# ORIFICE DISCHARGE COEFFICIENTS FOR

CARBOXYMETHYLCELLULOSE SOLUTIONS

Ву

KOHEI ISHIHARA Bachelor of Science Kyoto University Kyoto, Japan

1965

Submitted to the faculty of the Graduate College of the Oklahoma State University in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE May, 1967

OKLAHOMA STATE UNIVERSITY LIBRARY

UAN 10 1968

ORIFICE DISCHARGE COEFFICIENTS FOR

CARBOXYMETHYLCELLULOSE SOLUTIONS

Thesis Approved:

Sell Thesis Adviser Graduate College Dean of the

#### PREFACE

The discharge coefficients of sharp-edged orifices obtained in this work for carboxymethylcellulose water solutions (CMC) were correlated using the generalized Reynolds number derived by Metzner and Reed for pseudoplastic fluids. The discharge coefficients are compared with the data obtained by previous workers for Newtonian fluids. Also included is a discussion of static pressure distribution of pseudoplastic fluid flowing through the orifices.

I received aid from a number of people during the course of this project. I am indebted to Dr. Kenneth J. Bell, my adviser, for his aid and suggestions in relation to my study in this graduate school as well as to my thesis work. Mr. Don Adams gave many helpful suggestions and aid in the entire course of my study. Messrs. Gene E. McCroskey, Arlin Harris, and Preston Wilson were very helpful in the construction of the apparatus. I wish to express gratitude to Mrs. Don Adams who typed this thesis.

I am indebted to Oklahoma State University, which provided me with an institutional assistantship, and the Monsanto Chemical Company, which provided financial support for the experimental facilities.

iii

### TABLE OF CONTENTS

Chapte	r	Pa	ıge
I.	INTRODUCTION	•	1 🗸
II.	LITERATURE SURVEY	٥	2 🗸
	Fluid Flow Through an Orifice Aperture Orifice Discharge Coefficients for Newtonian Fluids	•	2 6 10 11 12
III.	EXPERIMENTAL APPARATUS	8	13
	General Arrangement	٥ •	13 15
IV.	EXPERIMENTAL PROCEDURE	٠	19
	Operation	•	19 19
v.	REPRESENTATION AND DISCUSSION OF RESULTS	•	20
	Orifice Discharge Coefficient	•	20 22
VI.	CONCLUSIONS AND RECOMMENDATIONS	•	29
	Conclusions	ė 4	29 29
A SELE	CTED BIBLIOGRAPHY	•	32
APPEND	IX A. NOMENCLATURE	•	33
APPEN D	IX B. EXPERIMENTAL AND CALCULATED DATA	•	35

### LIST OF TABLES

Table	Page
I.	Experimental and Calculated Data for Discharge Coefficients
II.	Viscosity Data Analysis and Specific Gravity 48-53
III.	Comparison of Coefficients at Like Reynolds Numbers in Dissimilar Conditions
IV。	Impact Pressure Data

### LIST OF ILLUSTRATIONS

Figure		Page
1.	Schematic Diagram Showing Static Pressure Distribution Along a Pipeline in the Vicinity of an Orifice Plate	3
2.	Impact Pressure in Percent of the Differential Pressure Measured Between Upstream Tapping Points A and aSee Figure 1	4
З,	Orifice Discharge Coefficients for Newtonian Fluids (G. L. Tuve and R. E. Sprenkle (2))	8
4.	Flow System	14
5.	Orifice Assembly	16
6.	Orifice Plates	18
7.	Orifice Discharge Coefficients Vs. Reynolds Number (Corner Connections)	21
8(a).	Static Pressure Distribution in the Vicinity of the Orifices for $\beta$ = 0.6 and 0.7% CMC	23
8(b).	Static Pressure Distribution in the Vicinity of the Orifices for $\beta$ = 0.2 and 0.7% CMC	24
8(c).	Static Pressure Distribution in the Vicinity of the Orifices for $\beta$ = 0.8 and 1.5% CMC	25
8(d).	Static Pressure Distribution in the Vicinity of the Orifices for $\beta$ = 0.6 and 1.5% CMC	26
8(e).	Static Pressure Distribution in the Vicinity of the Orifices for $\beta = 0.2$ and 1.5% CMC	27
9.	Composite Curves of Orifice Discharge Coefficients (Corner Connections)	30

#### CHAPTER I

#### INTRODUCTION

Because of its convenience and simplicity, an orifice meter is a commonly used device for flow rate measurement of fluids in pipe lines of chemical plants.

No data have been represented in papers concerning orifice discharge coefficients for non-Newtonian fluids; whereas for Newtonian fluids, complete studies have been presented in an ASME report on fluid meters (1) and by Tuve and Sprenkle (2) thirty years ago.

Obtaining experimental data and correlating it in applicable form are required for reliable guidance in the design of orifice meters for non-Newtonian fluids.

The following goals were set for this project:

- 1. Design, construct, and operate apparatus to obtain the orifice discharge coefficients and pressure drops between various taps with three different orifice apertures ( $\beta = 0.8$ , 0.6, and 0.2) and two fluid concentrations (0.7 percent and 1.5 percent CMC in water).
- Correlate these data as a function of flow rate, orifice dimensions, and the physical and rheological properties of non-Newtonian fluids.

l

#### CHAPTER II

### LITERATURE SURVEY

#### Fluid Flow Through an Orifice Aperture

Figure 1 illustrates diagrammatically the static pressure distribution in the vicinity of a typical sharp-edged orifice in a pipe.

It has been observed that there is a considerable and sharp increase in the static pressure, termed the impact pressure, which is usually one to twenty percent of differential pressure, immediately upstream of the orifice plate due to the change in the direction of the streamlines (4). The vena contracta is the point of minimum static pressure and minimum cross-sectional area of the jet of fluid after it emerges from the orifice. The jet enters the relatively stagnant fluid behind the orifice plate; and, as the jet expands to fill the pipe downstream from the vena contracta, it entrains some of the surrounding fluid.

Most of the overall energy loss in the orifice arises from the viscous interaction and accompanying eddy formation downstream from the orifice.

Engel and Davies (5) have theoretically calculated the impact pressure based on the Bakhmeteff and Prandtl power law velocity profile and obtained remarkably good agreement with experimental results for  $Re > 10^4$  (see Figure 2).



Figure 1. Schematic Diagram Showing Static Pressure Distribution Along a Pipeline in the Vicinity of an Orifice Plate

> Connection A-B: Vena Contracta Tapping a-b: Corner Tapping



Figure 2. Impact Pressure in Percent of the Differential Pressure Measured Between Upstream Tapping Points A and a--See Figure 1

The jet contraction is thoroughly investigated in the ASME report on fluid meters (1); and it has been found that the amount of contraction depends primarily upon the diameter ratio,  $\beta$ , and the fluid properties:

- 1. The ratio of the jet area at the vena contracta to the area of the orifice decreases as  $\beta$  decreases.
- The jet contraction decreases as the viscosity of the fluid increases.

These results would be expected because:

- 1. As the fluid particles near the wall of the channel converge toward the orifice, they attain greater radial velocity inward when  $\beta$  is small than when  $\beta$  is large.
- 2. As the viscosity increases, the effect of friction of the fluid against the surface of the channel extends farther toward the center; and the radial velocity of the streamlines from near the wall is small in proportion to the axial velocity of the streamlines at the center, thus making the vena contracta larger.

In this work, three inlet and six outlet pressure taps were used in order to study the points of minimum and maximum static pressure on the downstream side of the orifice as well as the magnitude of maximum static pressure on the upstream side. Connections between one upstream tap and each of six downstream taps gave the static pressure distribution along the pipe. The impact pressure could be measured as the pressure difference between the upstream corner tap and another tap on the same side (see Figure 5 and Table IV).

#### Orifice Discharge Coefficients for

### Newtonian Fluids

The general orifice discharge coefficient for incompressible fluids is derived from the extended Bernoulli equation or mechanical energy balance over an orifice between arbitrary positions 1 and 2 (see Figure 1):

$$\frac{u_2^2 - u_1^2}{2g_c} + \frac{P_2 - P_1}{\rho} + l_w = 0$$
 (1)

Assuming that the energy loss  $\ell_W$  from 1 to 2 is represented by some multiple of the pressure drop  $(P_2 - P_1)/\rho$  and substituting  $\ell_W = (C_v^2 - 1) (P_2 - P_1)/\rho$ , Equation 1 is then written

$$C_v^2 \frac{P_2 - P_1}{\rho} + \frac{u_2^2 - u_1^2}{2 g_c} = 0$$
 (2)

In order to eliminate the practical difficulty of evaluating the unknown velocity term  $u_2$ , the downstream velocity is more conveniently taken as the velocity through the orifice itself,  $u_0^{\circ}$ . To compensate the error thus introduced, a discharge coefficient,  $C_0$ , is defined by

$$C_{o}^{2} \frac{P_{2} - P_{1}}{\rho} + \frac{u_{o}^{2} - u_{1}^{2}}{2 g_{c}} = 0$$
(3)

Substitution of  $\beta = D_0/D$ ,  $\Delta P = P_2 - P_1$ , and  $u_0 D_0^2 = u_1 D^2$  gives the general discharge coefficient:

$$C_{o} = \frac{u_{o}}{\sqrt{\frac{2 g_{c} (\Delta P / \rho)}{(1 - \beta^{4})}}}$$
(4)

The discharge coefficient thus defined would also include various other effects, such as velocity profile effect, boundary layer effect, and roughness effect in the orifice itself.

The numerical values of  $C_0$  for sharp-edged orifices for Newtonian fluids with corner taps (see Figure 1) have been empirically determined by Tuve and Sprenkle (2) as a function of  $\beta$  and the orifice Reynolds number,

$$\operatorname{Re}_{o} = \frac{D_{o} u_{o} \rho}{\mu}, \qquad (5)$$

ranging from 4 to  $10^5$  (see Figure 3). The value of C<sub>o</sub> depends on the location of the pressure taps.

The orifice discharge coefficients with flange taps, vena contracta taps, and pipe taps are thoroughly investigated and tabulated over a large range of Reynolds numbers defined by Equation 5, extending to  $Re_{-}=10^{7}$  in Reference 1.

The ASME report states:

Some investigators have represented the ratio of minimum jet area to the orifice area by a separate factor, that is, the contraction coefficient  $C_c$ . Doing this, however, is of no practical advantage and including the effects of contraction in the orifice discharge coefficient is more convenient.

However, it is clear that separate treatment of  $C_c$  from  $C_o$  would be a vital step for theoretical analysis of discharge characteristics.

Von Mises (6) has estimated the discharge coefficient from theory with some success. Taking the position 2 in Figure 1 at the vena contracta and the position 1 at one pipe diameter upstream and substituting a coefficient of contraction of the jet.

$$C_{c} = \frac{A_{2}}{A_{o}}$$
 (6)



Figure 3. Orifice Discharge Coefficients for Newtonian Fluids (G. L. Tuve and R. E. Sprenkle (2))

and  $u_1 = \beta^2 u_0$  into Equation 2 and Equation 3 gives

$$\frac{P_2 - P_1}{\rho} = -\frac{1}{C_v^2} \left( \frac{1}{C_c^2} - \beta^4 \right) \frac{u_o^2}{2 g_c}$$
(7)

and

$$\frac{P_2 - P_1}{\rho} = -\frac{1}{C_0^2} (1 - \beta^4) \frac{u_0^2}{2g_c} , \qquad (8)$$

respectively. By equating Equations 7 and 8 and rearranging, it yields

$$C_{o} = C_{v} C_{c} \sqrt{\frac{1 - \beta^{4}}{1 - C_{c}^{2} \beta^{4}}}$$
 (9)

Vos Mises has calculated the value of  $C_c$  from the theory of ideal fluids of two dimensional jets with a flat velocity profile flowing into a fluid of much lower density. This gives a good estimation of  $C_c$  for a sharp-edged orifice, which is substituted into Equation 9 with an appropriate value of  $C_v$  (usually taken to be 0.98) with various values of  $\beta$  to give good agreement with the empirical value of 0.61 for  $Re_o > 50,000$ .

Equation 9 is not valid for lower Reynolds numbers, for which C<sub>o</sub> should include a correlation for the upstream velocity distribution and perhaps viscous dissipation effects.

All of these orifice discharge coefficients discussed above are obtained for Newtonian fluids and correlated to a Reynolds number defined as in Equation 5. Equation 5 is not valid for non-Newtonian fluids due to the difference in viscosity arising from changing shear rates through an orifice and across the stream as compared to the constant viscosity of Newtonian fluids. A more general Reynolds number definition is required to correlate discharge coefficients for non-Newtonian fluids.

#### Non-Newtonian Pseudoplastic Fluids

It has been found experimentally (3) that the shear curve for this type of fluid passes through the origin on a shear stress-shear rate plot, and its slope decreases with increasing shear rate, tending to become linear at very high shear rates. The relationship between shear rate and shear stress for pseudoplastic fluids may be represented closely over wide ranges of shear rate (tenfold to thousandfold) by a two constant power function of the form

$$\tau = K \left(\frac{du}{dy}\right)^n \tag{10}$$

The constant, n, characterizes the degree of non-Newtonian behavior; n is less than unity for pseudoplastic fluids, and the further n deviates from unity, the more the fluid behavior deviated from Newtonian fluid behavior. The companion parameter, K, is a physical property of a fluid and is called the consistency index. While two fluids might exhibit the same flow behavior index, n, the more viscous fluid would have the larger consistency index.

It has been reported (10) that CMC-water solutions exhibit slightly viscoelastic behavior at the higher concentrations. It will be appropriate to apply the power law equation for CMC-water solutions used in this study, most of which fall in the category of low concentration.

### Reynolds Number for Non-Newtonian

### Pseudoplastic Fluids

Metzner and Reed (3) have presented a generalized form of the Reynolds number to be applied to non-Newtonian pseudoplastic fluids. Their argument is as follows:

Rabinowitsch and Mooney (9) have developed an expression for the rate of shear at the wall of a tube for a time-independent fluid in laminar flow:

$$\left(\frac{du}{dy}\right)_{W} = 3 \left(\frac{8Q}{\pi D^{3}}\right) + \frac{D\Delta P}{4L} \frac{d \left(\frac{8Q}{\pi D^{3}}\right)}{d \left(\frac{D\Delta P}{4L}\right)}$$
(11)

Integration of Equation 11 and substitution of  $u = 4Q/\pi D^2$  and

$$n' = \frac{d \ln (D\Delta P/4L)}{d \ln (8V/D)}$$

gives

$$\frac{D\Delta P}{4L} = K^{\circ} \left(\frac{8u}{D}\right)^{n^{\circ}}$$
(12)

where n' is the flow behavior index and K' is the consistency index; these must not be confused with the n and K of Equation 10. Equation 10 and Equation 12 can be related under the generally acceptable assumption that n' and K' are constant;

$$n' = n$$
 (13)

$$K^{\circ} = K \left(\frac{3n+1}{4n}\right)^{n}$$
 (14)

Metzner then substituted Equation 12 into the Fanning friction

factor equation

$$f = \left(\frac{D\Delta P}{4L}\right) / \frac{u^2 \rho}{2 g_c}$$
(15)

Comparing this to f = 16/Re for the fully developed laminar flow region for a Newtonian fluid gives the following generalized Reynolds number:

$$Re = \frac{D^{n'} u^{2-n'} \rho}{\gamma}$$
(16)

$$\gamma = g_c \; K^* \; 8^{n'-1} \tag{17}$$

# Orifice Discharge Coefficients for Non-Newtonian Fluids

No data are available in the literature relative to orifice discharge characteristics for non-Newtonian fluids.

