745         2.4.0         1100         27.6         28.6           10.6         78         74.0         1100         26.6         30.3         26.6           10.6         74         24.0         1100         26.2         28.0         27.0           10.6         74         27.4         1100         28.2         28.0         28.1           10.6         74         27.4         1100         28.2         28.0         28.1           10.5         80         74.1         77.3         27.4         28.3         28.0           1.55         77         77.3         77.3         27.3         28.3         28.0			24.0	0011	29.6	29.2	3.%
Line         Bo         745         24.0         1100         27.4         27.4           5.42         7.4         7.3         24.0         1100         27.4         24.8           5.42         7.4         739         24.0         1100         29.4         26.8           5.42         7.4         739         24.0         1100         29.4         26.8           5.42         10.6         80         755         24.0         1100         26.6         26.3           10.6         78         74.0         1100         26.6         30.8         26.6           10.6         78         74.0         1100         26.9         26.4         26.6           10.6         78         74.0         1100         26.2         26.0         26.6           10.6         74.8         74.0         1100         26.2         26.3         26.0           10.6         60         74.1         77.3         27.0         26.3         26.0           10.5         60         74.1         77.3         27.9         26.3         26.0           1.5         77.8         1770         26.3         26.3         26.3		733	24.0	0011	27.8	27.2	3.58
3.42         80         745         24.0         1100         29.4         24.8           5.42         7.4         7.9         24.0         1100         29.4         28.8           5.42         10.6         80         755         24.0         1100         29.4         28.6           10.6         75         24.0         1100         29.4         28.6         28.5           10.6         75         24.0         1100         30.6         30.3         30.3           10.6         78         74.0         1100         30.6         30.3         30.3           10.6         741         24.0         1100         30.5         28.0         30.3           10.6         741         37.8         1770         28.2         28.0           1.55         77         77.3         1770         28.3         28.7	44444900000000000000000000000000000000		24.0	0011	27.9	27.4	3.87
74         739         24.0         1100         29.6         39.2           80         755         24.0         1100         26.6         39.3           80         755         24.0         1100         26.6         39.4           78         748         24.0         1100         26.6         39.4           78         748         24.0         1100         26.6         39.4           80         741         24.0         1100         28.2         28.0           80         741         24.0         1100         28.2         28.0           71         73         77.8         1770         28.3         28.0           77         733         77.8         1770         28.3         28.3	10	245	24.0	1100	29.4	28.8	3.73
74         739         24.0         1100         26.9         36.9           80         755         24.0         1100         26.9         36.9           78         74.0         1100         26.8         26.7           78         74.8         24.0         1100         30.8         29.7           78         74.8         24.0         1100         30.6         30.3           80         74.8         24.0         1100         28.2         28.0           80         74.1         27.4         1100         28.2         28.0           80         74.1         27.4         1100         28.2         28.0           71         77.3         1770         28.2         28.0         36.7           77         733         1770         28.3         28.0         36.7	10		24.0	0011	29.6	29.2	3.76
80         755         24.0         1100         26.6         26.6           78         745         24.0         1100         30.6         29.7           78         74.6         24.0         1100         30.6         30.3           78         74.8         24.0         1100         30.6         30.3           80         74.1         24.0         1100         28.2         28.0           80         74.1         27.3         1720         28.3         28.0           77         733         37.8         1770         28.3         28.3           77         733         37.8         1770         28.3         28.3		739	24.0	0011	26.9	26.9	4.06
60         755         24.0         1100         30.8         29.7           78         748         24.0         1100         30.4         30.3           78         748         24.0         1100         30.2         30.3           80         741         24.0         1100         28.2         28.0           80         741         27.8         1730         28.2         28.0           77         73         37.8         1730         28.3         28.3           77         73         37.8         1730         28.5         28.3			24.0	0011	26.8	26.6	3.77
78         748         24.0         1100         30.6         30.3           78         743         24.0         1100         28.2         28.0           80         741         27.4         1100         28.2         28.0           80         741         27.4         1730         28.2         28.0           77         733         37.8         1770         28.5         28.0           77         733         37.8         1770         28.5         28.3		755	24.0	0011	30.8	29.7	4042
76 748 24.0 1100 28.2 28.0 80 741 27.6 1100 28.2 28.0 77. 733 77.8 1720 28.3 28.3 77.8 1730 28.5 28.3			24.0	0011	30.6	30.3	4.02
80 741 24-0 1100 28-2 28.0 77.8 1730 28-3 28.3 77.8 1730 28-3 28.3 77.8 1730 28-5 28.7		148	24.0	0011	28.2	28.0	3.98
60 741 37.8 1730 28.3 28.3 37.8 1730 28.5 28.3 37.8 1730 26.5 26.7			24.0	OOTT	28.2	28.0	3.88
733 37.8 1730 28.3 26.3 37.8 1730 26.5 26.7	1.55	THL	37.8	1730	28.3	28.3	3.80
733 37.8 1730 26.5 26.7			37.8	1730	28.3	26.3	4.01
	-24 1-22 14	662	37.8	1730	26.5	26.7	3.46