The discharge coefficient for corner connections was measured in this work for comparison with the data by other investigators for Newtonian fluids with the corner connections. This coefficient includes the effects of orifice configuration, flow conditions, and varying apparent viscosities of non-Newtonian fluids due to varying shear stress. These effects are much less considerable for the corner tapping than for other tappings.

It was hoped that the relationship between orifice discharge coefficient for Newtonian fluids and orifice Reynolds number might be valid for non-Newtonian fluids with the non-Newtonian behavior being accounted for in the generalized Reynolds number.

#### CHAPTER III

### EXPERIMENTAL APPARATUS

#### General Arrangement

The fluid being circulated was pumped from a holding barrel into a two-inch Schedule 40 pipe where it flowed through a ten-foot long approach section pipe, then through an orifice plate, and back into the holding barrel (see Figure 4).

All data were obtained by means of the calibration tank system shown in Figure 4 which has a marked scale inside indicating the volume of ten liters between upper and lower marks. A Moyno 1L6, type CDQ, positive displacement pump was used for circulating the liquid. A variable speed drive attached to the electric motor of three horse power was used to control the flow rate. The 250-foot long, 1/2-inch 0.D. copper coil connected to both the steam line and the water supply pipe was placed inside the holding barrel for liquid temperature control. The pipe containing the orifice assembly was straight for 10 feet (L/D = 80) on the upstream side and 22.5 inches (L/D = 14) on the downstream side, both longer than standard requirements to eliminate entrance and outlet effects.

Three manometers of 30 inches, 60 inches, and 60 inches length, containing carbon tetrachloride, tetrabromoethane, and mercury, respectively, were used to measure the differential pressures for low, medium,



Figure 4. Flow System

and high flow rates, respectively. The manometers were connected to the orifice assembly which had three upstream and six downstream pressure taps with 1/4-inch copper tubing. Copper-constantan thermocouples were used to measure the bulk fluid temperature one foot downstream of the orifice plate. The manometer fluid temperatures were measured by the copper-constantan thermocouples placed in the two water displacement bombs. In order to obtain the quick response of manometer readings to the differential pressure and prevent CMC from entering manometer system, water displacement bombs filled with 1/2 gallon of water were placed between the manometer system and the orifice assembly so that the manometer fluids always contacted water; and most of the small diameter tubing was filled with water. A selector switch was used to select the proper thermocouple. Thermocouple output was measured on a portable Leeds and Northrup potentiometer. Standard tables were used to obtain the temperature from the potentiometer readings.

### Orifice Assembly

The orifice test section shown in Figure 5 was of 2-inch Schedule 40 pipe with welded flanges and so arranged so that it could be taken apart readily for changing orifices. The pressure taps on the inlet side, three in number, were 3/32-inch diameter holes capped with 1/8inch to 1/4-inch brass tube fittings welded on the pipe wall arranged in line: (1) on the flange face, (2) 0.5D, and (3) 1.0D upstream from the orifice plate along the pipe. The outlet pressure connections are the same as the inlet side connections in dimensions and arranged in line with the intervals shown in Figure 5.

The orifice plates were 0.0625-inch thick; and orifice diameters



Figure 5. Orifice Assembly

.

+ t





### CHAPTER IV

#### EXPERIMENTAL PROCEDURE

#### Operation

Ample time (from 30 to 60 minutes) was allowed before taking data on each run to insure steady state. Tests made under conditions which varied in the course of the test were rejected. The pump was operated at constant speed during a run. The flow rate was controlled by the variable speed drive attached to the electric motor. The bypass valve was not used to obtain the lower flow rate because of unstable flow rates and manometer readings. Special precautions were taken against air entrainment in the manometer system and in the test fluid.

### Observations

The orifice pressure drop for any connection was recorded three times in the time interval of 2 to 10 minutes to insure steady state. Discharge was measured by a Swiss-made precision stopwatch as the time necessary for 10 liters of liquid to flow into the calibration tank. Several of the time measurements were made to average the flow rate. Temperatures in the line were read every six minutes, and manometer temperatures were obtained several times in each run. Fluid viscosities were determined by a Fann V-G model 35 viscometer, and specific gravities were determined by a Fisher precision hydrometer.

#### CHAPTER V

### REPRESENTATION AND DISCUSSION OF RESULTS

### Orifice Discharge Coefficient

The orifice discharge coefficients were calculated using the general definition of Equation 4. The mean velocities through the orifice plates and pressure drops were calculated from volume flow rate and manometer readings, respectively. The orifice Reynolds numbers were calculated using Equation 16. The calculations were executed by an IBM 7040 computer. The results are tabulated in Table I, Appendix B.

Orifice coefficient versus Reynolds number curves obtained with corner connections are shown in Figure 7 for three different diameter ratios and two CMC concentrations. These are compared to the results obtained by Tuve and Sprenkle for Newtonian fluids. The discrepancies between coefficients at the same Reynolds number in different manometer fluids are a measure of experimental error in the manometer readings.

The following are found from this figure:

1. The discharge coefficients in this work, on the average, are lower than those of Tuve and Sprenkle. This would indicate that pseudoplastic fluids create more pressure drop through the orifice than Newtonian fluids do for the same Metzner and Reed Reynolds number because of their physical and rheological



Figure 7. Orifice Discharge Coefficient Vs. Reynolds Number (Corner Connections)

properties.

- 2. The trends of the correlation curves of orifice coefficients versus generalized Reynolds number for pseudoplastic fluids agree with those for Newtonian fluids very well, especially for the smaller diameter ratios.
- 3. Agreement of orifice coefficients obtained with different fluids, but at like Reynolds number, tends to support the validity of the generalized Reynolds number as the abscissa to the orifice discharge coefficients for non-Newtonian fluids (see Table III, Appendix B).

### Flow Pattern Around the Orifice Plate

The differential pressures between the upstream corner tap and six downstream taps are shown in Figure 8(a), (b), (c), (d), and (e) as a function of downstream tap locations for various Reynolds numbers. The criterion of vena contracta position in the following discussion is the point of minimum static pressure and presumably minimum cross-sectional area of the jet of fluid after it emerges from the orifice aperture (see Figure 1).

The following are found in these figures:

- No large jet contraction appears to exist over the range of Reynolds numbers observed in this work.
- 2. The vena contracta tends to appear to be further downstream from the orifice plate for larger Reynolds numbers or for fluids of lower consistency.
- 3. For Re<sub>o</sub> < 900, the vena contracta appears to be at the orifice plate regardless of orifice diameter or fluid consistency.



Figure 8(a). Static Pressure Distribution in the Vicinity of the Orifices for  $\beta = 0.6$  and 0.7% CMC



Figure 8(b). Static Pressure Distribution in the Vicinity of the Orifices for  $\beta = 0.2$  and 0.7% CMC



Figure 8(c). Static Pressure Distribution in the Vicinity of the Orifices for  $\beta = 0.8$  and 1.5% CMC



Figure 8(d). Static Pressure Distribution in the Vicinity of the Orifices for  $\beta = 0.6$  and 1.5% CMC



Figure 8(e). Static Pressure Distribution in the Vicinity of the Orifices for  $\beta = 0.2$  and 1.5% CMC

\* Concentration is more than 1.5%.

These results would be expected because:

- 1. Over the laminar and transitional regimes in this work, radial viscous momentum transport is sufficient to suppress the jet and minimize distinctive jet contraction.
- 2. As the Reynolds number increases and the consistency decreases, the axial momentum transport becomes predominant over radial transport, due to viscous shear and eddy motion, and makes the jet expand less rapidly.
- 3. For Re<sub>o</sub> < 900, the jet which emerges from the orifice aperture tends to creep along the channel wall due to predominant viscous shear compared to smaller inertial terms.

Another important factor related to contraction phenomena is impact pressure. Observed impact pressures are tabulated in Table III, Appendix B, and it was found that:

- Maximum impact pressure does not necessarily occur at the upstream corner of the orifice plate.
- 2. Impact pressure does not show a significant correlation with Reynolds number.

These discrepancies may be attributed to the indicated method of measuring the impact pressure as described on page 5 and in Table III, Appendix B.

### CHAPTER VI

### CONCLUSIONS AND RECOMMENDATIONS

#### Conclusions

The general conclusions from this study are briefly as follows:

- 1. Orifice coefficients for the entire range of laminar and critical flows (Re = 20-4,000) may be correlated satisfactorily (within \*6 percent) on the basis of the Metzner and Reed Reynolds numbers, as shown in the composite curves of Figure 9.
- 2. Tuve and Sprenkle's orifice coefficient versus Reynolds number curves for β less than 0.6 for Newtonian fluids may be used for approximate design purposes for non-Newtonian pseudoplastic fluids using the Metzner and Reed Reynolds number.
- 3. A orifice with a diameter ratio of 0.6 is recommended for commercial use because of relatively stable performance and & absence of large pressure loss.
- 4. The flow structure in the vicinity of the orifice plate for pseudoplastic fluids is similar to that for Newtonian fluids.

### Recommendations

The following are recommended:

1. Try to develop a theoretical approach for prediction of



Figure 9. Composite Curves of Orifice Discharge Coefficients (Corner Connections)

discharge characteristics of orifices for non-Newtonian fluids.

- 2. Try to develop orifice discharge coefficient for viscoelastic fluid by means of theoretical and experimental approaches.
- 3. Visual study of the flow of non-Newtonian fluids through an orifice should be carried out using transparent pipe and orifice assembly so that the contraction stagnation phenomena in the vicinity of the orifice will be better understood.
- 4. Detailed investigation of the velocity distribution across the upstream as well as the jets issuing from the orifice aperture should be executed by inserting a transverse pitot tube.
- 5. Finally, other types of orifice plates should be studied for commercial use, such as a quarter-circle edged orifice which yields much less permanent pressure loss than the sharp-edged type and gives a constant orifice coefficient over a large range of Reynolds numbers.

₩

#### A SELECTED BIBLIOGRAPHY

- 1. American Society of Mechanical Engineers. Fluid Meters: Their Theory and Application. New York, 1937.
- 2. Tuve, G. L. and R. E. Sprenkle. "Orifice Discharge Coefficient for Viscous Liquids." Instruments. Volume 6. (1955) 210.
- 3. Metzner, A. B. and J. C. Reed. "Flow of Non-Newtonian Fluids--Correlation of the Laminar, Transition, and Turbulent Flow Region." A.I.Ch.E. Journal. Volume I. (1955) 434.
- 4. Engel, F. V. A. and W. Stainby. "Discharge Coefficient Characteristics of Orifices." <u>The Engineer (London)</u>. Volume 218. (1964) 161.
- 5. Engel, F. V. A. and A. J. Davies. "Velocity Profiles and Flow of Fluids Through a Contracted Pipe Line." <u>The Engineer (London)</u>. Volume 166. (1938) 720.
- 6. Von Mises, R. Z. Deut. Ing. Volume 61. (1917) 447-451, 469-473, 493-497.
- 7. Rouse, H. and J. W. Howe. Basic Mechanics of Fluids. New York: John Wiley and Sons, 1953, p. 49.
- 8. Wilkinson, W. L. <u>Non-Newtonian Fluids</u>. New York: Pergamon Press, 1960, Chapter I.
- 9. Rabinowithsch, B. "Über die Viskösität und Elastizität von Solew." Z. Physik Chem. Volume I. (1929) 145A.
- 10. Christiansen, E. B. and S. E. Craig, Jr. "Heat Transfer to Pseudoplastic Fluids in Laminar Flow." <u>A.I.Ch.E. Journal</u>. (1962) 154.

#### APPENDIX A

#### NOMENCLATURE

- $A_{o}$  Cross-sectional area of orifice aperture, ft.<sup>2</sup> A, - Cross-sectional area of main pipe, ft.<sup>2</sup>  $A_2$  - Cross-sectional area of flow at vena contracta, ft<sup>2</sup> C<sub>o</sub> - Orifice discharge coefficient  $C_c$  - Coefficient of contraction C<sub>v</sub> - Discharge coefficient for some point of orifice D<sub>0</sub> - Diameter of orifice aperture, ft. f - Fanning's friction factor  $g_c$  - Conversion factor, 32.17,  $lb_{m}$ -ft./lb.f-sec.<sup>2</sup> K' - Consistency index for the generalized equation,  $lb_{f}$ -sec.<sup>n'</sup>/ft.<sup>2</sup> K - Consistency index for pseudoplastic fluids behavior expression, lb.\_-sec.<sup>n</sup>/ft.<sup>2</sup> L - Tube length, ft.  $l_w$  - Energy loss of flow,  $lb_{\circ f}$ -ft./sec.<sup>2</sup>-ft.<sup>3</sup> P - Pressure, lb.f/ft.<sup>2</sup> Q - Flow rate viscometer tube, ft.<sup>3</sup>/sec. R - Radius, ft. Re - Reynolds number Reo - Reynolds number for orifices u - Velocity, ft./sec.
  - V Flow rate through orifice and pipe,  $ft_{\circ}^{3}/sec_{\circ}$

du/dy - Shear rate, 1/sec. ( du/dy )<sub>w</sub> - Shear rate at the wall, 1/sec. AP - Pressure drop across section being considered, lb<sub>of</sub>/ft<sup>2</sup> τ - Shear stress, lb<sub>of</sub>/ft<sup>2</sup> μ - Viscosity, lb<sub>o</sub>/ft. sec. ρ - Density, lb<sub>o</sub>/ft.<sup>3</sup> γ - Some index of viscosity for pseudoplastic fluids, lb<sub>o</sub><sup>m</sup>/ft<sub>o</sub>-sec.<sup>2-n<sup>3</sup></sup> β - Diameter ratio, D<sub>o</sub>/D APPENDIX B

EXPERIMENTAL AND CALCULATED DATA

# TABLE I

### EXPERIMENTAL AND CALCULATED DATA

### FOR DISCHARGE COEFFICIENTS

Nomenclature

β	=	Orifice diameter ratio	:	-
Т	=	Temperature	:	°F
T.F.	=	Test fluid		
M.F.	=	Manometer fluid		•
V	-	Flow rate	:	ft <sup>3</sup> /sec
u		Orifice velocity	:	ft/sec
Re	=	Orifice Reynolds number	:	<b>a</b>
T.C.	=	Tap connection(see Fig. 5	i)	
∆h	-	Difference in manometer	re	adings; inch
∆P		Pressure drop	:	$1b_f/ft^2$
М	=	Mercury		-
TBE	=	Tetrabromoethane		
CTC	=	Carbon tetrachlorid		

Run Numbe	r 1			Run Numbe	r 2		
$\beta = 0.$	2	V =	0.0210	β = 0.	6	V =	= 0.0861
T = 78	T = 78.8 u		36.5	T = 78	. 8	u =	= 16.9
T.F. = 0.	7% CMC	Re = 1	3700	T.F. = 0.	7% CMC	Re =	= 3020
M.F. = M				$M \cdot F \cdot = M$			
T.C.	∆h	∆P	Co	Τ.C.	∆h	∆P	Co
1! - 1	52.53	3429	0.614	1' - 1	7.86	513	0.688
2	52.52	3428	0.614	2	7.85	512	0.688
3	52.57	3432	0.614	3	7.88	514	0.687
4	52.51	3422	0.614	4	7,92	517	0.685
5	52.48	3426	0.615	5	7.97	520	0.683
6	52.02	3396	0.617	6	6.02	393	0.786
2' - 1	52.41	3421	0.615	2! - 1	8.01	523	0.681
2	52.46	3424	0.615	2	8.05	525	0.680
3	5 <b>2.</b> 48	3426	0.614	3	8.02	524	0.681
4	52.49	342 <b>6</b>	0.615	4	8.09	528	0.678
5	5 <b>2.</b> 51	3428	0.614	5	8.17	533	0.675
6	52.03	3396	0.617	6	6.17	403	0.776
3! - 1	52.49	3426	0.615	3' - 1	8.10	529	0.678
2	52.50	3427	0.614	2	8.12	530	0.677
3	52.45	3424	0.615	3	8,14	531	0.676
4	52.40	3420	0.615	4	8.15	532	0.676
5	52.42	3422	0.615	5	8.16	533	0.675
6	51.95	3391	0.618	6	6.18	403	0.776

	Run Numb	er 2			Rui	n Numb	er 4		
	R = 0	6	V =	0.0861	8	= 0	.6	v	= 0.0682
	ייים ד יד 7	288	и ==	16.9	р Т	= 7	8.8		= 13.4
		0.0 7% CMC	Ro ==	3020	- T.1	$\bar{r}_{.} = 0$	7% CMC	Re	= 2550
	1.r U	• 7 % OF10	ve	5020	м 1	г. — О Г — Т	'RF		2550
	m.r 1	. DE	٨D	Co	e 1 • 1	r e	Ab	٨Þ	Co
	1, 1	50 02	512	0 690	1 1		31 41	321	0 688
	1' - 1	50.10	512	0.689	1.	- 1	21 65	321	0.686
	2	50.10	515	0.000		2	21 72	224	0.000
	3	50.30	515	0.007		<u>с</u>	31.72	224	0.005
	4	50.55	517	0.085		4 E	31.72	324	0.085
	5	50.85	520	0.683		5	31.80	323	0.084
	6	38.33	392	0./8/		0	23.21	238	0.800
	2' - 1	51.10	523	0.681	Ζ !	~ L	31.40	322	0.688
	2	51.35	525	0.680		2	31.63	324	0.686
	3	51.15	523	0.681		3	31.70	324	0.685
	4	51.60	528	0.678		4	31.78	325	0.684
	5	52.15	534	0.674		5	31.83	326	0.684
	. 6	39.45	404	0.776		6	23.21	238	0.800
	3' - 1	51.30	525	0.680	31	- 1	31.37	321	0.688
	2	51.85	530	0.676		2	31.46	322	0.688
	3	52.00	532	0.676		3	31.54	323	0.687
	4	52.05	533	0.675		4	31.56	323	0.686
	5	52.05	533	0.675		5	31.69	324	0.685
	6	39.55	405	0.775		6	23.05	326	0.803
					_				
	Run Numb	er 4			Rui	n Numb	er 6		
	Run Numb $\beta = 0$	er 4	v =	0.0682	Rui β	n Numb $= 0$	er 6	V =	= 0.0520
• • •	$\begin{array}{llllllllllllllllllllllllllllllllllll$	er 4 0.6 '8.8	V =	0.0682	Rui β T	n Numb = 0 = 7	er 6 .6 8.8	V = u =	= 0.0520 = 10.2
• .	Run Numb $\beta = 0$ T = 7 T.F. = 0	er 4 0.6 8.8 0.7% CMC	V = u = Re =	0.0682 13.4 2550	Run β T T.1	$ \begin{array}{r} \text{Numb} \\ = 0 \\ = 7 \\ \text{F.} = 0 \end{array} $	er 6 .6 8.8 .7% CMC	V = u = Re =	= 0.0520 = 10.2 = 1910
•	Run Numb $\beta = 0$ T = 7 T.F. = 0 M.F. = M	er 4 0.6 8.8 0.7% CMC	V == u == Re ==	0.0682 13.4 2550	Run β T T.l M.l	n Numb = 0 = 7 F. = 0 F. = M	er 6 9.6 8.8 9.7% CMC	V = u = Re =	= 0.0520 = 10.2 = 1910
•	Run Numb $\beta = 0$ T = 7 T.F. = 0 M.F. = M T.C.	er 4 3.6 3.8 3.7% CMC i Δh	V = u = Re =	0.0682 13.4 2550 Co	Run β T T.1 M.1	$ \begin{array}{l} \text{Numb} \\ = 0 \\ = 7 \\ \text{F.} = 0 \\ \text{F.} = M \\ \text{F.} = M \\ \text{F.} \\ \text{C.} \end{array} $	er 6 8.8 9.7% CMC	V = u = Re =	= 0.0520 = 10.2 = 1910 Co
	Run Numb $\beta = 0$ T = 7 T.F. = 0 M.F. = M T.C. 1' - 1	er 4 9.6 8.8 9.7% CMC i Δh 4.91	V = u = Re = ΔP 321	0.0682 13.4 2550 Co 0.689	Run β Τ Π.1 Μ.1	$ \begin{array}{rcl} \text{Numb} &= 0 \\ &= 7 \\ \text{F.} &= 0 \\ \text{F.} &= M \\ \text{F.} &= M \\ \text{F.} &= 1 \end{array} $	er 6 8.8 9.7% CMC Δh 2.72	V = u = Re = ∆P 178	= 0.0520 = 10.2 = 1910 Co 0.706
	Run Numb $\beta = 0$ T = 7 T.F. = 0 M.F. = M T.C. 1! - 1 2	er 4 0.6 8.8 0.7% CMC 1 Δh 4.91 4.96	V == u == Re == ΔP 321 324	0.0682 13.4 2550 Co 0.689 0.686	Run β Τ Τ.1 Μ.1	$ \begin{array}{rcl} n & \text{Numb} \\ &= 0 \\ &= 7 \\ F. &= 0 \\ F. &= M \\ F. C. \\ &- 1 \\ &2 \\ \end{array} $	er 6 8.8 .7% CMC Δh 2.72 2.73	V = u = Re = ∆P 178 178	= 0.0520 = 10.2 = 1910 Co 0.706 0.704
	Run Numb $\beta = 0$ T = 7 T.F. = 0 M.F. = M T.C. 1' - 1 2 3	er 4 8.8 0.7% CMC 1 Δh 4.91 4.96 4.97	V = u = Re = ΔP 321 324 324	0.0682 13.4 2550 Co 0.689 0.686 0.685	Run β Τ.1 Μ.1 1	$ \begin{array}{rcl} n & \text{Numb} \\ &= 0 \\ = 7 \\ F &= 0 \\ F &= 0 \\ F &= M \\ F &= 1 \\ 2 \\ 3 \\ \end{array} $	er 6 8.8 0.7% CMC Δh 2.72 2.73 2.73	V = u = Re = ∆P 178 178 178	= 0.0520 = 10.2 = 1910 Co 0.706 0.704 0.704
	Run Numb $\beta = 0$ T = 7 T.F. = 0 M.F. = M T.C. 1! - 1 2 3 4	er 4 8.8 0.7% CMC 1 Δh 4.91 4.96 4.97 4.97	V = u = Re = ΔP 321 324 324 324	0.0682 13.4 2550 Co 0.689 0.686 0.685 0.685	Run β T.1 M.1 2	$ \begin{array}{rcl} n & \text{Numb} \\ &= 0 \\ = 7 \\ F &= 0 \\ F $	er 6 8.8 0.7% CMC Δh 2.72 2.73 2.73 2.73	V = u = Re = △P 178 178 178 178	= 0.0520 = 10.2 = 1910 Co 0.706 0.704 0.704 0.704
	Run Numb $\beta = 0$ T = 7 T.F. = 0 M.F. = M T.C. 1' - 1 2 3 4 5	er 4 8.8 0.7% CMC 1 Δh 4.91 4.96 4.97 4.97 4.98	V = u = Re = ∆P 321 324 324 324 324 325	0.0682 13.4 2550 Co 0.689 0.686 0.685 0.685 0.685	Run β T.1 M.1 1	Numb = 0 = 7 F. = 0 F. = M F. = 1 2 3 4 5	er 6 8.8 0.7% CMC Δh 2.72 2.73 2.73 2.73 2.73 2.73	V = u = Re = △P 178 178 178 178 178	= 0.0520 = 10.2 = 1910 Co 0.706 0.704 0.704 0.704 0.704
	Run Numb $\beta = 0$ T = 7 T.F. = 0 M.F. = M T.C. 1' - 1 2 3 4 5 6	er 4 8.8 0.7% CMC i Δh 4.91 4.96 4.97 4.97 4.98 3.62	V = u = Re = ΔP 321 324 324 324 325 236	0.0682 13.4 2550 Co 0.689 0.686 0.685 0.685 0.685 0.684 0.802	Run β T.1 M.1 1'	Numb = 0 = 7 F. = 0 F. = M F. = M F 1 2 3 4 5 6	er 6 8.8 0.7% CMC Δh 2.72 2.73 2.73 2.73 2.73 2.73 2.73 2.10	V = u = Re = △P 178 178 178 178 178 178 178 137	= 0.0520 = 10.2 = 1910 Co 0.706 0.704 0.704 0.704 0.704 0.704 0.704 0.803
	Run Numb $\beta = 0$ T = 7 T.F. = 0 M.F. = M T.C. 1' - 1 2 3 4 5 6 2' - 1	er 4 0.6 8.8 0.7% CMC 1 4.91 4.96 4.97 4.97 4.98 3.62 4.92	V == u == Re = ΔP 321 324 324 324 324 325 236 321	0.0682 13.4 2550 Co 0.689 0.686 0.685 0.685 0.685 0.684 0.802 0.688	Run β T.1 M.1 1'	$ \begin{array}{rcl} n & \text{Numb} \\ &= & 0 \\ &= & 7$	er 6 8.8 5.7% CMC Δh 2.72 2.73 2.73 2.73 2.73 2.73 2.73 2.73 2.73	V = u = Re = ∆P 178 178 178 178 178 178 137 178	= 0.0520 = 10.2 = 1910 Co 0.706 0.704 0.704 0.704 0.704 0.704 0.704 0.803 0.706
	Run Numb $\beta = 0$ T = 7 T.F. = 0 M.F. = M T.C. 1! - 1 2 3 4 5 6 2! - 1 2	er 4 0.6 8.8 0.7% CMC 1 4.91 4.96 4.97 4.97 4.97 4.98 3.62 4.92 4.93	V = u = Re = ΔP 321 324 324 324 324 324 325 236 321 322	0.0682 13.4 2550 Co 0.689 0.686 0.685 0.685 0.685 0.684 0.802 0.688 0.687	Run β Τ Π.1 Μ.1 1	$ \begin{array}{rcl} n & \text{Numb} \\ &= & 0 \\ &= & 7 \\ F &= & 0 \\ F $	er 6 8.8 0.7% CMC Δh 2.72 2.73 2.73 2.73 2.73 2.10 2.72 2.74	V = u = Re = △P 178 178 178 178 178 137 178 137 178 137	= 0.0520 = 10.2 = 1910 Co 0.706 0.704 0.704 0.704 0.704 0.704 0.803 0.706 0.703
· · · · · · · · · · · · · · · · · · ·	Run Numb $\beta = 0$ T = 7 T.F. = 0 M.F. = M T.C. 1' - 1 2 3 4 5 6 2' - 1 2 3	er 4 8.8 0.7% CMC f Δh 4.91 4.96 4.97 4.97 4.98 3.62 4.92 4.93 4.96	V = u = Re = ΔP 321 324 324 324 324 325 236 321 322 321 322 324	0.0682 13.4 2550 Co 0.689 0.686 0.685 0.685 0.685 0.684 0.802 0.688 0.687 0.686	Run β Τ.1 Μ.1 1'	$ \begin{array}{rcl} n & \text{Numb} \\ &= & 0 \\ &= & 7$	er 6 8.8 0.7% CMC Δh 2.72 2.73 2.73 2.73 2.73 2.73 2.73 2.72 2.74 2.74	V = u = Re = △P 178 178 178 178 178 137 178 137 178 179 179	= 0.0520 = 10.2 = 1910 Co 0.706 0.704 0.704 0.704 0.704 0.704 0.803 0.706 0.703 0.703
· · · · · · · · · · · · · · · · · · ·	Run Numb $\beta = 0$ T = 7 T.F. = 0 M.F. = M T.C. 1' - 1 2 3 4 5 2' - 1 2 3 4	er 4 8.8 0.7% CMC 1 Δh 4.96 4.97 4.97 4.98 3.62 4.92 4.93 4.96 4.97	V = u = Re = ΔP 321 324 324 324 325 236 321 322 324 322 324 324	0.0682 13.4 2550 Co 0.689 0.686 0.685 0.685 0.684 0.802 0.688 0.687 0.686 0.685	Run β Τ.1 Μ.1 1' 2'	$ \begin{array}{rcl} n & \text{Numb} \\ &= 0 \\ = 7 \\ F &= 0 \\ F $	er 6 8.8 0.7% CMC Δh 2.72 2.73 2.73 2.73 2.73 2.73 2.74 2.74 2.74 2.74	V = u = Re = △P 178 178 178 178 178 137 178 179 179 179	= 0.0520 = 10.2 = 1910 Co 0.706 0.704 0.704 0.704 0.704 0.704 0.803 0.706 0.703 0.703 0.703