73     739     77.8     1739     77.8     1730     24.7       75     739     77.8     1730     24.7       76     755     77.8     1730     24.7       76     755     77.8     1730     24.7       76     755     77.8     1730     24.7       76     754     77.6     24.0     25.3       734     734     27.6     24.10     25.4       734     734     27.6     24.10     25.4       734     734     27.6     24.10     25.4       75     74     74.5     22.6     24.10       76     734     22.6     24.10     25.4       76     735     22.6     24.10     25.5       76     735     22.6     24.10     25.5       76     735     22.6     24.10     25.5       76     735     23.6     24.10     25.5       76     735     13.0     55.6     25.4       76     74     13.0     55.6     25.4       77     13.0     55.6     24.10     25.5       76     74     13.0     55.6     25.4       76     74     13.0	7,60         73         739         37,8         1730           7,60         73         739         37,8         1730           10,66         80         739         37,8         1730           10,66         80         739         37,8         1730           10,66         75         739         37,8         1730           10,66         75         739         37,8         1730           11,55         80         744         734         1730           11,55         80         744         734         24,00           5,425         73         74         74         24,00           5,425         74         74         74         24,00           5,425         76         745         52,60         24,00           10,66         76         745         52,60         24,00           10,6         76         745         52,60         24,00           10,6         76         745         52,60         24,10           10,6         76         745         52,60         24,10           10,6         76         745         52,66         24,10	Run No.	: Gas Rate : cu.ft./hr.	: Gas Temp	a : Column : Pressure : ma.Hg.	: Lidquid : Rate : Ib./hr.	: Mass Vel. : Mass Vel.	Inlet 00	Temp. : Outlet : oc :	CO2 absorbed lb./cu.ft.
7,60         73         97.8         1730         22.4           7,60         73         739         77.8         1730         22.4           10.6         75         739         77.8         1730         25.3           10.6         75         739         77.8         1730         25.4           10.6         75         739         77.8         1770         25.3           11.55         80         7.4         756         210         25.4           5.42         74         74         52.6         2410         25.4           5.42         74         74         52.6         2410         25.4           5.42         74         74         52.6         2410         25.6           5.42         76         74         52.6         2410         25.6           5.42         76         74         74         52.6         2410         25.6           5.42         76         74         74         52.6         2410         25.6           10.6         74         74         52.6         2410         25.6         25.6           10.5         52.6         24.0	7,60         7         7,90         7,18         1790         2,48         2,48           10,6         6         739         77.8         1770         25,3         35,3           10,6         76         739         77.8         1770         25,4         35,3           10,6         76         739         77.8         1770         25,4         35,3           11,55         80         744         75,6         24,10         26,4         26,4           11,55         81         736         27,48         1770         25,3         36,4           11,55         80         744         73,6         24,10         78,4         24,10         26,4         26,4           5,42         74         74         52,6         24,10         78,4         26,4         26,4           5,42         76         74         74         52,6         24,10         76,4         26,4           10,6         76         745         52,4         24,10         26,4         26,4           10,6         76         74         74         52,6         24,10         26,4         26,4           10,6         76 <t< td=""><td>4</td><td>7.60</td><td>73</td><td>6EL</td><td>37.8</td><td>1730</td><td>24.7</td><td>24.5</td><td>3.80</td></t<>	4	7.60	73	6EL	37.8	1730	24.7	24.5	3.80
7,60         73         739         77,8         1730         25,3           10,6         76         735         77,8         1730         25,5           10,6         76         735         77,8         1730         25,5           10,6         76         735         77,8         1730         25,5           11,55         80         745         77,8         1730         25,5           11,55         80         744         52,6         24,10         26,5           5,4,2         76         744         52,6         24,10         26,5           5,4,2         76         74,4         52,6         24,10         26,5           5,4,2         76         74,4         52,6         24,10         27,6           5,4,2         76         74,4         52,6         24,10         27,6           11,55         76         74,4         52,6         24,10         27,6           10,6         76         74,4         52,6         24,10         27,6           10,6         76         74,4         52,6         24,10         27,6           10,6         76         74,4         52,6	7,60         75         77,8         1790         25,3         25,2           10,6         75         77,8         1790         25,3         25,3         25,4           10,6         75         77,8         1790         25,3         35,4         35,4           10,6         75         77,8         1790         25,3         35,4         36,4           11,5         80         74,4         22,6         24,10         26,4         36,4           11,5         74         72,6         24,10         26,4         36,4         36,4           11,5         74         74,5         52,6         24,10         26,4         36,4           11,5         76         74,4         52,6         24,10         26,4         36,4           5,42         76         74,4         74,9         52,6         24,10         26,4         36,4           10,6         76         74,4         74,9         54,6         24,10         26,4         36,4           10,6         74,4         74,9         52,6         24,10         26,4         36,4           10,6         74,4         74,9         54,6         24,10	-	7.60			37.6	1730	24.8	24.8	3.84
7,60         732         77,8         1770         25,3           10,6         6         735         77,8         1770         25,3           11,55         80         744         726         2410         26,4           11,55         81         734         72,6         2410         26,4           11,55         81         734         72,6         2410         26,4           11,55         81         734         52,6         2410         26,4           5,4,2         76         745         52,6         2410         26,4           5,4,2         76         745         52,6         2410         26,4           5,4,2         76         745         52,6         2410         26,5           5,4,2         76         745         52,6         2410         26,5           10,6         76         745         52,6         2410         26,5           10,6         76         745         52,6         2410         26,5           10,6         76         745         52,6         2410         26,5           10,6         74         74,5         52,6         2410         26,5<	Trico         80         732         97.8         1790         25.3         35.4           10.6         75         77.8         1790         25.3         35.4           10.6         75         77.8         1790         25.4         36.4           11.55         80         744         32.6         2410         284.4         36.4           11.55         81         734         57.8         17790         36.4         36.4           11.55         81         734         57.6         2410         284.4         36.4           5.42         75.4         75.6         2410         77.4         55.6         2410         77.4         36.4           5.42         75.4         75.6         2410         77.4         36.4         36.4           5.42         76         745         55.6         2410         77.4         36.4           5.42         76         745         55.6         2410         77.4         36.4           10.6         76         745         55.6         2410         27.4         26.4           10.6         76         745         55.6         2410         27.4         27.4	-	7.60	22	664	37.8	1730	25.3	25.2	3.66
10.6         80         732         97.8         1770         26.4           10.6         76         735         97.8         1770         26.4           10.6         76         735         97.8         1770         26.4           11.55         80         7.44         52.6         2410         26.4           11.55         81         7.34         52.6         2410         26.4           5.42         7.44         52.6         2410         26.4           5.42         7.4         52.6         2410         26.4           5.42         7.4         52.6         2410         26.4           5.42         7.4         52.6         2410         26.4           5.42         7.4         7.4         52.6         2410         26.5           5.42         7.6         7.4         52.6         2410         26.5           10.6         7.6         7.4         52.6         2410         26.5           10.6         7.6         7.4         52.6         2410         26.5           10.6         7.6         7.4         52.6         2410         26.5           10.6 <td< td=""><td>10.6         80         732         77.8         1770         26.4         36.4           10.6         75         77.8         1770         26.4         24.0         26.4         26.4           1.55         80         745         77.8         1770         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4</td><td>8</td><td>7.60</td><td></td><td></td><td>37.8</td><td>1730</td><td>25.3</td><td>25.2</td><td>3.66</td></td<>	10.6         80         732         77.8         1770         26.4         36.4           10.6         75         77.8         1770         26.4         24.0         26.4         26.4           1.55         80         745         77.8         1770         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4	8	7.60			37.8	1730	25.3	25.2	3.66
10.6         755         77.8         1770         26.4           11.55         80         744         72.6         2410         26.4           11.55         80         744         72.6         2410         27.6           11.55         80         744         72.6         2410         27.6           5.425         77         734         52.6         2410         27.6           5.425         74         734         52.6         2410         27.6           5.425         76         734         52.6         2410         27.6           5.425         76         734         52.6         2410         27.6           5.426         76         734         52.6         2410         27.6           5.426         76         745         52.6         2410         27.6           5.426         76         735         52.6         2410         27.6           10.6         76         745         52.6         2410         27.6           10.6         76         741         13.0         97.6         27.9           5.428         76         741         13.0         97.6         2	Diology         Total         Type	-	10.6	80	752	37.8	1730	26.4	28.6	4.00
10.6         75         7.8         1730         26.5           11.55         80         7.4         72.6         24.10         26.5           11.55         80         7.4         72.6         24.10         76.4           11.55         81         734         52.6         24.10         76.4           11.55         81         734         52.6         24.10         76.4           5.42         7.4         52.6         24.10         77.6           5.42         7.4         52.6         24.10         77.6           5.42         7.4         52.6         24.10         77.6           5.42         7.6         7.4         52.6         24.10         77.6           5.42         7.6         7.4         52.6         24.10         27.6           5.42         7.6         7.4         7.4         52.6         24.10         27.6           10.6         7.4         7.4         7.4         52.6         24.10         27.6           11.55         76         7.4         13.0         57.6         24.10         27.6           11.55         76         7.3         13.0         57.6	10.6         75         77.8         1770         26.3         36.3           11.55         80         744         72.6         21.00         78.4         36.4           11.55         81         736         27.8         1770         26.4         26.4         26.4           11.55         81         736         21.00         78.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4	-	10.6			37.8	1730	28.4	28.4	3.79
10.6         74.4         27.8         1770         26.5           11.55         80         74.4         52.6         24.10         26.5           11.55         81         73.4         52.6         24.10         26.5           5.422         74         52.6         24.10         27.6           5.422         76         74.5         52.6         24.10         27.6           5.422         76         74.5         52.6         24.10         27.6           5.422         76         74.5         52.6         24.10         27.6           5.423         76         74.5         52.6         24.10         27.6           5.423         76         74.5         52.6         24.10         27.6           10.6         76         74.4         52.6         24.10         27.6           10.6         76         73.5         52.6         24.10         27.6           11.55         76         74.1         13.0         57.8         29.4           11.55         76         73.1         13.0         57.6         29.4           11.55         76         73.1         13.0         57.6 <td< td=""><td>10.6         11.5         20.8         1770         26.3         1770         26.3         27.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         <th< td=""><td>-</td><td>10.6</td><td>92</td><td>755</td><td>37.8</td><td>1730</td><td>26.3</td><td>26.3</td><td>3.70</td></th<></td></td<>	10.6         11.5         20.8         1770         26.3         1770         26.3         27.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4         26.4 <th< td=""><td>-</td><td>10.6</td><td>92</td><td>755</td><td>37.8</td><td>1730</td><td>26.3</td><td>26.3</td><td>3.70</td></th<>	-	10.6	92	755	37.8	1730	26.3	26.3	3.70
1155     30     744     92.6     2410     28.4       1155     81     734     92.6     2410     28.4       1155     81     734     92.6     2410     28.4       5.42     74     73     92.6     2410     26.4       5.42     75     74     92.6     2410     26.4       5.42     74     74     92.6     2410     26.4       5.42     75     74     92.6     2410     26.4       5.42     75     74     92.6     2410     26.4       5.42     76     73     92.6     2410     26.4       10.6     76     73     92.6     2410     26.4       11.55     76     73     92.6     2410     26.5       11.55     76     73     11.0     956     20.3       5.42     76     73     11.0     956     20.3       5.42     76     73     11.0     956     20.3       5.42     76     73     11.0     956     20.3       5.42     76     73     13.0     956     20.3       5.42     76     73     13.0     956     20.3       5.42 <td>1.55     80     744     92.6     2.410     28.4     38.4       1.155     81     7.34     92.6     2.410     28.4     38.4       1.155     81     7.34     92.6     2.410     28.4     38.4       5.42     7.4     92.6     2.410     28.4     28.4     28.4       5.42     7.4     92.6     2.410     28.4     28.4     28.4       5.42     7.4     92.6     2.410     28.4     28.4     28.4       5.42     7.4     92.6     2.410     28.4     28.4     28.4       5.42     7.4     7.5     92.6     2.410     28.4     28.4       10.6     7.6     7.3     92.6     2.410     28.4     28.4       10.6     7.6     7.3     92.6     2.410     28.4     28.4       10.6     7.4     7.3     92.0     28.4     77.3     28.4       1.155     7.6     7.3     92.0     28.4     77.3     28.4       1.155     7.6     7.10     7.9     79.3     77.3       1.155     7.6     7.3     10.0     79.6     77.3       1.15     5.4     7.3     10.0     79.6     77.3   &lt;</td> <td>-</td> <td>10.6</td> <td></td> <td></td> <td>27.8</td> <td>1730</td> <td>26.3</td> <td>26.3</td> <td>3.48</td>	1.55     80     744     92.6     2.410     28.4     38.4       1.155     81     7.34     92.6     2.410     28.4     38.4       1.155     81     7.34     92.6     2.410     28.4     38.4       5.42     7.4     92.6     2.410     28.4     28.4     28.4       5.42     7.4     92.6     2.410     28.4     28.4     28.4       5.42     7.4     92.6     2.410     28.4     28.4     28.4       5.42     7.4     92.6     2.410     28.4     28.4     28.4       5.42     7.4     7.5     92.6     2.410     28.4     28.4       10.6     7.6     7.3     92.6     2.410     28.4     28.4       10.6     7.6     7.3     92.6     2.410     28.4     28.4       10.6     7.4     7.3     92.0     28.4     77.3     28.4       1.155     7.6     7.3     92.0     28.4     77.3     28.4       1.155     7.6     7.10     7.9     79.3     77.3       1.155     7.6     7.3     10.0     79.6     77.3       1.15     5.4     7.3     10.0     79.6     77.3   <	-	10.6			27.8	1730	26.3	26.3	3.48
1155     11     734     92.6     2410     26.4       1155     71     734     92.6     2410     27.6       5.42     5.42     734     92.6     2410     27.6       5.42     5.42     734     92.6     2410     27.6       5.42     7.4     92.6     2410     27.6       5.42     7.4     92.6     2410     27.6       5.42     7.5     92.6     2410     25.0       5.42     7.5     92.6     2410     25.6       5.42     7.5     92.6     2410     25.5       10.6     75     92.6     2410     25.3       10.6     75     92.6     2410     25.3       11.5     76     735     92.6     2410     25.3       11.5     76     733     13.0     956     30.3       5.42     76     733     13.0     956     29.9       5.42     76     733     13.0     956     29.9       5.42     76     730     13.0     956     29.9       5.42     76     733     13.0     956     29.9       5.42     76     730     93.0     956     99.9	11:55     E1     734     32.6     24.0     73.4     33.4       11:55     54.2     73.4     52.6     24.0     73.4     33.4       5.4.2     54.2     73.6     24.0     73.5     73.4       5.4.2     75.4     73.6     24.0     73.5     73.4       5.4.2     75.6     24.0     75.6     24.0     75.6       5.4.2     75.6     24.0     75.6     24.0     75.4       5.4.2     75.6     24.0     75.6     24.0     75.4       5.4.2     75.6     24.0     75.0     25.0     25.0       10.6     75     75.6     24.0     75.3     25.4       10.6     75     52.6     24.0     75.3     25.4       10.6     74     75.6     24.0     25.3     25.4       11.5     76     73.5     13.0     75.3     25.4       5.42     77.9     77.9     77.9     77.9       5.42     77.9     77.9     77.9     77.9       11.5     76     71.0     75.3     77.4       5.44     77.9     77.9     77.9     77.9       5.45     77.9     77.9     77.9     77.9       <	-	1.55	80	744	52.6	2410	28.4	28.4	3.88
1155     81     734     92.6     2210     27.5       5.42     7.4     92.6     2210     27.5       5.42     7.4     72.6     2210     27.5       5.42     7.6     7.4     92.6     2210     27.5       5.42     7.6     7.4     92.6     2210     25.0       10.6     7.6     7.4     92.6     2210     25.0       10.6     7.6     7.4     92.6     2210     25.0       10.6     7.6     7.3     92.6     2210     25.0       10.6     7.6     7.3     92.6     2210     25.3       10.6     7.6     7.3     92.6     2210     25.3       11.5     7.6     7.3     92.6     2210     25.3       11.5     7.6     7.3     92.6     2210     25.3       11.5     7.6     7.3     19.0     95.6     32.4       11.5     7.7     7.4     19.0     95.6     20.3       5.42     7.7     7.4     19.0     95.6     20.3       5.42     7.7     7.4     19.0     95.6     20.3       5.42     7.7     7.4     19.0     95.6     20.3       5.42 <td>1.55     81     734     32.6     2.10     27.5     27.4       5.47     71     72,6     2.10     27.5     27.4       5.47     74     32.6     2.10     27.5     27.4       5.47     76     745     32.6     2.10     26.4       5.47     76     745     32.6     2.10     26.4       5.47     76     745     32.6     2.10     26.4       5.47     76     745     32.6     2.10     26.4       5.47     76     745     32.6     2.10     26.4       10.6     76     745     32.6     2.10     26.3       10.6     76     745     32.6     2.10     26.3       10.6     74     13.0     96.6     20.3     26.4       11.5     76     741     13.0     96.6     26.4       11.5     76     743     13.0     96.6     26.4       5.42     76     741     13.0     96.6     26.4       1.5     76     741     13.0     96.6     26.4       1.5     76     743     13.0     96.6     26.4       5.42     76     13.0     96.6     26.4     26</td> <td>-</td> <td>1.55</td> <td></td> <td></td> <td>52.6</td> <td>5410</td> <td>28.4</td> <td>28.4</td> <td>4.13</td>	1.55     81     734     32.6     2.10     27.5     27.4       5.47     71     72,6     2.10     27.5     27.4       5.47     74     32.6     2.10     27.5     27.4       5.47     76     745     32.6     2.10     26.4       5.47     76     745     32.6     2.10     26.4       5.47     76     745     32.6     2.10     26.4       5.47     76     745     32.6     2.10     26.4       5.47     76     745     32.6     2.10     26.4       10.6     76     745     32.6     2.10     26.3       10.6     76     745     32.6     2.10     26.3       10.6     74     13.0     96.6     20.3     26.4       11.5     76     741     13.0     96.6     26.4       11.5     76     743     13.0     96.6     26.4       5.42     76     741     13.0     96.6     26.4       1.5     76     741     13.0     96.6     26.4       1.5     76     743     13.0     96.6     26.4       5.42     76     13.0     96.6     26.4     26	-	1.55			52.6	5410	28.4	28.4	4.13
1,555     77     749     72,6     22,10     27,6       5,422     76     749     52,6     24,10     26,6       5,422     76     745     52,6     24,10     26,6       5,422     76     745     52,6     24,10     26,6       10,6     76     745     52,6     24,10     25,3       10,6     76     735     52,6     24,10     25,3       10,6     76     735     52,6     24,10     25,3       11,55     76     733     13,0     56,4     23,4       11,55     76     733     13,0     56,4     23,4       5,422     76     733     13,0     56,6     24,0       11,55     76     733     13,0     56,6     24,0       5,422     76     733     13,0     56,6     24,0       5,422     76     73,0     13,0     56,6     24,0       5,423     76     73,0     13,0     56,6     24,0       5,423     76     73,0     13,0     56,6     24,0       5,424     76     73,0     13,0     56,6     24,6       5,424     76     73,0     56,6     24,6 </td <td>1.55     71     72,6     24,0     27,6     24,10     27,6     24,10       5,12     5,12     5,12     77,6     24,10     75,6     24,10     75,6     24,10       5,12     5,12     75,6     24,10     75,6     24,10     75,6     24,10       5,12     75,6     24,10     75,6     24,10     75,6     24,10       10,6     76     75,4     75,6     24,10     75,3     25,4       10,6     76     75,5     52,6     24,10     25,3     25,4       10,6     76     73,5     74,0     25,3     25,4     26,6       1,55     76     73,3     11,0     95,6     24,10     25,3     25,4       1,54     76     73,3     11,0     95,6     24,10     25,3     25,4       1,54     76     73,3     11,0     95,6     24,10     25,3     25,4       1,54     76     73,3     11,0     95,6     24,10     25,3     25,4       1,54     76     73,3     11,0     95,6     24,10     25,4       5,42     76     73,3     11,0     95,6     24,10     25,4       5,42     76     73,3     1</td> <td>-</td> <td>1.55</td> <td>81</td> <td>734</td> <td>52.6</td> <td>5410</td> <td>27.5</td> <td>27.04</td> <td>3.75</td>	1.55     71     72,6     24,0     27,6     24,10     27,6     24,10       5,12     5,12     5,12     77,6     24,10     75,6     24,10     75,6     24,10       5,12     5,12     75,6     24,10     75,6     24,10     75,6     24,10       5,12     75,6     24,10     75,6     24,10     75,6     24,10       10,6     76     75,4     75,6     24,10     75,3     25,4       10,6     76     75,5     52,6     24,10     25,3     25,4       10,6     76     73,5     74,0     25,3     25,4     26,6       1,55     76     73,3     11,0     95,6     24,10     25,3     25,4       1,54     76     73,3     11,0     95,6     24,10     25,3     25,4       1,54     76     73,3     11,0     95,6     24,10     25,3     25,4       1,54     76     73,3     11,0     95,6     24,10     25,3     25,4       1,54     76     73,3     11,0     95,6     24,10     25,4       5,42     76     73,3     11,0     95,6     24,10     25,4       5,42     76     73,3     1	-	1.55	81	734	52.6	5410	27.5	27.04	3.75
5.42         77         749         52.6         2100         26.6           5.42         76         745         52.6         2100         26.6           10.6         76         745         52.6         2100         25.3           10.6         76         744         52.6         2100         25.3           10.6         76         734         52.6         2100         25.3           10.6         76         734         52.6         2100         25.3           10.6         76         734         52.6         2100         25.3           11.5         80         741         13.0         57.6         23.4           11.55         76         733         13.0         57.6         23.4           5.42         76         733         13.0         57.6         23.4           5.42         76         733         13.0         57.6         23.4           5.42         76         733         13.0         57.6         23.4           5.42         76         733         13.0         57.6         23.4           5.42         76         736         13.0         57.6	5.42         77         749         35.4         2.10         35.4         36.4           5.42         7.5         7.4         7.9         55.4         2.10         25.4         36.4           10.6         7.6         7.4         52.6         2.10         25.4         35.4           10.6         7.6         7.4         52.6         2.10         25.0         25.0           10.6         7.6         7.5         52.6         2.10         25.3         25.4           10.6         7.6         7.5         52.6         2.10         25.3         25.4           10.6         7.6         7.5         52.6         2.10         25.3         25.4           10.6         7.6         7.3         13.0         95.6         2.10         25.3         25.4           1.5         7.6         7.1         13.0         95.6         20.2         25.4           1.4         7.4         13.0         95.6         20.2         25.4         27.9           1.45         7.4         13.0         95.6         20.2         25.4         27.9           1.45         7.4         13.0         95.6         20.2	-	1.55			52.6	0172	27.6	27.7	3.84
5.42         5.42         5.42         5.42         5.42         5.42         5.42         5.41         25.6         2410         25.4           10.6         5.42         75         75         75.6         2410         25.3           10.6         76         734         52.6         2410         25.3           10.6         76         734         52.6         2410         25.3           10.6         76         734         52.6         2410         25.3           10.6         76         735         52.6         2410         25.3           11.55         76         735         52.6         2410         25.3           11.55         76         733         13.0         956         29.3           11.55         76         733         13.0         956         29.3           5.42         76         733         13.0         956         29.3           5.42         76         735         13.0         956         29.3           5.42         76         736         13.0         956         29.4           5.42         76         736         13.0         956         29.4	5.42         5.42         5.43         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44         5.44 <th< td=""><td>-</td><td>5.42</td><td>44</td><td>671</td><td>52.6</td><td>2410</td><td>26.4</td><td>26.4</td><td>3.93</td></th<>	-	5.42	44	671	52.6	2410	26.4	26.4	3.93
5,422         76         745         52.6         24.0         25.0           10.6         76         745         52.6         24.0         25.0           10.6         76         754         52.6         24.0         25.0           10.6         76         754         52.6         24.0         25.3           10.6         76         735         52.6         24.0         25.3           10.6         76         735         52.6         24.0         25.3           11.55         76         733         13.0         556         23.4           11.55         76         733         13.0         556         23.4           5.42         76         733         13.0         556         29.3           5.42         76         733         13.0         556         29.3           5.42         76         733         13.0         556         29.3           5.42         76         733         13.0         556         29.3           5.42         76         730         13.0         556         29.3           5.42         76         73.0         13.0         556	5.42         7.43         52.6         2.410         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0         25.0 <t< td=""><td></td><td>5.42</td><td></td><td></td><td>52.6</td><td>2410</td><td>26.4</td><td>26.4</td><td>3.64</td></t<>		5.42			52.6	2410	26.4	26.4	3.64
5.42         754         52.6         2210         25.0           10.6         76         734         52.6         2210         25.0           10.6         76         734         52.6         2210         25.3           10.6         76         735         52.6         2210         25.3           10.6         76         735         52.6         2210         25.3           11.55         76         735         52.6         2410         25.3           11.55         76         733         13.0         956         33.4           5.422         76         733         13.0         956         39.9           5.422         76         733         13.0         956         39.9           5.422         76         733         13.0         956         39.9           5.422         76         735         13.0         956         29.9           5.422         76         735         13.0         956         29.9           5.422         76         735         13.0         956         29.9           5.422         76         736         13.0         956         29.4	Ji.42         Tild         Zi.6         Zill         Zill </td <td>4</td> <td>5.42</td> <td>22</td> <td>745</td> <td>52.6</td> <td>2410</td> <td>25.0</td> <td>25.0</td> <td>3.71</td>	4	5.42	22	745	52.6	2410	25.0	25.0	3.71
10.6         76         734         52.6         24.0         25.3           10.6         76         734         52.6         24.0         25.3           10.6         76         735         52.6         24.0         25.3           10.6         76         735         52.6         24.0         25.3           10.6         76         735         52.6         24.0         25.3           11.55         76         733         13.0         596         33.4           1.155         76         733         13.0         596         33.4           1.155         76         733         13.0         596         23.4           5.422         76         733         13.0         596         23.4           5.422         76         733         13.0         596         23.4           5.422         76         733         13.0         596         29.3           5.422         76         73.0         59.4         29.4         29.4           5.422         76         73.0         59.4         29.4         29.4           5.422         76         73.0         59.4         29.4 <td>10.6         76         734         53.6         24.0         25.3         25.4           10.6         76         754         53.6         24.0         25.3         25.4           10.6         76         755         53.6         24.0         25.3         25.4           10.6         75         53.6         24.0         25.3         25.4         35.4           10.6         75         53.6         24.0         25.3         35.4         35.4           1.55         76         733         13.0         956         27.4         36.6           1.55         76         733         13.0         956         27.4         26.4           5.42         76         733         13.0         956         27.3         21.4           5.42         76         733         13.0         956         27.3         21.4           5.42         76         733         13.0         956         27.3         21.4           5.42         76         733         13.0         956         27.3         21.4           5.42         76         733         13.0         956         27.3         21.4      1</td> <td>-</td> <td>5.42</td> <td></td> <td></td> <td>52.6</td> <td>24,10</td> <td>25.0</td> <td>25.0</td> <td>3.77</td>	10.6         76         734         53.6         24.0         25.3         25.4           10.6         76         754         53.6         24.0         25.3         25.4           10.6         76         755         53.6         24.0         25.3         25.4           10.6         75         53.6         24.0         25.3         25.4         35.4           10.6         75         53.6         24.0         25.3         35.4         35.4           1.55         76         733         13.0         956         27.4         36.6           1.55         76         733         13.0         956         27.4         26.4           5.42         76         733         13.0         956         27.3         21.4           5.42         76         733         13.0         956         27.3         21.4           5.42         76         733         13.0         956         27.3         21.4           5.42         76         733         13.0         956         27.3         21.4           5.42         76         733         13.0         956         27.3         21.4      1	-	5.42			52.6	24,10	25.0	25.0	3.77
10.6         735         52.6         22.00         25.3           10.6         75         52.6         22.00         25.3           10.6         75         52.6         22.00         25.3           11.55         76         735         52.6         24.10         25.3           11.55         76         733         13.0         55.4         32.4           11.55         76         733         13.0         556         32.4           5.42         76         733         13.0         556         32.4           5.42         76         733         13.0         556         29.4           5.42         76         733         13.0         556         29.4           5.42         76         735         13.0         556         29.4           5.42         76         735         13.0         556         29.4           5.42         76         735         13.0         556         29.4           5.42         76         736         73.0         556         29.4           5.42         76         736         73.0         556         29.4           5.42	10.6         75         52.6         2.20         25.3         25.4           10.6         75         52.6         2.20         25.3         25.4           10.6         75         52.6         2.10         25.3         25.4           1.55         7.6         2.10         25.3         25.4         25.4           1.55         7.6         2.10         25.3         25.4         25.4           1.55         7.6         731         13.0         956         33.4         27.9           1.55         7.6         733         13.0         956         33.4         27.9         27.9           5.42         7.4         13.0         956         30.2         27.9         27.9           5.42         7.6         733         13.0         956         30.2         27.9           5.42         7.6         13.0         956         30.2         27.9         27.9           5.42         7.6         13.0         956         30.2         27.9         27.9           5.42         7.6         13.0         956         30.2         27.9         27.9           10.6         7.6         13.0	-	10.6	92	154	52.6	0172	25.3	25.3	3.73
10.6         76         735         52.6         2410         25.3           10.6         76         735         52.6         2410         25.3           1.55         80         741         13.0         556         31.5           1.55         76         733         13.0         556         31.5           1.55         76         733         13.0         556         32.4           1.55         76         733         13.0         556         32.9           5.42         76         733         13.0         556         30.3           5.42         76         748         13.0         556         30.3           5.42         76         748         13.0         556         30.3           5.42         76         748         13.0         556         30.3           5.42         76         73.0         556         30.3         31.1           5.42         76         73.0         556         30.3         32.4           5.42         76         73.0         556         30.3         32.4           5.42         76         76         73.0         556         30	10.6         75         52.6         2410         25.3         25.4           10.6         75         52.6         2410         25.3         25.4           1.55         76         735         19.0         55.3         35.4           1.55         76         733         19.0         556         24.0         25.3         35.4           1.55         76         733         19.0         556         32.4         30.8           1.55         76         733         19.0         556         32.4         30.8           5.42         76         733         19.0         556         32.4         30.8           5.42         76         733         19.0         556         32.4         30.8           5.42         76         733         19.0         556         30.2         27.3           5.42         76         733         19.0         556         30.2         27.3           5.42         76         733         19.0         556         30.2         27.3           10.6         76         19.0         556         30.2         27.9         35.4           10.6         76	-	10.6	-		52.6	2470	25.3	25.4	3.90
10.6         92.6         24.0         25.3           11.55         80         741         19.0         596         31.5           11.55         76         733         19.0         596         32.4           11.55         76         733         19.0         596         30.2           11.55         76         733         19.0         596         30.2           5.42         76         733         19.0         596         30.2           5.42         76         733         19.0         596         30.2           5.42         76         735         13.0         596         30.2           5.42         76         735         13.0         596         30.2           5.42         76         735         13.0         596         30.2           5.42         76         73.0         13.0         596         30.1           10.6         77         747         13.0         596         29.4           10.6         77         747         13.0         596         29.2	J0.6         32.6         24.0         25.3         35.4           1.55         80         741         13.0         556         31.5         20.6           1.55         76         733         13.0         556         31.5         20.6           1.55         76         733         13.0         556         30.2         27.9           1.55         76         733         13.0         556         29.4         70.8           5.42         76         733         13.0         556         29.4         70.8           5.42         76         735         13.0         556         29.4         70.3           5.42         76         735         13.0         556         29.4         20.3           5.42         76         735         13.0         556         20.3         27.9           5.42         76         735         13.0         556         20.3         27.9           10.6         77         13.0         556         20.3         27.9         27.9           10.6         77         13.0         556         20.2         27.9         27.9           10.6         77	-	10.6	22	755	52.6	2410	25.3	25.4	4.004
1.55 80 741 13.0 596 31.5 1.55 76 733 13.0 596 32.4 1.55 76 733 13.0 596 32.4 5.42 76 733 13.0 596 29.4 5.42 76 735 13.0 596 29.4 5.42 76 735 13.0 596 29.4 13.0 596 39.4 13.0 596 39.4 13.0 596 39.4	1.55     80     741     19.0     56     31.5     29.6       1.155     76     733     19.0     566     39.4     30.8       1.155     76     733     19.0     566     39.4     30.8       5.42     77     748     19.0     566     39.4     37.9       5.42     77     748     19.0     566     39.3     37.9       5.42     76     735     19.0     566     39.3     37.9       5.42     76     735     19.0     566     39.3     37.9       5.42     76     735     19.0     566     30.3     37.9       5.42     76     735     19.0     566     30.3     37.9       10.6     76     736     19.0     566     30.2     37.9       10.6     76     19.0     566     30.2     27.9       10.6     76     19.0     566     30.2     27.9       10.6     76     19.0     566     30.2     27.9       10.6     76     30.2     27.9     27.9       10.0     566     30.2     27.9     27.9       10.0     566     30.2     27.9     27.9 </td <td>8</td> <td>10.6</td> <td></td> <td></td> <td>52.6</td> <td>0172</td> <td>25.3</td> <td>25.4</td> <td>3.78</td>	8	10.6			52.6	0172	25.3	25.4	3.78
L155         76         733         11.0         956         32.4           11.55         76         733         11.0         956         30.4           5.442         77         748         13.0         956         30.4           5.442         77         748         13.0         956         30.4           5.442         76         735         13.0         956         20.4           5.442         76         735         13.0         956         20.4           5.442         76         735         13.0         956         31.1           5.442         76         735         13.0         956         31.1           10.6         77         13.0         956         29.4           10.6         77         13.0         956         29.4	Lumber         Lumber <thlumber< th=""> <thlumber< th=""> <thlumber< t<="" td=""><td>-</td><td>1.55</td><td>80</td><td>147</td><td>13.0</td><td>596</td><td>31.5</td><td>29.6</td><td>4.07</td></thlumber<></thlumber<></thlumber<>	-	1.55	80	147	13.0	596	31.5	29.6	4.07
11.55         76         733         13.0         596         29.9           5.42         77         748         13.0         596         30.3           5.42         77         748         13.0         596         30.3           5.42         76         735         13.0         596         30.3           5.42         76         735         13.0         596         30.3           5.42         76         735         13.0         596         30.4           5.42         76         735         13.0         596         31.1           5.42         76         750         13.0         596         31.1           10.6         76         730         13.0         596         29.4           10.6         77         747         13.0         596         29.4	11.55         76         733         13.0         556         23.9         27.3           5.42         77         74.8         13.0         556         32.3         27.9           5.42         76         735         13.0         556         33.3         27.9           5.42         76         735         13.0         556         33.3         27.9           5.42         76         735         13.0         556         33.1         35.3           5.42         76         735         13.0         556         33.1         35.3           5.42         76         73.0         556         33.1         35.4         36.7           10.6         76         73.0         556         30.2         27.9         27.9           10.6         77         74.7         13.0         556         30.3         27.9           10.6         77         13.0         556         30.3         27.9         27.9           10.6         77         13.0         556         30.3         27.9         27.9	m	2.55			13.0	596	32.4	30.8	4.48
1.55         77         748         13.0         956         30.2           5.42         77         748         13.0         956         30.3           5.42         76         735         13.0         956         30.3           5.42         76         735         13.0         956         30.3           5.42         76         735         13.0         956         31.1           5.42         76         730         13.0         956         31.1           10.6         77         13.0         956         29.4         31.1           10.6         77         747         13.0         956         29.4         29.4	1.55         77         748         13.0         956         30.2         27.9           5.42         77         748         13.0         556         29.3         26.0           5.42         76         735         13.0         556         30.3         26.4           5.42         76         735         13.0         556         31.1         29.3           5.42         76         735         13.0         556         31.1         29.3           10.6         76         730         13.0         596         29.4         28.4           10.6         77         13.0         596         29.4         28.4         28.7           10.6         77         13.0         596         29.2         27.9         27.9           10.6         77         13.0         596         29.3         27.9         27.9           10.6         77         13.0         596         29.3         27.9         27.9	-	1.55	26	733	13.0	236	29.9	27.3	4.18
5.42         77         745         13.0         556         29.3         50.5         50.3         50.5         50.3         50.5         50.3         50.5         50.3         50.5         50.5         50.3         50.5         50.3         50.5         50.3         50.5         50.4         50.5         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.4         50.	5.42         77         74.8         13.0         556         29.3         36.0           5.42         76         735         13.0         556         30.3         36.1           5.42         76         735         13.0         556         31.1         29.3           5.42         76         755         13.0         596         31.1         29.7           10.6         76         790         13.0         596         31.1         29.7           10.6         77         74.7         13.0         596         30.2         27.9           10.6         77         74.7         13.0         596         30.2         27.9           10.6         77         74.7         13.0         596         29.3         27.9           10.6         77         13.0         596         29.3         27.9	-	1.55			13.0	596	30.2	27.9	4.22
5.42         5.42         76         735         13.0         596         30.9           5.42         76         735         13.0         596         31.1           5.42         76         735         13.0         596         31.1           10.6         76         750         13.0         596         29.4           10.6         77         747         13.0         596         29.4	5.42         7.6         735         13.0         956         90.9         86.4           5.42         7.6         735         13.0         556         31.1         29.7           5.42         7.6         735         13.0         556         31.1         29.7           10.6         7.6         750         13.0         556         31.1         29.7           10.6         77         13.0         556         29.4         26.7           10.6         77         747         13.0         556         29.4         26.7           10.6         77         747         13.0         556         30.2         27.9           10.6         77         747         13.0         556         30.3         26.6	-	5.42	44	748	13.0	596	29.3	26.0	missing
5.42         76         735         13.0         556         31.1           10.6         76         750         13.0         596         31.1           10.6         76         750         13.0         596         29.4           10.6         77         747         13.0         596         29.4	5.42         76         735         13.0         556         31.1         23.3           5.42         76         755         13.0         596         31.1         23.7           10.6         76         750         13.0         596         30.1         27.9           10.6         77         747         13.0         596         30.2         27.9           10.6         77         747         13.0         596         30.2         27.9           10.6         77         747         13.0         596         30.3         28.6           10.6         77         747         13.0         596         20.3         28.6	-	5.42			13.0	596	30.9	28.4	4.84
5.42 5.42 13.0 596 31.1 10.6 76 750 13.0 596 29.4 10.6 77 747 13.0 596 30.2 10.6 77 747 33.0 596 30.2	5.42 76 750 13.0 556 31.1 29.7 10.6 76 750 13.0 596 29.4 26.7 10.6 77 747 13.0 596 29.4 27.9 10.6 77 747 13.0 596 29.3 27.8 10.6 10.6 27.8 27.8	-	5.42	26	262	23.0	265	32.1	29.3	3.99
10.6 76 750 13.0 596 29.4 10.6 77 747 13.0 596 30.2 10.6 77 747 13.0 596 30.2	10.6 76 750 13.0 596 29.4 26.7 4 10.6 77 74.7 13.0 596 29.2 27.9 1 10.6 77 74.7 13.0 596 29.3 28.6 4 10.6 10.6 13.0 596 30.3 28.6 4	-	5.42			13.0	596	31.1	29.7	3.84
10.6 77 747 13.0 596 30.2 10.6 77 747 13.0 596 29.8	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	-	10.6	9/2	750	13.0	596	29.4	26.7	4.10
1 10.6 77 747 13.0 596 29.8	1 10.6 77 747 13.0 596 29.8 27.8 4 13.0 596 30.3 28.6 4	-	10.6	1		13.0	236	30.2	27.9	4.30
	13.0 596 30.3 28.6 4	at o	10.0	11	147	13.0	236	29.8	27.8	4.36