	Run Numb $\beta = 0$ T = 7 T.F. = 0 M.F. = M T.C. 1' - 1 2 3 4 5 2' - 1 2 3 4 5 6 2' - 1 2 3 4 5 5 6 2' - 1 2 3 4 5 5 6 7 7 7 7 7 7 7 7	er 4 8.8 0.7% CMC 1 Δh 4.91 4.96 4.97 4.97 4.98 3.62 4.92 4.93 4.96 4.97 4.93 4.96 4.97 4.93 4.96 4.97 4.98	V = u = Re = ΔP 321 324 324 324 325 236 321 322 324 321 322 324 325	0.0682 13.4 2550 Co 0.689 0.686 0.685 0.685 0.684 0.687 0.688 0.687 0.686 0.685 0.685	Run β T.1 M.1 1'	Numb = 0 = 7 = 0 F. = 0 F. = M F. = M F. = 1 = 2 3 4 5 6 - 1 2 3 4 5 6 5 5 5 5 5 5 5 5 5 5 5 5 5	er 6 8.8 0.7% CMC Δh 2.72 2.73 2.73 2.73 2.73 2.73 2.73 2.74 2.74 2.74 2.74	V = u = Re = △P 178 178 178 178 178 137 178 137 179 179 179 179	= 0.0520 = 10.2 = 1910 Co 0.706 0.704 0.704 0.704 0.704 0.704 0.704 0.704 0.703 0.703 0.703 0.703 0.703
· · · · · · · · · · · · · · · · · · ·	Run Numb $\beta = 0$ T = 7 T.F. = 0 M.F. = M T.C. 1' - 1 2 3 4 5 6 2' - 1 2 3 4 5 6	$\begin{array}{c} \text{per } 4 \\ 0.6 \\ 8.8 \\ 0.7\% \text{ CMC} \\ 1 \\ 4.91 \\ 4.96 \\ 4.97 \\ 4.97 \\ 4.98 \\ 3.62 \\ 4.92 \\ 4.93 \\ 4.96 \\ 4.97 \\ 4.98 \\ 3.62 \\ 3.62 \end{array}$	V == u == Re == ΔP 321 324 324 324 324 325 326 321 322 324 322 324 325 326	0.0682 13.4 2550 Co 0.689 0.686 0.685 0.685 0.684 0.802 0.688 0.687 0.686 0.685 0.685 0.684 0.685	Run β T.1 M.1 1'	Numb = 0 = 7 = 0 F. = 0 F. = M F. = M F. C. = 1 = 2 3 4 5 6 = 1 2 3 4 5 6 = 5 6 = 5 6 = 5 = 6 = 7 = 9 = 9 = 9 = 9 = 9 = 9 = 9	er 6 8.8 9.7% CMC Δh 2.72 2.73 2.73 2.73 2.73 2.73 2.73 2.74 2.74 2.74 2.74 2.74 2.74 2.74	V = Re = △P 178 178 178 178 178 178 137 178 137 179 179 179 179 138	= 0.0520 = 10.2 = 1910 Co 0.706 0.704 0.704 0.704 0.704 0.704 0.803 0.706 0.703 0.703 0.703 0.703 0.703 0.703 0.801
	Run Numb $\beta = 0$ T = 7 T.F. = 0 M.F. = M T.C. 1' - 1 2 3 4 5 6 2' - 1 2 3 4 5 6 3' - 1	per 4 28.8 28.8 2.7% CMC 4.91 4.96 4.97 4.97 4.98 3.62 4.92 4.93 4.93 4.96 4.97 4.98 3.62 4.98 3.62 4.98 3.62 4.98 3.62 4.98 3.62 4.98 3.62 4.98 3.62 4.98 4.98 3.62 4.89	V = u = Re = ΔP 321 324 324 324 324 325 236 321 322 324 322 324 325 326 319	0.0682 13.4 2550 Co 0.689 0.686 0.685 0.685 0.684 0.802 0.688 0.687 0.686 0.685 0.685 0.684 0.802 0.684 0.802 0.690	Run β Τ Π.1 Μ.1 1' 2'	$ \begin{array}{r} \text{Numb} \\ = 0 \\ = 7 \\ \text{F.} = 0 \\ \text{F.} = M \\ \text{F.} = M \\ \text{F.} = 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \\ - 1 \\ 3 \\ 4 \\ 5 \\ 6 \\ - 1 \end{array} $	er 6 8.8 9.7% CMC Δh 2.72 2.73 2.73 2.73 2.73 2.73 2.73 2.74 2.74 2.74 2.74 2.74 2.74 2.74 2.74	V = u = Re = △P 178 178 178 178 178 137 178 137 179 179 179 179 179 179 179 17	= 0.0520 = 10.2 = 1910 Co 0.706 0.704 0.704 0.704 0.704 0.704 0.704 0.704 0.703 0.703 0.703 0.703 0.703 0.703 0.703 0.703 0.703 0.706
	Run Numb $\beta = 0$ T = 7 T.F. = 0 M.F. = M T.C. 1' - 1 2 3 4 5 2' - 1 2 3 4 5 6 3' - 1 2	$\begin{array}{c} 0.6 \\ 8.8 \\ 0.7\% \ \mathbf{CMC} \\ 1 \\ 4.91 \\ 4.96 \\ 4.97 \\ 4.97 \\ 4.98 \\ 3.62 \\ 4.92 \\ 4.93 \\ 4.96 \\ 4.97 \\ 4.98 \\ 3.62 \\ 4.98 \\ 3.62 \\ 4.98 \\ 3.62 \\ 4.99 \\ 4.92 \end{array}$	V = u = Re = ΔP 321 324 324 324 324 325 326 319 321	0.0682 13.4 2550 Co 0.689 0.685 0.685 0.685 0.684 0.802 0.688 0.687 0.686 0.685 0.685 0.684 0.802 0.684 0.802 0.690 0.688	Run β Τ Π.Π Μ.Π 21	$ \begin{array}{r} \text{Numb} \\ = 0 \\ = 7 \\ \text{F.} = 0 \\ \text{F.} = M \\ \text{F.} = M \\ \text{F.} - 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \\ 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \\ 1 \\ 2 \end{array} $	er 6 8.8 0.7% CMC 2.72 2.73 2.73 2.73 2.73 2.73 2.73 2.74 2.74 2.74 2.74 2.74 2.74 2.74 2.74	V = u = Re = △P 178 178 178 178 137 178 137 178 137 179 179 179 179 179 179 179 17	= 0.0520 = 10.2 = 1910 Co 0.706 0.704 0.704 0.704 0.704 0.704 0.704 0.704 0.703 0.703 0.703 0.703 0.703 0.703 0.703 0.706 0.706 0.706 0.706 0.706 0.706 0.706 0.706 0.706 0.706 0.706 0.706 0.706 0.706 0.704 0.704 0.704 0.704 0.704 0.704 0.704 0.704 0.704 0.704 0.704 0.704 0.704 0.704 0.705 0.706 0.704 0.704 0.704 0.704 0.704 0.704 0.704 0.705 0.706 0.704 0.704 0.704 0.704 0.705 0.706 0.704 0.704 0.704 0.705 0.706 0.706 0.704 0.704 0.704 0.704 0.703 0.703 0.703 0.703 0.703 0.706 0.703 0.703 0.706 0.704 0.703 0.703 0.703 0.706 0.705 0.703 0.705 0.703 0.705 0.703 0.703 0.705 0.706 0.703 0.703 0.703 0.706 0.703 0.703 0.703 0.706 0.703 0.703 0.703 0.706 0.703 0.703 0.703 0.706 0.705 0.703 0.703 0.706 0.706 0.703 0.703 0.703 0.706 0.706 0.703 0.703 0.706
	Run Numb $\beta = 0$ T = 7 T.F. = 0 M.F. = M T.C. 1' - 1 2 3 4 5 2' - 1 2 3 4 5 6 2' - 1 2 3 4 5 6 3' - 1 2 3	$\begin{array}{c} 0.6 \\ 8.8 \\ 0.7\% \ \mathbf{CMC} \\ 1 \\ 4.96 \\ 4.97 \\ 4.96 \\ 4.97 \\ 4.98 \\ 3.62 \\ 4.92 \\ 4.93 \\ 4.96 \\ 4.97 \\ 4.98 \\ 3.62 \\ 4.98 \\ 3.62 \\ 4.89 \\ 4.92 \\ 4.92 \\ 4.92 \\ 4.92 \\ 4.92 \end{array}$	V = u = Re = ΔP 321 324 324 324 325 236 321 322 324 324 325 326 319 321 321 321 321 322	0.0682 13.4 2550 Co 0.689 0.686 0.685 0.685 0.685 0.684 0.687 0.686 0.685 0.685 0.684 0.802 0.684 0.802 0.688 0.688 0.688	Run β Τ.Ι Μ.Ι 1' 2'	$ \begin{array}{r} \text{Numb} \\ = 0 \\ = 7 \\ = 0 \\ \text{F.} $	er 6 8.8 0.7% CMC Δh 2.72 2.73 2.73 2.73 2.73 2.73 2.73 2.74 2.74 2.74 2.74 2.74 2.74 2.74 2.74	V = u = Re = △P 178 178 178 178 178 137 178 137 179 179 179 179 138 178 178 178 178 178 178 178 17	= 0.0520 = 10.2 = 1910 Co 0.706 0.704 0.704 0.704 0.704 0.704 0.704 0.703 0.703 0.703 0.703 0.703 0.703 0.703 0.703 0.703 0.706 0.706 0.706 0.706 0.704
	Run Numb $\beta = 0$ T = 7 T.F. = 0 M.F. = M T.C. 1' - 1 2 3 4 5 2' - 1 2 3 4 5 6 2' - 1 2 3 4 5 6 3' - 1 2 3 4	$\begin{array}{c} 0.6 \\ 8.8 \\ 0.7\% \ \mathbf{CMC} \\ 1 \\ 4.91 \\ 4.96 \\ 4.97 \\ 4.97 \\ 4.98 \\ 3.62 \\ 4.92 \\ 4.93 \\ 4.96 \\ 4.97 \\ 4.98 \\ 3.62 \\ 4.93 \\ 4.96 \\ 4.97 \\ 4.98 \\ 3.62 \\ 4.92 \\ 4.92 \\ 4.92 \\ 4.93 \end{array}$	$V = 0$ $Re = 0$ $\Delta P$ $321$ $324$ $324$ $324$ $325$ $236$ $321$ $322$ $324$ $324$ $325$ $324$ $325$ $326$ $319$ $321$ $321$ $321$ $322$	0.0682 13.4 2550 Co 0.689 0.686 0.685 0.685 0.684 0.688 0.688 0.685 0.684 0.685 0.684 0.685 0.684 0.688 0.688 0.688 0.688	Run β T.1 M.1 1' 2'	$ \begin{array}{r} \text{Numb} \\ = 0 \\ = 7 \\ = 0 \\ \text{F.} $	er 6 8.8 9.7% CMC 2.72 2.73 2.73 2.73 2.73 2.73 2.73 2.73	V = u = Re = △P 178 178 178 178 178 178 179 179 179 179 179 179 179 178 178 178 178 178 178 178 178	= 0.0520 = 10.2 = 1910 Co 0.706 0.704 0.704 0.704 0.704 0.704 0.704 0.703 0.703 0.703 0.703 0.703 0.703 0.703 0.703 0.703 0.703 0.704 0.706 0.706 0.706 0.706 0.704 0.704
	Run Numb $\beta = 0$ T = 7 T.F. = 0 M.F. = M T.C. 1' - 1 2 3 4 5 2' - 1 2 3 4 5 3' - 1 2 3 4 5 3' - 1 2 3 4 5 5 3' - 1 2 3 4 5 5 6 3' - 1 2 3 4 5 6 3' - 1 2 3 4 5 5 6 7 7 7 7 7 7 7 7	$\begin{array}{c} \text{per} 4 \\ 0.6 \\ 8.8 \\ 0.7\% \text{ CMC} \\ 1 \\ 4.91 \\ 4.96 \\ 4.97 \\ 4.97 \\ 4.98 \\ 3.62 \\ 4.93 \\ 4.96 \\ 4.93 \\ 4.96 \\ 4.97 \\ 4.98 \\ 3.62 \\ 4.93 \\ 4.92 \\ 4.92 \\ 4.92 \\ 4.93 \\ 4.93 \\ 4.93 \end{array}$	$V = 0$ $Re = 0$ $\Delta P$ $321$ $324$ $324$ $324$ $325$ $236$ $321$ $322$ $324$ $324$ $325$ $326$ $319$ $321$ $321$ $322$ $322$ $322$	0.0682 13.4 2550 Co 0.689 0.686 0.685 0.685 0.685 0.684 0.687 0.688 0.685 0.685 0.684 0.685 0.684 0.688 0.688 0.688 0.688	Run β T.1 M.1 1' 2' 3'	$ \begin{array}{r} \text{Numb} \\ = 0 \\ = 7 \\ \text{F.} = 0 \\ \text{F.} = M \\ \text{F.} = 1 \\ $	er 6 8.8 9.7% CMC Δh 2.72 2.73 2.73 2.73 2.73 2.73 2.73 2.74 2.74 2.74 2.74 2.74 2.74 2.74 2.74	V = Re = △P 178 178 178 178 178 178 179 179 179 179 179 179 179 179	= 0.0520 = 10.2 = 1910 Co 0.706 0.704 0.704 0.704 0.704 0.704 0.704 0.703 0.703 0.703 0.703 0.703 0.703 0.703 0.703 0.703 0.703 0.704 0.704 0.704 0.704