Run No.	: Gas Rate : cu.ft./hr.	: Gas Temp. : of	: Column	: Rate	: Liguid : Mass Wel. :	Inlet	Temp. : Outlet:	CO2 absort 1b./cu.ft.
ALT	1-55	78	737	21.0	UULL	26.7	26.6	1.72
-	1.55	2	2	24.0	1100	26.9	26.8	3.98
-24	1.55	81	734	24.0	0011	30.2	29.7	3.68
8	1.55			24.0	0011	30.4	30.0	3.64
AL-	5.42	80	14712	24.0	1100	30.8	30.3	4.02
A	5.42			24.0	1100	30.9	30.5	4.20
-24	5.42	78	739	24.0	0011	27.0	26.9	3.95
8	5.42			24.0	0011	27.1	2730	3.68
AL-	10.6	342	752	24.0	1100	28.6	27.3	3.77
-	10.6			24.0	1100	28.6	27.3	3.55
-24	10.6	84	748	24.0	OOLI	27.8	27.7	3.86
8	10.6			24.0	0011	27.8	27.7	3.84
-14	1.55	76	71,2	37.8	1730	25.8	25.8	4.03
8	1.55			37.8	1730	35.8	35.8	3.83
-24	1.55	34	737	37.8	1730	25.6	25.7	3.92
A	1.55			37;8	1730	25.6	25.7	4.24
PI-	5.42	64	746	3738	1730	28.6	28.5	4.00
-	5.42			37.8	1730	28.7	28.6	3.74
-24	5.42	76	1477	37.8	1730	26.5	26.5	3.67
2	5.42			37.8	1.730	26.5	26.5	3.44
14	20.6	80	750	37.8	1730	28.2	28.2	3.83
8	10.6			37.8	1730	28.2	28.2	3.73
-2A	10.6	78	736	37.8	1730	25.1	25.4	4.17
2	10.6			37.8	1730	25.1	25.4	3.85
TT-	1.55	24	746	52.6	2410	26.6	26.7	3.62
2	1.55 1			52.6	2410	26.6	26.6	3.60
-24	1.55	81	734	52.6	2410	28.3	28.3	3.94
-	1.55			52.6	2410	28.3	28.3	3.75
AL-	5.42	80	141	52.6	2410	28.3	28.3	missing
A	5.42			52.6	5410	28.3	28.3	3.92
-2A	5.42	78	745	52.6	2410	26.5	26.5	3.62
B	5.42			52.6	2410	26.5	26.5	3.78
TT-	10.6	92	754	52.6	9172	25.3	25.4	3.72
A	10.6			52.6	2410	25.3	25.4	3.87
-2A	10.6	81	742	52.6	2410	28.1	28.3	3.58
-								

T/a		92	23	63	1:	16	66	03	74	12	05	22	15	200	62	29	38	16	29	98	34		12	88	500	76	53	87
log kla		1.1492	1.1523	1.19	1.164	1.1492	1.19	1.17	1.1614	1.12	1.24	1.21	To J	045E-L	1.39	1.37	1.38	1.42	1.37	1.47	1014	1.40	Cor .	12.01	10.1	1.52	1.56	1.5587
Rta Kta Coefficient : 14 uid Film Coefficient : 15.	(.)(Ib./en.ft.) : Corrected :	14.1	14.2	15.5	14.6	1440	15.7	14.8	14.5	13.4	17.4	16.3	2.2	22.8	24.9	23.6	24.2	26.4	23.6	30.1	×0.0	25.0	10470	201	33.0	33.7	26.5	36.2
Liguta Figure	Observed :	15.5	16.1	16.8	16.3	15.7	17.3	16.5	15.8	9-11	18.7	17.9	0.00	24.1	26.6	26.2	26.8	27.5	24.6	34.1	0.00	4.12	0.02	E 77	34.4	35.1	36.2	36.2
(4C)1.m. 1b./cu.ft.		5.68	5.50	5.62	5.55	5.66	5.46	5.46	5.79	5.69	5.57	5.55	20.07	6.15	5.99	5.87	5.80	6.08	6.32	5.35	4C .C	2.4	5 02	2.80	6.41	6.41	6.68	6.75
Absorption Rate : 1b./hr. : x10 <sup>3</sup> :		8.41	8.48	10.6	8.65 6 65	0.00 8.18	9.22	8.62	8.73	8.09	10.00	9.51	C4047	14.10	15.25	14.70	14.82	16.00	14.85	17.42	10°04	00°CT	11 26	67.76	21.07	21.44	23.14	23.39
Idquid : Mass Velocity : 1b./hrsq.ht.:		596	596	596	946	200	596	596	596	596	236	266	OULL	DOTT	0011	DOLL	0011	0011	0011	DOTT	UULL	UULL	1730	1730	1730	1730	1730	1730
Run : No. :		VI-OOI	-	-24	a tod	8	-24	A	R02-14	m ;	-24	R OLO	H	-24	-	AL-LLR	2	-24		RI-SIA	AC	49-	AL-US	A	-2A	8	R21-1A	EA :