.**.**3

Х.,

•

Run Numb	er 6			Run Numb	er 6		
β = 0	0.6	<b>v</b> =	= 0.0520	β = 0	.6	V =	0.0353
T = 7	78.8	u =	= 10.2	T = 7	8•8	บ =	6.94
T.F. = 0	.7% CMC	Re =	= 1910	T.F. = 0	.7% CMC	Re =	1200
M.F. = 7	CBE	_		$M \cdot F \cdot = C$	TC		
T.C.	٨h	ΔP	Co	T.C.	۸h	ΔP	Со
1' - 1	17.44	178	0.704	1! - 1	25.55	79.4	0.717
2	17.45	178	0.704	2	25.55	79.4	0.717
3	17.46	179	0.704	- 3	25.53	79.3	0.717
4	17.47	179	0.703	4	25.44	79.0	0.719
5	17.48	179	0.703	5	25.38	78.8	0.720
6	13.47	138	0.801	6	24.47	76.0	0.733
2! = 1	17.45	178	0.704	21 - 1	25.46	70.0	0.718
2 2	17.48	179	0.704	2 - 1	25.46	70 1	0.718
- 3	17.48	179	0.703	- 3	25.45	79 0	0.716
у 4	17.52	179	0.702	4	25.41	78 Q	0.719
5	17.52	170	0 703	5	25.38	78 8	0.720
5	13 54	138	0.799	6	25.45	763	0.720
31 1	17 45	178	0.704	31 - 1	25.45	70.5	0.731
J, = 1 2	17.43	179	0.704	J · − 1 9	25.47	79.0	0.719
2	17.43	170	0.704	2	25.45	79.1	0.710
	17.44	170	0.704		23.42	79.0	0.710
4 E	17.43	170	0.704	4 E	23+30	70.9	0.719
5	1/.4/	1/9	0.703	5	24.05	/ð≈ð 7( (	0.720
D	13.34	138	0.799	o	24.03	/0.0	0.730
Run Numl	ber 7			R <b>un N</b> umb	er 8		
Run Numl $\beta = 0$	ber 7 D.6	V =	= 0.0353	$\begin{array}{llllllllllllllllllllllllllllllllllll$	er 8 .6	V =	0.0274
$\begin{array}{llllllllllllllllllllllllllllllllllll$	ber 7 0.6 78.8	V = u =	= 0.0353 = 6.94	$\begin{array}{llllllllllllllllllllllllllllllllllll$	er 8 •6 8.8	V = u =	0.0274 5.39
Run Numi $\beta = 0$ T = 1 $T_{\circ}F_{\circ} = 0$	ber 7 0.6 78.8 0.7% CMC	V = u = Re =	= 0.0353 = 6.94 = 1200	$\begin{array}{llllllllllllllllllllllllllllllllllll$	er 8 .6 8.8 .7% CMC	V = u = Re =	0.0274 5.39 894
Run Numi $\beta = 0$ T = 1 $T \cdot F = 0$ $M \cdot F \cdot = 1$	ber 7 0.6 78.8 0.7% CMC FBE	V = u = Re =	= 0.0353 = 6,94 = 1200	Run Numb $\beta = 0$ T = 7 T.F. = 0 M.F. = C	er 8 .6 8.8 .7% CMC TC	V = u = Re =	0.0274 5.39 894
Run Numl $\beta = 0$ T = 1 $T \cdot F = 0$ $M \cdot F \cdot = 1$ $T \cdot C \cdot 1$	ber 7 0.6 78.8 0.7% СМС ГВЕ Дh	V = u = Re =	= 0.0353 = 6.94 = 1200 Co	$\begin{array}{llllllllllllllllllllllllllllllllllll$	er 8 .6 8.8 .7% CMC TC ∆h	V = u = Re = 0	0.0274 5.39 894 Co
Run Numl $\beta = 0$ T = 1 $T \cdot F \cdot = 0$ $M \cdot F \cdot = 1$ $T \cdot C \cdot 1$	ber 7 0.6 78.8 0.7% CMC FBE Δh 7.70	V = u = Re = ∆P 78.8	= 0.0353 = 6.94 = 1200 Co 0.720	Run Numb $\beta = 0$ T = 7 T.F. = 0 M.F. = C T.C. 1' - 1	er 8 .6 8.8 .7% CMC TC Δh 15.26	V = u = Re = ∆P 47.4	0.0274 5.39 894 Co 0.721
Run Numi $\beta = 0$ T = 1 $T \cdot F \cdot = 0$ $M \cdot F \cdot = 1$ $T \cdot C \cdot 1$ 1' - 1 2	ber 7 0.6 78.8 0.7% CMC TBE Δh 7.70 7.70 7.70	V = u = Re = ∆P 78.8 78.8	= 0.0353 = 6.94 = 1200 Co 0.720 0.720	Run Numb $\beta = 0$ T = 7 T.F. = 0 M.F. = C T.C. 1' - 1 2	er 8 .6 8.8 .7% CMC TC Δh 15.26 15.27	V = u = Re = ∆P 47.4 47.4	0.0274 5.39 894 Co 0.721 0.720
Run Numl $\beta = 0$ T = 2 $T \cdot F = 0$ $M \cdot F \cdot = 2$ $T \cdot C \cdot 1$ 1' - 1 2 3	ber 7 0.6 78.8 0.7% CMC TBE Δh 7.70 7.70 7.69	V = u = Re = ∆P 78.8 78.8 78.8 78.7	= 0.0353 = 6,94 = 1200 Co 0.720 0.720 0.720 0.720	Run Numb $\beta = 0$ T = 7 T.F. = 0 M.F. = C T.C. 1' - 1 2 3	er 8 .6 8.8 .7% CMC TC Δh 15.26 15.27 15.22	V = u = Re = 47.4 47.4 47.3	0.0274 5.39 894 Co 0.721 0.720 0.722
Run Numl $\beta = 0$ T = 2 $T \cdot F = 0$ $M \cdot F \cdot = 2$ $T \cdot C \cdot$ 1' - 1 2 3 4	ber 7 0.6 78.8 0.7% CMC TBE Δh 7.70 7.70 7.69 7.68	V == u = Re = 78.8 78.8 78.8 78.7 78.6	= 0.0353 = 6,94 = 1200 Co 0.720 0.720 0.720 0.721	Run Numb $\beta = 0$ T = 7 T.F. = 0 M.F. = C T.C. 1' - 1 2 3 4	er 8 .6 8.8 .7% CMC TC Δh 15.26 15.27 15.22 15.16	V = u = Re = 0 AP 47.4 47.4 47.3 47.1	0.0274 5.39 894 Co 0.721 0.720 0.722 0.723
Run Numl $\beta = 0$ T = 1 $T \cdot F = 0$ $M \cdot F = 2$ $T \cdot C \cdot$ 1' - 1 2 3 4 5	ber 7 0.6 78.8 0.7% CMC TBE Δh 7.70 7.70 7.69 7.68 7.66	V = u = Re = 78.8 78.8 78.7 78.6 78.4	= 0.0353 = 6.94 = 1200 Co 0.720 0.720 0.720 0.721 0.722	Run Numb $\beta = 0$ T = 7 T.F. = 0 M.F. = C T.C. 1' - 1 2 3 4 5	er 8 .6 8.8 .7% CMC TC Δh 15.26 15.27 15.22 15.16 15.07	V = u = Re = 0 AP 47.4 47.4 47.3 47.1 46.8	0.0274 5.39 894 Co 0.721 0.720 0.722 0.723 0.725
Run Numl $\beta = 0$ T = 1 $T \cdot F = 0$ $M \cdot F \cdot = 1$ $T \cdot C \cdot 1$ 1' - 1 2 3 4 5 6	ber 7 0.6 78.8 0.7% CMC TBE Δh 7.70 7.69 7.68 7.66 7.38	V = u = Re = 78.8 78.8 78.7 78.6 78.4 75.5	= 0.0353 = 6.94 = 1200 Co 0.720 0.720 0.720 0.721 0.722 0.735	Run Numb $\beta = 0$ T = 7 T.F. = 0 M.F. = C T.C. 1' - 1 2 3 4 5 6	er 8 .6 8.8 .7% CMC TC Δh 15.26 15.27 15.22 15.16 15.07 14.31	V = u = Re = 0 AP 47.4 47.4 47.3 47.1 46.8 44.4	0.0274 5.39 894 Co 0.721 0.720 0.722 0.723 0.725 0.744
Run Numi $\beta = 0$ T = 1 $T \cdot F = 0$ $M \cdot F \cdot = 1$ $T \cdot C \cdot 1$ 1' - 1 2 3 4 5 2' - 1	ber 7 0.6 78.8 0.7% CMC TBE Δh 7.70 7.69 7.68 7.66 7.38 7.69	V = u = Re = ∆P 78.8 78.8 78.7 78.6 78.4 75.5 78.7	= 0.0353 = 6.94 = 1200 Co 0.720 0.720 0.720 0.721 0.721 0.722 0.735 0.720	Run Numb $\beta = 0$ T = 7 T.F. = 0 M.F. = C T.C. 1' - 1 2 3 4 5 6 2' - 1	er 8 .6 8.8 .7% CMC TC Δh 15.26 15.27 15.22 15.16 15.07 14.31 15.23	V = u = Re = 0 AP 47.4 47.4 47.3 47.1 46.8 44.4 47.3	0.0274 5.39 894 Co 0.721 0.720 0.722 0.723 0.725 0.744 0.721
Run Numi $\beta = 0$ T = 1 $T \cdot F = 0$ $M \cdot F \cdot = 1$ $T \cdot C \cdot 1$ 1' - 1 2 3 4 5 2' - 1 2	ber 7 0.6 78.8 0.7% CMC TBE Δh 7.70 7.69 7.68 7.66 7.38 7.69	V = u = Re = ∆P 78.8 78.8 78.8 78.7 78.6 78.4 75.5 78.7 78.7	= 0.0353 = 6.94 = 1200 Co 0.720 0.720 0.720 0.721 0.722 0.735 0.720 0.720	Run Numb $\beta = 0$ T = 7 T.F. = 0 M.F. = C T.C. 1' - 1 2 3 4 5 6 2' - 1 2	er 8 .6 8.8 .7% CMC TC Δh 15.26 15.27 15.22 15.16 15.07 14.31 15.23 15.23	V = u = Re = 0 AP 47.4 47.4 47.3 47.1 46.8 44.4 47.3 47.4	0.0274 5.39 894 Co 0.721 0.720 0.722 0.723 0.725 0.744 0.721 0.721
Run Numi $\beta = 0$ T = 1 $T \cdot F = 0$ $M \cdot F \cdot = 1$ 1' - 1 2 3 4 5 2' - 1 2 3	ber 7 0.6 78.8 0.7% CMC TBE Δh 7.70 7.69 7.68 7.66 7.38 7.69 7.69 7.69 7.69 7.69 7.69 7.69 7.69 7.69 7.69	V = u = Re = ∆P 78.8 78.8 78.7 78.6 78.4 75.5 78.7 78.7 78.7 78.7	= 0.0353 = 6,94 = 1200 Co 0.720 0.720 0.720 0.721 0.722 0.735 0.720 0.720 0.720	Run Numb $\beta = 0$ T = 7 T.F. = 0 M.F. = C T.C. 1' - 1 2 3 4 5 6 2' - 1 2 3	er 8 .6 8.8 .7% CMC TC Δh 15.26 15.27 15.22 15.16 15.07 14.31 15.23 15.23 15.20	$V = u = Re = 0$ $\Delta P$ $47.4$ $47.4$ $47.3$ $47.1$ $46.8$ $44.4$ $47.3$ $47.3$ $47.3$ $47.3$ $47.3$ $47.3$	0.0274 5.39 894 Co 0.721 0.720 0.722 0.723 0.725 0.744 0.721 0.721 0.721
Run Numi $\beta = 0$ T = 1 $T \cdot F = 0$ $M \cdot F \cdot = 1$ $T \cdot C \cdot 1$ 1' - 1 2 3 4 5 2' - 1 2 3 4 5 2' - 1 2 3 4	ber 7 0.6 78.8 0.7% CMC TBE Δh 7.70 7.69 7.68 7.66 7.38 7.69	V = u = Re = ∆P 78.8 78.8 78.7 78.6 78.4 75.5 78.7 78.7 78.7 78.7 78.7	= 0.0353 = 6.94 = 1200 Co 0.720 0.720 0.720 0.721 0.722 0.735 0.720 0.720 0.720 0.720 0.720 0.720	Run Numb $\beta = 0$ T = 7 T.F. = 0 M.F. = C T.C. 1' - 1 2 3 4 5 6 2' - 1 2 3 4	er 8 .6 8.8 .7% CMC TC Δh 15.26 15.27 15.22 15.16 15.07 14.31 15.23 15.23 15.20 15.15	$V = u = Re = 0$ $\Delta P = 0$ $47.4 = 0$ $47.4 = 0$ $47.3 = 0$ $47.3 = 0$ $47.3 = 0$ $47.3 = 0$	0.0274 5.39 894 Co 0.721 0.720 0.722 0.723 0.725 0.744 0.721 0.721 0.722 0.723
Run Numi $\beta = 0$ T = 1 $T \cdot F = 0$ $M \cdot F \cdot = 1$ $T \cdot C \cdot 1$ 1' - 1 2 3 4 5 2' - 1 2 3 4 5 6 2' - 1 2 3 4 5 5 6 2' - 1 2 3 4 5 5 6 7 7 7 7 7 7 7 7	ber 7 0.6 78.8 0.7% CMC TBE Δh 7.70 7.69 7.68 7.69 7.68 7.68 7.68 7.68	V == u = Re = ∆P 78.8 78.8 78.7 78.6 78.4 75.5 78.7 78.7 78.7 78.7 78.7 78.6 78.4	= 0.0353 = 6,94 = 1200 Co 0.720 0.720 0.720 0.721 0.722 0.735 0.720 0.720 0.720 0.720 0.720 0.721 0.721 0.722	Run Numb $\beta = 0$ T = 7 T.F. = 0 M.F. = C T.C. 1' - 1 2 3 4 5 2' - 1 2 3 4 5	er 8 .6 8.8 .7% CMC TC Δh 15.26 15.27 15.22 15.16 15.07 14.31 15.23 15.23 15.20 15.15	$V = u = Re = 0$ $\Delta P$ $47.4$ $47.4$ $47.3$ $47.1$ $46.8$ $44.4$ $47.3$ $47.3$ $47.3$ $47.3$ $47.3$ $47.3$ $47.3$ $47.3$ $47.3$	0.0274 5.39 894 Co 0.721 0.720 0.722 0.723 0.725 0.744 0.721 0.721 0.722 0.723 0.723
Run Numl $\beta = 0$ T = 1 $T \cdot F = 0$ $M \cdot F = 2$ $T \cdot C \cdot$ 1' - 1 2 3 4 5 2' - 1 2 3 4 5 6 2' - 1 2 3 4 5 6 2' - 1 2 3 4 5 6 6 7 6 7 6 7 6 7 6 7 6 7 6 7 7 6 7 7 7 7 7 7 7 7	ber 7 0.6 78.8 0.7% CMC TBE Δh 7.70 7.69 7.68 7.69 7.68 7.69 7.68	V = u = Re = ∆P 78.8 78.8 78.7 78.6 78.4 75.5 78.7 78.7 78.7 78.7 78.7 78.7 78.6 78.4 75.8	= 0.0353 = 6.94 = 1200 Co 0.720 0.720 0.720 0.721 0.722 0.735 0.720 0.720 0.720 0.720 0.720 0.720 0.721 0.722 0.734	Run Numb $\beta = 0$ T = 7 T.F. = 0 M.F. = C T.C. 1' - 1 2 3 4 5 2' - 1 2 3 4 5 6	er 8 .6 8.8 .7% CMC TC Δh 15.26 15.27 15.22 15.16 15.07 14.31 15.23 15.23 15.20 15.15 15.07 14.32	$V = u = Re = 0$ $\Delta P$ $47.4$ $47.4$ $47.3$ $47.1$ $46.8$ $44.4$ $47.3$ $47.3$ $47.3$ $47.3$ $47.3$ $47.3$ $47.3$ $47.3$ $47.3$ $47.4$ $47.3$ $47.4$ $47.3$ $47.5$	0.0274 5.39 894 Co 0.721 0.720 0.722 0.723 0.725 0.744 0.721 0.721 0.722 0.723 0.725 0.723