uno.	: Mass Velocity : : Nass Velocity : : Th. An an. At. :	Absorption Rate : 1b./hr	10-/cuitt.	: Liquid Film:	kra : Liquid Film Coefficient : 1b. Coefficient :	log k <sub>L</sub> a
		1		: (hrcu.ft.	)(lb./cu.ft.) : : Corrected :	
T	1100	15.84	5.40	30.8	27.0	1.4314
-	DOLL	16.55	5.31	32.6	28.7	1.4579
-2A	1100	15.56	6.11	26.6	25.3	1.4031
-	DOLL	14.50	6.30	24.2	27.5	1.4393
TA	0011	14.85	6.16	25.2	23.4	1.3692
-	0011	13.99	6.26	23.4	21.8	1.3385
SA	0011	15.21	6.16	25.9	24.3	1.3856
-	OOLI	15.13	6.15	25.7	24.1	1.3820
E20-14	1730	24.54	6.38	40.2	39.4	1.5955
-	1730	23.32	. 6.53	37.3	36.6	1.5635
2A	1730	23.87	6.40	39.2	38.6	1.5866
2	1730	25.21	6.23	42.1	42.04	1.6170
E21-1A	1730	24.36	5.80	44.0	40.4	1.6064
20	1730	22.78	5.95	40.2	36.8	1.5658
SA	1730	22.35	6.52	35.9	34.8	1.5416
m	1730	20.95	6.65	33.0	31.9	1.5038
E22-1A	1730	23.32	6.02	40.5	37.7	1.5763
-	1730	22.72	6.07	39.1	36.3	1.5599
SA	1730	25.40	6.34	42.0	42.0	1.6232
m	1730	22.45	6.57	35.8	35.8	1. 5539
E30-14	2410	30.51	6.45	49.5	47.6	1.6776
8	2410	30.34	6.45	49.5	47.5	1.6767
ZA	2410	33.21	5.82	59.6	55.5	1.7435
-	2410	31.61	5.96	55.5	52.0	1.7160
\$31-1A	2410					missing
-	0172	33.04	5.92	58.4	54.0	1.7324
2A	2410	30.51	6.17	51.7	6.64	1.6981
2	0172	31.86	6.05	55.2	53.4	1.7275
E32-14	2410	31.36	6.83	48.0	47.6	1.6776
-	2410	32.62	6.75	50.7	50.1	1.6998
-ZA	2410	30.18	6.10	51.8	48.1	1.6821
-	0110	00 00		A 44	A 84	and the second s

#### IV. Statistical Analysis

<u>PC series</u>. Data taken from the last column of Table 4 are summarized in Table 8a. The following sums of squares are calculated from the main table and sub-tables of Table 8 a,b,c, and d.

 $\texttt{C.F.}=(74.6514)^2/72$  - 77.40043 , where 72 is the total number of observation.

(a) 
$$0.7852^2 + 1.3424^2 - C.F. = 2.49332$$

(b)  $(1.5704^2 + \dots + 2.6096^2)/2 - C.F. = 2.37931$ 

(c)  $(17.8723^2+\ldots+19.1362^2)/18 - C.F. = 0.22781$ 

(d)  $(35.4286^2 + \dots + 39.2228^2)/36 - C.F. = 0.19995$ 

(e)  $(3.2152^2 + \dots + 5.0626^2)/4 - C.F. = 2.04449$ 

(f) (6.6249<sup>2</sup>+....+ 9.9347<sup>2</sup>)/8 - C.F. = 1.93212

(g)  $(36.6593^2 + \dots + 37.9921^2)/36 - C.F. = 0.02467$ 

(h)  $(9.6952^2 + \dots + 14.9618^2)/12 - C.F. = 1.92405$ 

(1)  $(24.4221^2 + \dots + 24.7320^2)/24 - C. F. = 0.02553$ 

(j)  $(11.8503^2, \dots, 12.3982^2)/12 = C.F. = 0.05986$ 

(k) (20.0281<sup>2</sup>+....+ 29.5656<sup>2</sup>)/24 - C.F. - 1.89697

Sum of square for R = d, T = e, RxT = b-d-e

for main effects: F = g, L = k, G = i

for interactions: FxL = h-g-k , FxG = j-i-g , IxG = f-k-i FxIxG = d-f-g-h-i-j-k

for observation within run: a-b

<u>QD series</u>. We attempt was made to test for significance of effects flow type with this experiment. The purpose of conducting this experiment was to furnish more data to determine the relationship between  $k_{\tilde{L}}$  and the liquid rate. Therefore only error of observation within run was calculated. This was done by the method as described for PC series, i.e. to find the corresponding a-b term.

<u>RE sories</u>. Computation similar to that done in PC series was carried out. There were two missing data, EOL-1A and E3L-1A, due to known errors. In order to facilitate computation, these data were substituted by values that would give minimum errors. The new values were calculated with the following formula (5):

 $X_{11} = \frac{nX_{11} + (v-1)X_{11} + X_{21} - X_{11}}{(v-2)(n-1)}$  $X_{21}^{\prime} = \frac{nX_{\cdot1} + (v-1)X_{2} + X_{1} - X_{\cdot}}{(v-2)(v-1)}$ 

where

X = value of observation

- X<sub>11</sub> the estimated value of the missing one of replicate 1 and treatment 1.
- X21 = the estimated value of the missing one of replicate 1 and treatment 2.
- $X_{\gamma}$  = the sum of replicate 1 excluding  $X_{\gamma\gamma}$ .
- $X_{1,}$  = the sum of treatment 1 excluding  $X_{71}$ .
- X .. = the grand total excluding the missing one.
- n = number of replicate.
- v = number of treatment.

According to the above formula and using the first sample (a) of replicate 1 as the replicate in the formula, we can calculate the best estimate values for EOL-1A and E31-JA. These are 1.2096 and 1.7221 respectively.

Since we have introduced two values with minimum error, the total number of observation for determining experimental error will thus be reduced by two. So total degree of freedom becomes 96-1-2=93. The logarithm of liquid film coefficient, log  $(k_{\rm L}~x~10),$  data from the absorption experiment of  $\rm CO_2-H_2O$  system in the disc column. Table S.

(a) Replicate versus treatment.

Treatment				Replicate			
	TA	3B	sum 1.	24	2B	gum 2	Total
700 2 1	.7852 .6693 .7679	.77852 .6857 .7135	1.5704 1.3550 1.4814	.9129 .9120	. 8319 . 8976 . 8865	1.6448 1.8396 1.8030	3.2152 3.1946 3.2844
P10 2 2	.9689 1.0835 1.0835	.9786	1.8286 2.1423 2.0621	.9768 1.1732 1.1673	1.0043 1.0588 .9479	1.9811 2.2320 2.1152	3.8097 4.3743 4.1773
P20 2 1	1.2041	1.3181 1.2095 1.1173	2.5222 2.3556 2.2245	1.1761 1.2742 1.3444	1.1271 1.2765 1.3032	2.3032 2.5507 2.6476	4-8254 4-9063
000 000	.8463 .8129 .7404	1169. 12613.	1.6314 1.6324 1.4315	.8710 1.1673	. 8573 . 9217 . 8820	1.7283 2.0890 1.7713	3.4097 3.7214 3.2028
610	1.0730 .9643 .9380	1.0550 .9800 .9253	2.1280 1.9443 1.8633	1.1959	1.1139 1.0550 1.0934	2.3098 2.1815 2.2695	4.4378 4.1258 4.1328
620	1.1430 1.3032 1.2355	1.0792 1.2272 1.2175	2.2222 2.5304 2.4530	1.2279 1.3320 1.2672	1.2742 1.3424	2.5021 2.6096 2.6096	4.7243 5.1749 5.0626
Total	17.8723	17.5563	35.4386	20.0866	19.1362	39.2228	74.6514