Run Numl $\beta = 0$ T = 1 $T \cdot F = 0$ $M \cdot F = 2$ $T \cdot C \cdot 1$ 1' - 1 2 3 4 5 2' - 1 2 3 4 5 6 3' - 1	ber 7 0.6 78.8 0.7% CMC TBE Δh 7.70 7.69 7.68 7.69 7.68 7.66 7.66 7.66 7.69 7.69 7.69 7.69 7.68 7.66 7.66 7.68 7.66	V = u = Re = ∆P 78.8 78.8 78.7 78.6 78.4 75.5 78.7 78.7 78.7 78.7 78.7 78.6 78.4 75.8 78.4	= 0.0353 = 6.94 = 1200 Co 0.720 0.720 0.720 0.721 0.722 0.735 0.720 0.720 0.720 0.720 0.720 0.720 0.720 0.721 0.722 0.734 0.721	Run Numb $\beta = 0$ T = 7 T.F. = 0 M.F. = C T.C. 1' - 1 2 3 4 5 2' - 1 2 3 4 5 6 2' - 1 2 3 4 5 6 3' - 1 2 3 4 5 6 3' - 1 7 7 7 7 7 7 7 7	er 8 .6 8.8 .7% CMC TC Δh 15.26 15.27 15.22 15.16 15.07 14.31 15.23 15.23 15.20 15.15 15.07 14.32 15.28	V = u = Re	0.0274 5.39 894 Co 0.721 0.720 0.722 0.723 0.725 0.744 0.721 0.722 0.723 0.725 0.723 0.725 0.744 0.720
Run Numi $\beta = 0$ T = 2 T · F · = 0 M · F · = 2 T · C · 1' - 1 2 3 4 5 2' - 1 2 3 4 5 6 3' - 1 2	ber 7 0.6 78.8 0.7% CMC TBE Δh 7.70 7.69 7.68 7.69	V = u = Re = AP 78.8 78.8 78.7 78.6 78.4 75.5 78.7 78.7 78.7 78.7 78.7 78.6 78.4 75.8 78.4 75.8 78.4 75.8 78.4 75.8 78.4 75.8 78.4 75.7	= 0.0353 = 6.94 = 1200 Co 0.720 0.720 0.720 0.721 0.722 0.735 0.720 0.720 0.720 0.720 0.720 0.721 0.722 0.734 0.721 0.721 0.721 0.721	Run Numb $\beta = 0$ T = 7 T.F. = 0 M.F. = C T.C. 1' - 1 2 3 4 5 2' - 1 2 3 4 5 3' - 1 2	er 8 .6 8.8 .7% CMC TC Δh 15.26 15.27 15.22 15.16 15.07 14.31 15.23 15.23 15.20 15.15 15.07 14.32 15.28 15.28 15.28	V = u = Re = AP 47.4 47.4 47.3 47.1 46.8 44.4 47.3 47.3 47.2 47.0 46.8 44.5 47.4	0.0274 5.39 894 Co 0.721 0.720 0.722 0.723 0.725 0.744 0.721 0.722 0.723 0.725 0.744 0.725 0.744 0.720 0.720
Run Numi $\beta = 0$ T = 1 $T \cdot F = 0$ $M \cdot F \cdot = 1$ 1' - 1 2 3 4 5 2' - 1 2 3 4 5 3' - 1 2 3	ber 7 0.6 78.8 0.7% CMC TBE Δh 7.70 7.69 7.68 7.66 7.38 7.69	V = u = Re = ΔP 78.8 78.8 78.7 78.6 78.4 75.5 78.7 78.7 78.7 78.7 78.7 78.6 78.4 75.8 78.4 75.8 78.4 75.8 78.4	= 0.0353 = 6.94 = 1200 Co 0.720 0.720 0.720 0.721 0.722 0.735 0.720 0.720 0.720 0.720 0.720 0.720 0.721 0.722 0.734 0.721 0.720 0.721	Run Numb $\beta = 0$ T = 7 T.F. = 0 M.F. = C T.C. 1' - 1 2 3 4 5 6 2' - 1 2 3 4 5 6 3' - 1 2 3	er 8 .6 8.8 .7% CMC TC Δh 15.26 15.27 15.22 15.16 15.07 14.31 15.23 15.23 15.20 15.15 15.07 14.32 15.28 15.28 15.23	V = u = Re = 0 Re = 0 AP 47.4 47.4 47.3 47.1 46.8 44.4 47.3 47.3 47.3 47.3 47.3 47.3 47.4 47.3 47.4 47.3 47.4 47.3 47.4 47.4 47.3 47.4 47.3 47.4 47.3 47.4 47.3 47.4 47.3 47.3 47.3 47.3 47.4 47.3 47.3 47.3 47.3 47.4 47.4 47.3 47.3 47.4 47.4 47.3 47.3 47.4	0.0274 5.39 894 Co 0.721 0.720 0.722 0.723 0.725 0.744 0.721 0.722 0.723 0.725 0.744 0.720 0.720 0.720 0.720 0.720
Run Numi $\beta = 0$ T = 1 $T \cdot F = 0$ $M \cdot F \cdot = 2$ $T \cdot C \cdot 1$ 1' - 1 2 3 4 5 2' - 1 2 3 4 5 3' - 1 2 3 4 5 3' - 1 2 3 4 5 3' - 1 2 3 4 5 4 5 6 3' - 1 2 3 4 5 6 3' - 1 2 3 4 5 6 7 7 7 7 7 7 7 7	ber 7 0.6 78.8 0.7% CMC TBE Δh 7.70 7.69 7.68 7.69	V = u = Re = ΔP 78.8 78.8 78.7 78.6 78.4 75.5 78.7 78.7 78.7 78.7 78.7 78.7 78.7 78.7 78.7 78.7 78.7 78.6 78.4 75.8 78.4 75.8 78.4 75.8 78.4 75.8 78.4 75.5 78.4 75.5 78.4 78.5 78.2	= 0.0353 = 6.94 = 1200 Co 0.720 0.720 0.720 0.721 0.722 0.735 0.720 0.720 0.720 0.720 0.720 0.720 0.721 0.722 0.734 0.721 0.721 0.722	Run Numb $\beta = 0$ T = 7 T.F. = 0 M.F. = C T.C. 1' - 1 2 3 4 5 6 2' - 1 2 3 4 5 6 3' - 1 2 3 4	er 8 .6 8.8 .7% CMC TC Δh 15.26 15.27 15.22 15.16 15.07 14.31 15.23 15.23 15.20 15.15 15.07 14.32 15.28 15.28 15.23 15.23 15.23 15.23 15.23 15.23 15.23 15.23 15.23 15.23 15.23 15.23 15.23 15.23 15.23 15.23 15.23 15.24 15.25 15.27 15.25 15.27 15.23 15.20 15.27 15.23 15.20 15.27 15.23 15.20 15.27 15.23 15.20 15.27 15.23 15.20 15.27 15.23 15.20 15.27 15.23 15.20 15.27 15.23 15.20 15.27 15.23 15.20 15.27 15.23 15.20 15.27 15.23 15.20 15.27 15.23 15.20 15.27 15.23 15.20 15.27 15.20 15.27 15.23 15.20 15.27 15.20 15.27 15.20 15.27 15.20 15.27 15.20 15.27 15.20 15.27 15.28 15.28 15.23 15.23 15.28 15.28 15.23 15.23 15.28 15.23 15.24 15.25 15.2	$V = u = Re = \Delta P$ 47.4 47.3 47.1 46.8 44.4 47.3 47.3 47.2 47.0 46.8 44.5 47.4 47.3 47.2 47.0	0.0274 5.39 894 Co 0.721 0.720 0.722 0.723 0.725 0.744 0.721 0.722 0.723 0.725 0.744 0.721 0.725 0.744 0.720 0.721 0.721 0.721 0.721 0.725 0.744 0.721 0.722 0.723 0.725 0.744 0.721 0.722 0.723 0.725 0.744 0.721 0.722 0.723 0.725 0.721 0.721 0.725 0.744 0.721 0.722 0.723 0.725 0.721 0.721 0.725 0.744 0.721 0.725 0.721 0.725 0.721 0.725 0.721 0.725 0.721 0.725 0.721 0.725 0.721 0.725
Run Numi $\beta = 0$ T = 1 $T \cdot F = 0$ $M \cdot F \cdot = 2$ $T \cdot C \cdot 1$ 1' - 1 2 3 4 5 2' - 1 2 3 4 5 3' - 1 2 3 4 5 6 3' - 1 2 3 4 5 5 6 3' - 1 2 3 4 5 6 3' - 1 2 3 4 5 5 6 3' - 1 2 3 4 5 5 6 3' - 1 2 3 4 5 5 6 3' - 1 2 3 4 5 5 6 7 7 7 7 7 7 7 7	ber 7 0.6 78.8 0.7% CMC TBE Δh 7.70 7.69 7.68 7.69 7.69 7.69 7.69 7.69 7.69 7.69 7.69 7.69 7.69 7.69 7.69 7.66 7.41 7.66 7.69 7.67 7.64 7.62	V = u = Re = ΔP 78.8 78.8 78.7 78.6 78.4 75.5 78.7 78.7 78.7 78.7 78.7 78.6 78.4 75.8 78.4 75.8 78.4 75.8 78.4 75.8 78.4 75.8 78.4 75.8 78.4 75.8 78.4 75.5 78.7 78.6 78.7 78.6 78.7 78.5 78.2 78.0	= 0.0353 = 6,94 = 1200 Co 0.720 0.720 0.720 0.721 0.722 0.735 0.720 0.720 0.720 0.720 0.720 0.720 0.721 0.722 0.734 0.721 0.722 0.721 0.722 0.723	Run Numb $\beta = 0$ T = 7 T.F. = 0 M.F. = C T.C. 1' - 1 2 3 4 5 2' - 1 2 3 4 5 3' - 1 2 3 4 5 6 3' - 1 2 3 4 5 5 6 3' - 1 2 3 4 5 6 3' - 1 2 3 4 5 6 3' - 1 2 3 4 5 6 7 7 7 7 7 7 7 7	er 8 .6 8.8 .7% CMC TC Δh 15.26 15.27 15.22 15.16 15.07 14.31 15.23 15.23 15.20 15.15 15.07 14.32 15.28 15.28 15.28 15.23 15.23 15.21 21 21 21 21 21 21 21 21 21	$V = u = Re = \Delta P$ 47.4 47.4 47.3 47.1 46.8 44.4 47.3 47.3 47.2 47.0 46.8 44.5 47.4 47.3 47.2 47.0	0.0274 5.39 894 Co 0.721 0.720 0.722 0.723 0.725 0.744 0.721 0.721 0.722 0.723 0.725 0.744 0.720 0.725 0.744 0.720 0.722 0.723 0.725 0.744 0.722 0.723 0.725 0.724 0.722 0.723 0.725 0.721 0.722 0.724 0.722 0.723 0.725 0.744 0.722 0.723 0.725 0.744 0.722 0.723 0.725 0.744 0.722 0.723 0.725 0.744 0.722 0.723 0.725 0.744 0.725 0.725 0.724 0.725 0.724 0.725 0.724 0.725 0.725 0.744 0.725 0.725 0.724 0.725 0.725 0.725 0.724 0.725 0.726 0.725 0.725 0.726 0.725 0.726 0.725 0.725 0.726 0.727 0.725 0.726 0.727 0.725 0.726 0.727 0.726 0.727 0.726 0.726 0.727 0.726 0.727 0.726 0.726 0.726 0.726 0.726 0.726 0.726 0.726 0.726 0.727 0.726 0.726 0.726 0.726 0.727 0.726 0.726 0.726 0.726 0.727 0.726 0.727 0.726 0.727
Run Numi $\beta = 0$ T = 1 $T \cdot F = 0$ $M \cdot F = 2$ $T \cdot C \cdot 1$ 1' - 1 2 3 4 5 2' - 1 2 3 4 5 3' - 1 2 3 4 5 6 3' - 1 2 3 4 5 6 6 3' - 1 2 3 4 5 6 3' - 1 2 3 4 5 6 6 7 6 7 7 7 7 7 7 7 7	ber 7 0.6 78.8 0.7% CMC TBE Δh 7.70 7.69 7.68 7.69 7.64 7.62 7.43	V = u = Re = ΔP 78.8 78.8 78.7 78.6 78.4 75.5 78.7 78.5 78.2 78.0 78.	= 0.0353 = 6.94 = 1200 Co 0.720 0.720 0.720 0.721 0.722 0.735 0.720 0.720 0.720 0.720 0.720 0.720 0.721 0.722 0.734 0.721 0.721 0.722 0.723 0.723 0.733	Run Numb $\beta = 0$ T = 7 T.F. = 0 M.F. = C T.C. 1' - 1 2 3 4 5 2' - 1 2 3 4 5 3' - 1 2 3 4 5 6 3' - 1 2 3 4 5 6 6 7 7 7 7 7 7 7 7	er 8 .6 8.8 .7% CMC TC Δh 15.26 15.27 15.22 15.16 15.07 14.31 15.23 15.23 15.20 15.15 15.07 14.32 15.28 15.28 15.28 15.23 15.19 15.12 14.37	$V = u = Re = \Delta P$ 47.4 47.4 47.3 47.1 46.8 44.4 47.3 47.3 47.2 47.0 46.8 44.5 47.4 47.3 47.2 47.0 46.8 44.5 47.4 47.3 47.2 47.0 46.8	0.0274 5.39 894 Co 0.721 0.720 0.722 0.723 0.725 0.744 0.721 0.721 0.722 0.723 0.725 0.744 0.720 0.720 0.720 0.722 0.723 0.725 0.744 0.720 0.721 0.722 0.721 0.722 0.724 0.720 0.721 0.722 0.724 0.720 0.721 0.722 0.723 0.721 0.721 0.725 0.744 0.721 0.721 0.721 0.725 0.744 0.721 0.721 0.721 0.725 0.744 0.721 0.722 0.723 0.721 0.721 0.725 0.744 0.721 0.722 0.723 0.725 0.744 0.721 0.725 0.724 0.721 0.725 0.724 0.722 0.723 0.725 0.724 0.725 0.724 0.725 0.724 0.725 0.724 0.725 0.724 0.725 0.724 0.725 0.724 0.725 0.724 0.725 0.724 0.725 0.724 0.725 0.724 0.725 0.724 0.725 0.724 0.725 0.724 0.725 0.724 0.725 0.724 0.720 0.725 0.724 0.720 0.725 0.724 0.720 0.725 0.724 0.720 0.722 0.724 0.722 0.722 0.724 0.722 0.724 0.722 0.724 0.722 0.724 0.722 0.724 0.722 0.724 0.722 0.724 0.722 0.724 0.722 0.724 0.722 0.724 0.724 0.722 0.724 0.725 0.724 0.724 0.725 0.724 0.724 0.725 0.724 0.724 0.725 0.724 0.724 0.725 0.724 0.724 0.725 0.724 0.724 0.725 0.724 0.725 0.724 0.724 0.725 0.724 0.724 0.725 0.724 0.724 0.725 0.724 0.724 0.725 0.724 0.724 0.725 0.724 0.725 0.724 0.725 0.724 0.725 0.724 0.725 0.724 0.725 0.724 0.725 0.725 0.724 0.725

TABLE I (Continued)

Þ

.

Kun Num	ib <b>er 9</b>			Run Numb	er 10			
β =	0.6	V =	0.0198	$\beta = 0$	.2	V =	0.0164	
T =	78.8	u =	3.89	T = 7	8.8	u =	28.9	
T.F. =	0.7% CMC	Re =	606	T.F. = 0	.7% CMC	Re =	2800	
M.F. =	CTĊ			M.F. = M				
T.C.	∆h	∆P	Co	T.C.	∆h	ΔP	Co	
1! - 1	7.72	24.0	0.730	1' - 1	33.28	2172	0.612	
2	7.70	23.9	0.731	2	33.29	2173	0.612	
3	7.65	23.8	0.734	3	33.29	2173	0.612	
4	7.63	23.7	0.735	4	33.31	2174	0.612	
5	7.56	23.5	0,738	5	33.34	2176	0.612	÷.,
6	6.87	21.3	0.774	6	32,98	2153	0.615	
2! - 1	8.20	25.5	0.709	2! - 1	33.30	2174	0.612	
2	8.19	25.4	0.709	2	33.30	2174	0.612	
3	8.14	25.3	0.711	3	33.32	2175	0.612	
4	7.79	24.2	0.727	4	33.33	2176	0.612	
: • 5	7.66	23.8	0.733	5	33.33	2176	0.612	
6	7.03	21.8	0.765	6	32.98	2153	0.615	
3! = 1	7.74	24.0	0.730	3! - 1	33.26	2171	0.612	
· 2	7.74	24.0	0.730	2	33.28	2172	0.612	
3	7.70	23.9	0.731	3	33.30	<b>21</b> 74	0.612	
4	7.64	23.7	0.734	4	33.31	2174	0.612	
5	7.53	23.4	0.740	5	33.30	2174	0.612	
6	7.00	21.7	0.767	6	32.94	2150	0.615	
Run Num A =	ber 11 0.2	V =	0.0122	Run Number $\beta = 0$	er 14 .2	V =	0.00738	3
Run Num β = T =	ab <b>er 11</b> 0.2 78.8	V = u =	0.0122 21.6	$\begin{array}{llllllllllllllllllllllllllllllllllll$	er 14 .2 8.8	V = u =	0.00738	3
$\begin{array}{l} \operatorname{Run} \operatorname{Num} \\ \beta & = \\ T & = \\ T, F, = \end{array}$	ber 11 0.2 78.8 0.7% CMC	V = u = Re =	0.0122 21.6 1980	Run Number $\beta = 0$ T = 73 T, F, = 0	er 14 .2 8.8 .7% CMC	V = u = Re =	0.00738 13.0 1130	3
Run Num $\beta =$ T = T.F. = M.F. =	ab <b>er 11</b> 0.2 78.8 0.7% CMC M	V = u = Re =	0.0122 21.6 1980	Run Number $\beta = 0$ T = 73 T.F. = 0 M.F. = T	er 14 .2 8.8 .7% CMC BE	V = u = Re =	0.00738 13.0 1130	3
Run Num $\beta =$ T = T.F. = M.F. = T.C.	ber 11 0.2 78.8 0.7% CMC Μ Δh	V = u = Re =	0.0122 21.6 1980 Co	Run Numbe $\beta = 0$ T = 73 T.F. = 0 M.F. = The T.C.	er 14 .2 8.8 .7% CMC BE Ah	V == u == Re == AP	0.00738 13.0 1130	}
Run Num $\beta = T$ T = T.F. = M.F. = T.C. 1' = 1	ber 11 0.2 78.8 0.7% CMC M Δh 17.99	V = u = Re = ΔP 1174	0.0122 21.6 1980 Co 0.623	Run Numbe $\beta = 0$ T = 73 T.F. = 0 M F. = T T.C. $1^{7} - 1$	er 14 .2 8.8 .7% CMC BE Δh 38.03	V = u = Re = ΔP 389	0.00738 13.0 1130 Co 0.653	3
Run Num $\beta = T$ T = T.F. = M.F. = T.C. 1' - 1 2	ber 11 0.2 78.8 0.7% CMC Μ Δh 17.99 17.99	V = u = Re = ΔP 1174 1174	0.0122 21.6 1980 Co 0.623 0.623	Run Number $\beta = 0$ T = 74 T.F. = 0 M F. = T T.C. $1^{1} - 1$ 2	er 14 .2 8.8 .7% CMC BE Δh 38.03 38.03	V = u = Re = ∆P 389 389	0.00738 13.0 1130 Co 0.653 0.653	3
Run Num $\beta = T$ T = T. F. = M.F. = T.C. 1' - 1 2 3	ber 11 0.2 78.8 0.7% CMC Μ Δh 17.99 17.99 17.99	V = u = Re = ΔP 1174 1174 1174	0.0122 21.6 1980 Co 0.623 0.623 0.623	Run Number $\beta = 0$ $T = 73$ $T.F. = 0$ $M.F. = T$ $T.C.$ $1^{1} - 1$ $2$ $3$	er 14 .2 8.8 .7% CMC BE Δh 38.03 38.03 37.98	V = u = Re = ∆P 389 389 389 389	0.00738 13.0 1130 Co 0.653 0.653 0.653	3
Run Num $\beta = T$ T = T.F. = M.F. = T.C. $1^{1} - 1$ 2 3 4	ber 11 0.2 78.8 0.7% CMC M Δh 17.99 17.99 17.99 17.99	V = u = Re = ΔP 1174 1174 1174 1174	0.0122 21.6 1980 Co 0.623 0.623 0.623 0.623	Run Numbe $\beta = 0$ $T = 73$ $T.F. = 0$ $M.F. = T$ $T.C.$ $1' - 1$ $2$ $3$ $4$	er 14 .2 8.8 .7% CMC BE Δh 38.03 38.03 37.98 38.02	V == u == Re = 389 389 389 389 389 389	<ul> <li>0.00738</li> <li>13.0</li> <li>1130</li> <li>Co</li> <li>0.653</li> <li>0.653</li> <li>0.653</li> <li>0.653</li> </ul>	}
Run Num $\beta = T$ T = T.F. = M.F. = T.C. 1' - 1 2 3 4 5	ber 11 0.2 78.8 0.7% CMC M Δh 17.99 17.99 17.99 17.99 17.99 17.99	$V = u = Re = \Delta P$ 1174 1174 1174 1174 1174	0.0122 21.6 1980 Co 0.623 0.623 0.623 0.623 0.623	Run Number $\beta = 0$ $T = 73$ $T.F. = 0$ $M \cdot F. = T$ $T.C.$ $1^{1} - 1$ $2$ $3$ $4$ $5$	er 14 .2 8.8 .7% CMC BE Δh 38.03 38.03 37.98 38.02 37.96	V = u = Re = ∆P 389 389 389 389 389 389 389 388	0.00738 13.0 1130 Co 0.653 0.653 0.653 0.653 0.653	3
Run Num $\beta = T = T = T = T = T = T = T = T = T = $	ber 11 0.2 78.8 0.7% CMC M Δh 17.99 17.99 17.99 17.99 17.99 17.99 17.99	$V = u = Re = \Delta P$ 1174 1174 1174 1174 1174 1174 1174 1163	0.0122 21.6 1980 Co 0.623 0.623 0.623 0.623 0.623 0.623 0.623	Run Numbe $\beta = 0$ T = 73 T.F. = 0 M F. = T. T.C. 1' - 1 2 3 4 5 6	er 14 .2 8.8 .7% CMC BE Δh 38.03 38.03 37.98 38.02 37.96 37.54	V = u = Re = 389 389 389 389 389 389 389 389 388 388	0.00738 13.0 1130 Co 0.653 0.653 0.653 0.653 0.653 0.653	3
Run Num $\beta = T$ T = T. F. = $T \cdot F \cdot = T \cdot C \cdot 1^{1} - 1^{2} \cdot 2^{3} \cdot 4^{5} \cdot 5^{6} \cdot 5$	ber 11 0.2 78.8 0.7% CMC M Δh 17.99 17.99 17.99 17.99 17.99 17.99 17.99 17.99	$V = u = Re = \Delta P$ 1174 1174 1174 1174 1174 1173	0.0122 21.6 1980 Co 0.623 0.623 0.623 0.623 0.623 0.623 0.626 0.623	Run Numbe $\beta = 0$ T = 77 T.F. = 0 M F. = T T.C. $1^{1} - 1$ 2 3 4 5 6 $2^{1} - 1$	er 14 .2 8.8 .7% CMC BE Δh 38.03 37.98 38.02 37.96 37.54 37.92	V = u = Re = ∆P 389 389 389 389 388 388 388 388	<ul> <li>0.00738</li> <li>13.0</li> <li>1130</li> <li>Co</li> <li>0.653</li> <li>0.653</li> <li>0.653</li> <li>0.653</li> <li>0.653</li> <li>0.653</li> <li>0.653</li> <li>0.653</li> <li>0.653</li> </ul>	}
Run Num $\beta = T$ $T = T \cdot F \cdot = T \cdot F \cdot = T \cdot C \cdot 1^{1} - 1^{1} \cdot 2^{3} \cdot 3^{4} \cdot 5^{6} \cdot 5^{6} \cdot 5^{6} \cdot 5^{7} \cdot 5^{6} \cdot 5^{7} \cdot 5^$	ber 11 0.2 78.8 0.7% CMC M Δh 17.99 17.99 17.99 17.99 17.99 17.99 17.99 17.99 17.99	$V = u = Re = \Delta P$ 1174 1174 1174 1174 1174 1173 1173	0.0122 21.6 1980 Co 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623	Run Numbe $\beta = 0$ T = 74 T.F. = 0 M.F. = T. T.C. $1^{1} - 1$ 2 3 4 5 6 $2^{1} - 1$ 2	er 14 .2 8.8 .7% CMC BE Δh 38.03 37.98 38.02 37.96 37.54 37.92 37.88	V = u = Re = ∆P 389 389 389 389 389 388 388 384 388 388	0.00738 13.0 1130 0.653 0.653 0.653 0.653 0.653 0.653 0.653 0.653 0.654	3
Run Num $\beta = T$ T = T. F. = M.F. = T.C. 1' - 1 2 3 4 5 2' - 1 2 3	ber 11 0.2 78.8 0.7% CMC M Δh 17.99 17.99 17.99 17.99 17.99 17.82 17.97 17.97 17.97	$V = u = Re = \Delta P$ 1174 1174 1174 1174 1174 1173 1173 1173	0.0122 21.6 1980 Co 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623	Run Numbe $\beta = 0$ T = 73 T.F. = 0 M.F. = T. T.C. 1' - 1 2 3 4 5 6 2' - 1 2 3	er 14 .2 8.8 .7% CMC BE Δh 38.03 37.98 38.02 37.96 37.54 37.92 37.88 37.89	V = u = Re = ∆P 389 389 389 389 389 388 388 388 388 388	<ul> <li>0.00738</li> <li>13.0</li> <li>1130</li> <li>Co</li> <li>0.653</li> <li>0.653</li> <li>0.653</li> <li>0.653</li> <li>0.653</li> <li>0.653</li> <li>0.654</li> <li>0.654</li> <li>0.654</li> </ul>	3
Run Num $\beta = T$ T = T. F. = M.F. = T.C. 1' - 1 2 3 4 5 2' - 1 2 3 4 5 2' - 1 2 3 4	ber 11 0.2 78.8 0.7% CMC M 17.99 17.99 17.99 17.99 17.99 17.82 17.97 17.97 17.97 17.97 17.97	$V = u = Re = \Delta P$ 1174 1174 1174 1174 1174 1173 1173 1173 1174	0.0122 21.6 1980 Co 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623	Run Numbe $\beta = 0$ T = 73 T.F. = 0 M F. = T T.C. $1^{1} - 1$ 2 3 4 5 $2^{1} - 1$ 2 3 4 5 4 3 4 5 4 3 4 3 4 3 4 3 4 5 6 $2^{1} - 1$ 2 3 4 5 6 $2^{1} - 1$ 2 3 4 4 5 6 $2^{1} - 1$ 2 3 4 4 5 6 $2^{1} - 1$ 2 3 4 4 5 6 $2^{1} - 1$ 2 3 4 4 4 5 5 6 $2^{1} - 1$ 2 3 4 4 5 5 6 $2^{1} - 1$ 2 3 4 4 5 5 6 $2^{1} - 1$ 2 3 4 4 4 4 5 5 6 $2^{1} - 1$ 2 3 4 4 4 4 4 4 4 4	er 14 .2 8.8 .7% CMC BE Δh 38.03 37.98 38.02 37.96 37.54 37.92 37.88 37.89 37.88	V = u = Re = ∆P 389 389 389 389 389 389 388 388 388 388	0.00738 13.0 1130 Co 0.653 0.653 0.653 0.653 0.653 0.655 0.655 0.654 0.654 0.654	3
Run Num $\beta = T$ T = T.F. = M.F. = T.C. 1' - 1 2 3 4 5 2' - 1 2 3 4 5 2' - 1 2 3 4 5 5 5 5 5 5 4 5 5 5 5 5 5 5 5	ber 11 0.2 78.8 0.7% CMC M Δh 17.99 17.99 17.99 17.99 17.99 17.99 17.97 17.97 17.97 17.97 17.98 17.99	$V = u = Re = \Delta P$ 1174 1174 1174 1174 1163 1173 1173 1174 1174	0.0122 21.6 1980 Co 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623	Run Number $\beta = 0$ T = 73 T.F. = 0 $M \cdot F. = T.$ T.C. 1' - 1 2 3 4 5 2' - 1 2 3 4 5 5	er 14 .2 8.8 .7% CMC BE Δh 38.03 37.98 38.02 37.96 37.54 37.92 37.88 37.89 37.88 37.88 37.88 37.72	V = u = Re = ∆P 389 389 389 389 389 389 388 388 388 388	0.00738 13.0 1130 Co 0.653 0.653 0.653 0.653 0.653 0.653 0.654 0.654 0.654 0.654	3
Run Num $\beta = T$ T = T. F. = M. F. = T. C. 1' - 1 2 3 4 5 2' - 1 2 3 4 5 6 2' - 1 2 3 4 5 6	ber 11 0.2 78.8 0.7% CMC M Δh 17.99 17.99 17.99 17.99 17.99 17.99 17.99 17.99 17.99 17.99 17.99 17.97 17.97 17.97 17.98 17.99 17.98 17.99 17.98 17.99 17.98	$V = u = Re = \Delta P$ 1174 1174 1174 1174 1173 1173 1173 1173	0.0122 21.6 1980 Co 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623	Run Number $\beta = 0$ T = 73 T.F. = 0 M F. = T. T.C. $1^{1} - 1$ 2 3 4 5 $2^{1} - 1$ 2 3 4 5 $3^{1} - 6$	er 14 .2 8.8 .7% CMC BE Δh 38.03 37.98 38.02 37.96 37.54 37.92 37.88 37.89 37.88 37.89 37.88 37.72 37.25	V = u = Re = ΔP 389 389 389 389 389 389 388 388	0.00738 13.0 1130 Co 0.653 0.653 0.653 0.653 0.653 0.653 0.654 0.654 0.654 0.655 0.659	3
Run Num $\beta = T$ T = T. F. = T.F. = T.C. 1' - 1 2 3 4 5 2' - 1 2 3 4 5 3' - 1	ber 11 0.2 78.8 0.7% CMC M Δh 17.99 17.99 17.99 17.99 17.99 17.99 17.99 17.99 17.99 17.99 17.97 17.97 17.97 17.98 17.99 17.98 17.99 17.98 17.99	$V = u = Re = \Delta P$ 1174 1174 1174 1174 1173 1173 1173 1173	0.0122 21.6 1980 Co 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623	Run Number $\beta = 0$ T = 73 T.F. = 0 M F. = T2 T.C. 1' - 1 2 3 4 5 2' - 1 2 3 4 5 3' - 6 1	er 14 .2 8.8 .7% CMC BE Δh 38.03 37.98 38.02 37.96 37.54 37.92 37.88 37.89 37.88 37.89 37.88 37.72 37.25 37.62	V = u = Re = ΔP 389 389 389 389 389 388 388 388	<ul> <li>0.00738</li> <li>13.0</li> <li>1130</li> <li>Co</li> <li>0.653</li> <li>0.653</li> <li>0.653</li> <li>0.653</li> <li>0.653</li> <li>0.654</li> <li>0.654</li> <li>0.654</li> <li>0.655</li> <li>0.659</li> <li>0.656</li> </ul>	3
Run Num $\beta = T$ T = T.F. = M.F. = T.C. 1' - 1 2 3 4 5 2' - 1 2 3 4 5 3' - 1 2	ber 11 0.2 78.8 0.7% CMC M Δh 17.99 17.99 17.99 17.99 17.99 17.99 17.97 17.97 17.97 17.97 17.97 17.97 17.97 17.97 17.99 17.99 17.97 17.97 17.97 17.99	$V = u = Re = \Delta P$ 1174 1174 1174 1174 1173 1173 1173 1174 1174	0.0122 21.6 1980 Co 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623	Run Numbe $\beta = 0$ T = 73 T.F. = 0 M F. = Th T.C. 1' - 1 2 3 4 5 2' - 1 2 3 4 5 3' - 6 1 2	er 14 .2 8.8 .7% CMC BE Δh 38.03 37.98 38.02 37.96 37.54 37.92 37.88 37.92 37.88 37.89 37.88 37.72 37.25 37.62 37.40	V = u = Re = ΔP 389 389 389 389 389 388 388 388 388 388	0.00738 13.0 1130 Co 0.653 0.653 0.653 0.653 0.653 0.653 0.654 0.654 0.654 0.655 0.659 0.656 0.658	3
Run Num $\beta = T$ T = T. F. = M.F. = T.C. 1' - 1 2 3 4 5 2' - 1 2 3 4 5 6 3' - 1 2 3	ber 11 0.2 78.8 0.7% CMC M Δh 17.99 17.99 17.99 17.99 17.99 17.99 17.97	$V = u = Re = \Delta P$ 1174 1174 1174 1174 1173 1173 1173 1173	0.0122 21.6 1980 Co 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623	Run Number $\beta = 0$ T = 73 T.F. = 0 M F. = T T.C. $1^{1} - 1$ 2 3 4 5 $2^{1} - 1$ 2 3 4 5 $3^{1} - 6$ 1 2 3 $3^{1} - 6$ 1 2 $3^{1} - 6$ 1 $3^{1} - 6$ 1 2 $3^{1} - 6$ 1 2 $3^{1} - 6$ 1 1 1 1 1 1 1 1	er 14 .2 8.8 .7% CMC BE Δh 38.03 37.98 38.02 37.96 37.54 37.92 37.88 37.92 37.88 37.89 37.88 37.72 37.25 37.62 37.40 37.46	V = u = Re = ΔP 389 389 389 389 389 389 389 388 388	0.00738 13.0 1130 Co 0.653 0.653 0.653 0.653 0.653 0.653 0.654 0.654 0.654 0.655 0.659 0.656 0.658 0.657	3
Run Num $\beta = T$ T = T. F. = M.F. = T.C. 1' - 1 2 3 4 5 2' - 1 2 3 4 5 3' - 1 2 3 4 5 3' - 1 2 3 4	ber 11 0.2 78.8 0.7% CMC M Δh 17.99 17.99 17.99 17.99 17.99 17.99 17.97	$V = u = Re = Re = \Delta P$ 1174 1174 1174 1174 1174 1173 1173 1173 1173 1173 1173 1173 1173 1173	0.0122 21.6 1980 Co 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623	Run Number $\beta = 0$ T = 73 T.F. = 0 M.F. = T. T.C. 1' - 1 2 3 4 5 2' - 1 2 3 4 5 3' - 6 1 2 3 4 3 4 5 3' - 6 1 2 3 4 3 4 3 4 5 3' - 6 1 2 3 4 3 3 4 3 4 3 3 4 3 3 3 3 4 3 3 3 3 3 3 3 3	er 14 .2 8.8 .7% CMC BE Δh 38.03 37.98 38.02 37.96 37.54 37.92 37.88 37.92 37.88 37.89 37.88 37.72 37.25 37.62 37.40 37.46 37.24	V = u = Re = ΔP 389 389 389 389 389 389 389 388 388	0.00738 13.0 1130 Co 0.653 0.653 0.653 0.653 0.653 0.653 0.654 0.654 0.654 0.654 0.655 0.659 0.656 0.658 0.657 0.659	3
Run Num $\beta = T$ T = T. F. = T.F. = T.C. 1' - 1 2 3 4 5 2' - 1 2 3 4 5 3' - 1 2 3 4 5 3' - 1 2 3 4 5 5 3' - 1 2 3 4 5 5 5 5 6 3' - 1 2 3 4 5 5 6 3' - 1 2 3 4 5 5 6 5 5 6 5 5 6 5 5 6 5 5 6 5 5 6 5 5 6 3' - 1 2 3 4 5 5 6 5 5 6 5 5 6 5 5 6 5 5 6 5 5 6 5 5 6 5 5 6 5 5 6 5 5 6 5 5 6 5 5 6 5 5 5 6 5 5 6 5 5 5 6 5 5 5 6 5 5 5 5 6 5 5 6 5 5 5 5 6 5 5 5 5 6 5 5 5 6 5 5 5 6 5 5 6 5 5 5 6 5 5 5 6 5 5 5 6 5 5 5 6 5 5 5 6 5 5 5 5 6 5 5 5 6 5 5 5 5 5 6 5 5 5 5 5 5 5 5	ber 11 0.2 78.8 0.7% CMC M Δh 17.99 17.99 17.99 17.99 17.99 17.99 17.97 17.98	V = u = Re = $\Delta P$ 1174 1174 1174 1174 1173 1173 1173 1173 1173 1173 1173 1173 1173 1173 1174	0.0122 21.6 1980 Co 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623 0.623	Run Number $\beta = 0$ T = 73 T.F. = 0 M F. = T. T.C. 1' - 1 2 3 4 5 2' - 1 2 3 4 5 3' - 6 1 2 3 4 5 3' - 6 1 2 3 4 5 5 3' - 6 1 2 3 4 5 3' - 6 1 2 3 4 5 5 3' - 6 1 2 3 4 5 5 3' - 6 1 2 3 4 5 5 5 5 5 5 5 5	er 14 .2 8.8 .7% CMC BE Δh 38.03 37.98 38.02 37.96 37.96 37.92 37.88 37.92 37.88 37.92 37.88 37.72 37.88 37.72 37.62 37.40 37.40 37.46 37.24 37.26	V = u = Re = ΔP 389 389 389 389 389 389 388 388	0.00738 13.0 1130 Co 0.653 0.653 0.653 0.653 0.653 0.653 0.654 0.654 0.654 0.654 0.655 0.659 0.656 0.659 0.659 0.659 0.659	3