Table 8. (Cont'd)

(b) Flow type versus flow rate

-											-							
Total	-	6.6249 6.9160 6.4872	8.2475 8.5001 8.3101	9.5497 10.0812 9.9347	74.6514		Total	24.4221	25.4973	24.7320	74.6514		Totel		20.0281	25.05777	29.5656	7159-74
		10.3339	12.6964	14.9618		-		-										
0	0	3.4097 3.7214 3.2028	4.4378 4.1258 4.1328	4.7243 5.1749 5.0626	37.9921		o	12.5718	13.0221	12.3982	37.9921			2	6.4872	8.3101	9.9347	24.7320
Flow type		9.6942	12.3613	14.6038		ts rate.	-					quid rate.	Gas Rate	1	6.9160	\$° 5001	10.0812	28. 4973
	P	3.2152 3.1946 3.2844	3.8097 4.3743 4.1773	4.8254 4.9063 4.8721	36.6593	Flow type versus gas rate.	Ą	11.8503	12.4752	12.3338	36.6593	Gas rate versus liquid rate.		0	6.6249	8.2475	9.5497	24.4221
Rates		848	9 H 8	8 H 8	Total	(c) Flow	Gas Rate	0	1	2	Total	(d) Gas	Liquid Rate		0	-	8	Total

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The logarithm of liquid film coefficient, log (k1 x 10), data from the absorption	(ex
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		Sample		Run No.		Semple	
	Y	B	Sum		A	B	Sum
7	0.9135	6768.0	1.8084	D5-1	0.9031	0.8921	1.7952
2	0.8543	0.8555	1.7098	3	0.8982	0.8751	1.7733
3	0.8482	0.9085	1.7567	-	0.9004	0.88/2	1.7846
	0.8663	0.9170	1.7833	1	0.8075	0.8035	1.6110
ñ	0.6946	0.7126	1.4072	1-90	6768.0	0.9004	1.7953
+	0.9754	0.9566	1.9320	2	0466.0	0.9180	1.8550
-	1.0656	1.0622	2.1278	5	0.7275	0.6937	1.4212
3	1616.0	1.0212	2.0003	4-	1116.0	T716.0	1.9518
5	1.0043	0.9814	1.9857	D'-L	0.9908	1.0170	2.0078
1	1.0407	1.0212	2.0619	3	1616.0	0.9795	1.8986
ŝ	1.0577	1.0607	2.1184	-3	1.0128	1.0128	2.0256
*	1.0690	1.0645	2.1335	D8-1	0.9827	1.0043	1.9870
2	1.0278	1.0203	2.0481	2	0.9675	0.9823	1.9498
9	1666.0	1.0755	2.0746	-	1.0351	1.0237	2.0588
5-	1.0577	1.0382	2.0959	1	1.0958	1.0919	2.1677
ę	1.1038	3.1106	2.2144	5-	1716.0	1.0682	2.0423
-	1.0068	1.0076	2.0154	9	1,0191	1.0531	2.0722
4	1.0237	1.0395	2.0632	1-	1.0433	1.0719	2.1152
				1-60	1.0203	1.0374	2.0577
				9	1.0531	1.0000	2.0531

The logarithm of liquid film coefficient, log  $k_{\rm L}$  , data from the absorption experiment of  $\rm GO_2$  -  $\rm H_2O$  system in the packed column. Table 10.

(a) Replicate versus treatment.

	Total	4.6562	4.6798	4.7412	5.5402	5.5512	5.7027	6.2354	6.2042	6.2095	6.9533	6.7844	6.8026	4.8106	4.8301	4.7459	5.6160	5.7317	5.4753	6.3526	6.2176	6.3133	6.8138	6.8801	6.7730	210 1000
	sum 2	2.3547	2.3662	2.4527	2.7541	2.7945	2.8009	3.0461	3.0832	3.0416	3.4353	3.3839	3.4136	2.3890	2.3282	2.3886	2.7437	2.8424	2.7676	3.2036	3.0454	3.1771	3.4595	3.4256	3.3956	PADA ANA
	88	1.1644	1.1703	1.2122	1.3962	1.3729	1.3927	1.5276	31.5416	1.5038	1.7243	1.6844	1.6893	1.1987	1.1492	1.1818	1.3617	1.4393	1.3820	1.6170	1.4038	1.5539	1.7160	1.7275	1.7135	A 1 0000
Replicate	2.4	1.1903	1.1959	1.2405	1.3579	1.4216	1.4282	1.5185	1.5416	1.5378	1.7110	1.6955	1.7243	1.1903	1.1790	1.2068	1.3820	1.4031	1.3856	1.5866	1.5416	1.6232	1.7436	1.6981	1.6821	AF 21 FO
	sum 1	2.3015	2.3136	2.2885	2.7861	2.7567	2.9018	3.1893	3.1210	3.1679	3.5180	3.4005	3.3890	2.4216	2.5019	2.3573	2.8723	2.8893	2.7077	3.1590	3.1722	3.1362	3.3543	3.4545	3.3774	and name
	IB	1.1523	1.1492	1.1271	1.4150	1.3838	1.4232	1.6107	1.5587	1.5658	1.7896	1.6812	1.7042	1.2455	1.2923	1.1959	1.4409	1.4579	1.3385	1.5635	1.5658	1.5599	1.6767	1.7324	1.6998	A 4000
	IA	1.1492	1.1644	1.1614	1.3711	1.3729	1.4786	1.5786	1.5623	1.6021	1.7284	1.7193	1.6848	1.1761	(a=1.2096)	1.1614	1.4314	1.4314	1.3692	1.5955	1.6064	1.5763	1.6776	(b- 1.7221)	1.6776	THOUSE IS
Treatment		ROO	-	2	RIO	-	~	RZO	r-i	2	R30	-	~	EOO	-1	2	EIO	-	2	E20	r-l	2	E30	eri	2	T-4-2

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-	*>* 0101

) Flow type versus flow rates

-		1		28.4638			33.6171		37.5126		C400 17	with the second														
Total		9.4668	9.5099	9.4871	11.1562	11.2829	11.1780	12.5980	12.6228	13.7671	13.6645	AUEY UTL	Informer		Total	1886.94	1678.64	46.7635	140.6307		Total		28.4638	33.6171	37-5426	41.0016
				14.3866			16.8230		18.8935		20.1669															
	53	4.8106	1068.4	4.4759	0.5160	5.7317	5.4753	6.3626 6 2176	6.3133	6.8138	6.8801	70. 4700			A	23.6030	23.6596	23.3075	70.5700			2	1784.9	11.1780	12.5228	N/1007
Flow Type		•												ate.						rate.	Gas Rate	1	9.5099	11.2829	12.4218	7400000
				14.0772			1762.91		1679.91		20- 5403			Flow type versus gas rate.						Gas rate versus liquid rate.	Gai		9.4668	11.1562	12.5980	
	X	4.6562	4.6789	4.7412	5.5402	5.5512	5.7027	6.2012	6.2095	6.9533	6.8026	70.0607		Flow type	R	23.3851	23.2196	23.4560	70.0607	Gas rate 1		0	7°6	11.1	13.51	
Rates		8	-1	5	10	-	N	2	2	30	-1 01	Total		(c)	Gas Rate	0	el	2	Total	(P)	Liquid Rate		0		N2 (PM	P.A.S

# V.Derivation of Equations

- (4)  $k_{\rm L} = 0.0203 \, 10.745$
- (5)  $k_{1.8} = 0.0655 L^{0.85}$

<u>Selection of data</u>. All data from REseries were used to derive equation (5), but data from FC series were examined carefully, because the analytical result (Table 1) showed the significance of variation due to replicate in FC series. There are two possibilities; (a) the experiment is irreproducible in the disc column, or (b) some unnoticed error has been introduced in either of the two replicates.

Though the performance in different disc columns may give different results (2.0), it is not plausible that the experiment is irreproducible in the same column. The changable de-wotting phenomenon will definitely increase the experimental error to a considerable degree, but it will not introduce any systematical error. Therefore, the irreproducibility of the experiment will not be considered.

The detail of experimental procedure was exactly the same for both replicates. The HCl solution used belonged to the same batch and was analyzed from time to time for check. The only difference between the replicates was the MaOH solution used. In replicate 1 a batch of MaOH solution of concentration 0.0465M was used, and in replicate 2 another batch of 0.0510W was used. Two samples of HaOH solution were determined for effective concentration for each batch, and one obeck was made during the experiment (For QD and RE series, the concentration of  $GO_2$  in inlet water and the effective concentration of MaOH were checked every six runs. The three series were performed in the order of PC, QD and RE.). Thus the concentration determination would not be the source of error. Since the record did not show any perceivable mistake, a comparison of data from replicate 1 and 2 of PC series with those from QD series was made.

The total of 164 k<sub>L</sub> data for the disc column were separated into three groups, FC-1 (for rep. 1), FC-2 and QD. Every observation was compared with the mean value of the observations that belonged to the same group and had the same liquid rate (ignoring the flow type and gas rate difference). If that observation had a deviation more than 20 percent from the mean, it was discarded. The rejected observations were F10-1B, F12-2B, F20-1B, P20-2B, F22-2A, G02-1B, G20-1B, G21-1A, G10-1A, G01-2A, G21-2A, G6-3A and B, D6-3A and B, a total number of 15 observations. The resulting means after these observations were rejected, were plotted on Flate |X. It is obvious from the plot that data from FC-1 are consistent with those from QD, while data from FC-2 give higher k<sub>L</sub> values. Therefore, all data from FC-2 were not used in correlation. <u>Derivation</u>. Least square method (same as that used in linear regression determination) was used in derivation. The procedure can be found in Snedecor's Statistical Methods p.138.

The sample standard deviation from the resulting function (regression) can be evaluated by:

$$S_{y,x} = \sqrt{\frac{1}{n-2} \left( \Sigma_y^2 - b \Sigma_{xy} \right)}$$

where n is the number of data used, b is the slope (coefficient of regression), y and xy are deviation of I (dependent variable) and XI (independent variable times I) of a single point with the means. Since  $S_{y,x}$  is expressed in the logarithmic scale, we must change it back to unit related to  $k_{L}$ , e.g. a 0.02 unit of  $S_{y,x}$  has an anti-logarithm of 1.047. It means that the standard deviation is 4.7 percent.

Data beyond 95 percent confidence limits were rejected. For the disc

# EXPLANATION OF PLATE IX

Mean value of kr vs. Plot for series PC-1, PC-2, and QD

kr -- 11quid-film coefficient, lb./(hr.-sq.ft.)(lb./ou.ft.)

7 --- wetting rate (liguid rate per mean wetting perimeter of disc), lb./hr.ft.

PG-1 --- replicate 1 of PC series

PG-2 --- replicate 2 of PC series

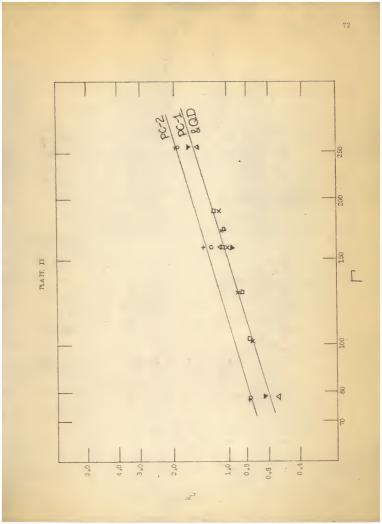
△ date from PC-1 for co-current flow

t --- data from PC-2 for co-current flow

× ---- data from QD for co-current flow

data from FO-1 for countercurrent flow
 ---- data from FO-2 for countercurrent flow

D ---- date from QD for countercurrent flow



column there were 20, and for the packed column 8. The remaining data were used to recalculate the equation of least deviation. The resulting equations were further transferred to that for 20°G by use of equation (3).

The final equation for the disc column, based on PC-1 and QD, is:

$$k_{r} = 0.0203 \, [^{-0.745}$$
 (4)

and for the packed column is:

$$k_{ra} = 0.0655 \perp^{0.85}$$
 (5)

and for the disc column based on PG-2 is:

$$k_{\rm T} = 0.0304 \ \Gamma^{0.738}$$
 (18)

The last equation given is for comparison only. Equation (4.) is the sole one that is considered as the result  $\overline{c}$  the present experiment for the disc column, and used anywhere for interpretation and correlation. The fact that the two lines expressed by equations (4) and (13) are parallel indicated that the experimental error associated with  $k_{\underline{L}}$  is in simple multiple form (cf. p.||). Therefore use of logarithmic transformation is justified.

# VI. Derivation of Equations (8) and (9)

Equations (8) and (9) are of the general forms for the disc column and packed column respectively. They are easy to obtain by comparing the equations (8) and (9) with the generalized equation (6) and (7) together with the following data:

$$D = 7.0 \times 10^{-5} \text{ ft}^2/\text{hr.},$$
 (17)

# VII. Equations for Cl2-H20 System in the Disc Column

Equation predicted from the result of this investigation. From the generalized equation (6),  $k_L$  is proportional to  $D^{0.5}$ . The equation for  $CO_2-H_2O$  system is:

$$k_{T} = 0.0203 \Gamma^{0.745}$$

and the diffusivity of  $Cl_2$  in vater is 5.4 x 10<sup>-5</sup> ft<sup>2</sup>/hr. (19). Therefore, the equation for  $Cl_2-H_2O$  will be:

$$k = 0.0178 h^{0.745}$$

Equation predicted by use of Chu's equation. Chu's (1) equation for  $CO_{q}$ -H<sub>2</sub>O system in the same disc column is:

kL= 0.0383 0.644

and the resulting equation for Cl2-H20 system is:

kr = 0.0338 1.0.644

(19)

Some particular points on lines predicted by the equations (12) and (19).

For equation (19):

Г	Г <sup>0.644</sup>	kī
150	25.1	0.848
200	30.3	1.03
300	39.3	1.33
400	47.5	1.61

For equation (12):

Г	M 0.745-	kL		
150	42.0	0.748		
200	50.5	0.897		
300	70.0	1.240		
400	87.0	1.545		

## VIII. Gas-Film Coefficient of Ammonia-water System in the Disc Column

# Equations.

# (a) Predicted equation for liquid-film coefficient:

The diffusivity of NH<sub>3</sub> in water is given as  $7.9 \ge 10^{-5}$  ft.<sup>2</sup>/hr. (19). The equation for  $CO_2$ -H<sub>2</sub>O system in the disc column was suggested by the present paper as:

$$k_{L} = 0.0203 \cap 0.745$$

and so the resulting equation for NH3-H20 system will be (cf. Appendix VII):  $k_L^{}=0.0216\,|^{10}.745 \tag{20}$ 

(b) Relation between overall and film coefficients is:

$$\frac{1}{k_{\rm G}} = \frac{1}{k_{\rm G}} - \frac{\rm H}{k_{\rm L}} \tag{21}$$

as given in any absorption book. The Henry constant H for ammonia in water at 20°C is taken as 0.013 atm./(lb. of NH<sub>2</sub>/cu.ft. of H<sub>2</sub>0), which was evaluated by Hwu (9) from Kowalke's equation.

(c) k, vs. relative velocity:

Through Hwu's experimental result showed that the relation between  $k_{g}$  and relative velocity in the disc column could be represented by  $k_{g} \simeq v^{0.65}$ , the following conventional relation was used:

which has been verified by Stephens and Morris, and also by Taylor and Roberts in four different disc columns (19) (20).

# Experimental Data.

The NH<sub>3</sub> absorption experiment in the disc column was performed by Huu (9). Data at six different liquid rates with nearly equal interval were taken for the present correlation. These data and the corresponding  $k_{\rm g}$  values calculated with equations (20) (21) and (22) are listed in the following table:

						2			
	m :	Liquid rate	:	Relative	2	K <sub>G</sub> at 20°C lb.	1	kg	
	:1	b./hr.ft	. :	ft./sec.	:	hr.sq.ft.atm.	:	At v	5.84 It./sec.
2		220		4.82		9.55		10.6	12.1
3		360		5.34		12.2		13.4	14.2
5		185		4.69		8.91		10.0	11.6
7		255		4.97		10.57		11.8	13.2
10		300		5.33		11.6		12.9	13.7
13		395		5.65		13.02		14.3	14.6

Table 11. Absorption data of NH\_-H\_O system

The first four columns were taken from Table 3 of Hwu's thesis (9). The last two columns were calculated with equations (20)(21) and (22).

With the data given above we can derive an equation of kg vs. through the same procedure as described in Appendix V. The resulting Equation is:

$$k_{\rm G} = 3.06 \, |^{0.30}$$
 (23)

In order to compare with other investigator's results, we transform

equation (23) to satisfy the condition of relative velocity equal to

8.4 ft./sec. Thus the fanal equation becomes:

At two particular points,	∏ = 155 lb./hr.ft.	k <sub>G</sub> = 17.7 lb./(hr. ft?atm.)
	/1 = 400 lb./hr.ft.	kg = 23.6 lb./(hr.ft <sup>2</sup> .atm.)

GAS ABSORPTION IN CO\_CURRENT FLOW

by

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B. S., National Taiwan University, China, 1954

AN ABSTRACT OF A MASTER'S THESIS

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#### ABSTRACT

The purpose of this investigation was to study the effect of flow type on liquid film coefficient in gas absorption. Experiments under both countercurrent flow and co-current flow were carried out, and their results were compared. Experimental data of some previous workers were also recorrelated.

CO<sub>2</sub>-H<sub>2</sub>O system was chosen for this study. Apparatus used were 1-1/2 inch disc column with 35 pieces of 1.5 mm diameter I 0.48 th<sup>1</sup>k ceramic discs, and a 2 inch packed column with 3 mm packings. The experiments were designed and their results were analyzed statistically. The liquid rate covered a range from 10.0 lb./hr. to 52.6 lb./hr., and gas rate covered a range from 1.55 cu.ft./hr. to 10.6 cu.ft./hr.

From the secults of this investigation the following conclusions were reached:

(1) Flow type has no effect on magnitude of liquid film coefficient within the range of study.

(2) Results obtained from disc column will generally wary from column to column.

(3) Data of CO<sub>2</sub>-H<sub>2</sub>O system for the columns used in this investigation can be correlated by the following equations:

> for the disc column  $k_L = 0.0203 |^{0.745}$  at 20°C, for the packed column  $k_{La} = 0.0655 L^{0.85}$  at 20°C.

(4) A general equation for liquid film coefficient in the disc column can be obtained from the present results. It is expressed as:

$$\frac{k_{\rm L}}{D} = 7.44 \left(\frac{4\pi}{\mu}\right)^{0.745} \left(\frac{\mu}{\rm p}\right)^{0.5}$$

This equation was verified with experimental data of  $Gl_2-H_2O$  system obtained by the previous investigators.

(5) Gas film coefficient in the disc column can be predicted with considerable accuracy with the following equation:

 $\frac{k_GP}{\sqrt{r_4}} = 0.0326 \, p^{0.30} \times (\frac{\sqrt{d}r}{\sqrt{r}})^{-0.33} \left(\frac{M}{\ell D}\right)^{-0.56} \frac{P}{\frac{P}{PBM}}$  which was obtained from the results of this investigation and that of another investigator.