D M	mbor 14			D				
AUN NUI		17	0 00700	KUN NUM		17	0.0050	
= q	0.2	v =	0.00/38	₿ = (	J•8	v =	0.0853	
T =	78.8	u =	13.0	T = 8	36.0	u =	9.43	
T.F. =	0.7% CMC	Re =	1120	T.F. = 1	L.5% CMC	Re =	501	
M.F. =	TBE			M.F. = 0	CTC			
T.C.	∆h	ΔP	Co	т.с.	∆h	ΔP	Co	
1' - 1	5.95	388	0.653	11 - 1	24.33	75.6	0.822	
2	5,95	388	0.653	2	20.50	63.7	0.896	
3	5,95	388	0.653	3	15.99	49.7	1.014	
4	5.95	388	0.653	4	14.18	44.0	1.077	
5	5 95	388	0.653		13 07	44.0	1 085	
5	5 87	383	0.658	5	1/ 07	46 5	1.048	
21 1	5.0/	200	0.654	2, 1	24.27	72 0	0 932	
2, ∞ 1 2	J.94 5 04	200	0.054	∠' ∾ 1 ⊃	23.77	13.0	0.007	4
2	5.94	200	0.654	2	19.97	02.0	0.907	
3	5.94	388	0.654	3	15.79	49.0	1.020	
4	5.94	388	0.654	4	13.78	42.8	1.092	
5	5.90	385	0.656	5	13.47	41.8	1.105	
6	5.82	380	0.660	6	14.46	44.9	1.066	
3' - 1	5 <b>.9</b> 9	384	0.656	3' - 1	24.82	77.1	0.814	
2	5.85	382	0.659	2	21.14	65.6	0.882	
3	5.85	382	0.659	3	17.01	52.8	0.983	a.
4	5.81	379	0.661	4	15.03	46.7	1.046	
5	5.81	379	0.661	5	14.67	45.6	1.059	
6	5.75	375	0.664	6	15.79	49.0	1.020	
Run Nur	mber 15			Run Numb	oer 15			
β =	0.8	V =	0.0853	$\beta = 0$	.8	V =	0.0853	
T ==	86.0	u =	9.43	T = 8	36.0	u =	9.43	
T.F. =	1.5% CMC	Re =	501	T.F. = 1	L.5% CMC	Re =	501	
M.F. =	TBE			M.F. = N	1			
T.C.	Δh	ΔP	Co	т.С.	٨h	ΛP	Co	
11 - 1	7,33	75.0	0.825	11	1,17	76.4	0.818	
2	6.10	62.4	0.904	2	0.97	63.3	0.898	
- 3	4 85	49.6	1 01/	2	0.77	50.2	1.008	
ر ،	4.05	42.0	1.014		0.77	12 7	1 000	
4	4.55	44.5	1.074	4	0.07	43.7	1.001	
5	4.23	43.3	1.080	5	0.07	43 1	1.001	
6	4.52	40.2	1.051	6	0./1	40.3	1.050	
21 = 1	/.15	/3.2	0.835	21 <del>~</del> 1	1.15	/5.1	0.825	
2	6.01	61.5	0.911	2	0.97	63.3	0.898	
3	4.77	48.8	1.023	3	0.78	50.9	1.002	
4	4.17	42.7	1.094	4	0.66	43.1	1.089	
5	4.09	41.8	1.105	5	0.64	41.8	1.106	
6	4.38	44.8	1.067	6	0.70	45.7	1.057	
31 - 1	7.45	76.2	0.818	31 - 1	1.20	78.3	0.807	
2	6.35	65.0	0.886	2	1.02	66.6	0.876	
3	5.13	52.5	0.986	3	0.82	53.5	0.977	
4	4.56	46.7	1.046	4	0.73	47.6	1.035	
•			1 0(0		0 72	170	1 0/2	
.5	4.44	45.4	1.000	2	0.72	47.0	1+042	
5	4.44 4.72	45.4 48.3	1.080	5	0.72	47.0 50.3	1.0042	
5 6	4.44 4.72	45.4 48.3	1.028	5 6	0.72	50.3	1.008	

Run Num	ber 16			Run Numbe	er 16		
8 =	0.8	V =	= 0.0625	β = 0.	8	V =	0.0625
T =	86.0	u =	= 6.90	T = 86	5.0	u =	6.90
T.F. =	1.5% CMC	Re =	= 324	T.F. = 1.	5% CMC	Re =	324
M.F. = 1	CTC			M.F. = TI	BE		J = -7
Τ.C.	٨h	ΛΡ	Co	Τ.C.	Λh	ΛΡ	Co
11 - 1	14.20	44.1	0.788	11 _ 1	4.31	43.7	0.788
2	10.63	33.0	0.910	2	3.22	31.3	0.911
3	8.34	25.6	1.028	3	2.50	24.8	1.034
4	7.80	24.0	1.063	4	2.35	24.2	1.067
5	8,19	25.3	1.037	5	2.47	25.4	1.041
6	9.67	29.6	0.955	6	2.89	30.0	0.962
21 - 1	12.25	38.1	0.848	21 - 1	3.72	37.2	0.848
2	9.46	29.4	0,965	2	2.87	29.4	0.965
3	7.75	23.9	1,066	3	2.34	23.5	1.069
4	7.42	22.8	1,090	4	2.23	23.5	1.095
5	7.93	24.4	1.054	5	2.38	24.2	1.060
6	9.24	28.4	0.976	6	2.78	29.4	0.981
31 - 1	13.19	40.6	0.817	31 - 1	3.97	41.1	0.821
2	10.69	33.0	0.908	2	3.23	33.3	0.910
3	9,02	27.9	0.988	3	2.73	28.1	0.990
4	8.69	26.6	1.007	4	2.60	26.8	1.014
5	9.15	28.3	0.981	5	2.77	28.7	0.983
6	10,51	32.4	0.916	6	3.17	32.6	0.918
$\begin{array}{llllllllllllllllllllllllllllllllllll$	b <b>er 16</b> 0.8 86.0	V = 11 =	= 0.0625 = 6.90	$\begin{array}{llllllllllllllllllllllllllllllllllll$	er 17 8	V = u =	0.0458
- T.F. =	1.5% CMC	Re =	= 324	T.F. = 1.	5% CMC	Re =	209
M.F. = 1	M	1.0	3=4	M.F. = CI			207
т.с.	∆h	ΔP	Co	T.C.	∆h	∆P	Co
11 - 1	0.67	44.1	0.791	1† - 1	7.33	22.8	0.805
2	0.48	33.0	0.934	2	6.54	20.3	0.852
3	0.38	25.9	1.050	3	5.01	15.6	0.974
4	0.37	24.2	1.064	4	5.29	16.4	0.947
5	0.39	25.4	1.037	, 5	5.95	18.5	0.893
6	0.46	30.0	0.955	6	7.30	22.7	0.806
21 - 1	0.57	38.0	0.858	2' - 1	6.55	20.3	0.851
2	0.45	29.4	0.965	2	6.21	19.3	0.874
3	0.36	24.1	1.079	3 -	4.79	14.9	0.996
4	0.36	24.1	1.079	4	4.85	15.1	0.989
5	0.37	24.6	1.064	5	5.52	17.1	0.927
6	0.45	28.7	0.965	6	6.88	21.4	0.831
31 - 1	0.63	41.0	0.816	31 - 1	7.68	23.8	0.786
2	0.51	33.2	0.907	2	6.08	18.9	0.884
2	0.31	55.4					
2	0.43	28.0	0.987	3	5.69	17.7	0.914
2 3 4	0.43	28.0 27.0	0.987	3 4	5.69 6.01	17.7 18.7	0.914 0.889
2 3 4 5	0.43 0.41 0.44	28.0 27.0 28.4	0.987 1.011 0.976	3 4 5	5.69 6.01 6.65	17.7 18.7 20.6	0.914 0.889 0.845

.

Run 1	Number	17			Rur	n Numb	er 18		
8	= 0.8		V =	0.0458	8	= 0	.8	V =	0.0353
Ť	= 86.	0	u =	5.07	Ţ	= 8	6.0	u =	3.90
- Т.F.	= 1.5	% GMC	Re =	209		$r_{1} = 1$	.5% CMC	Re =	143
M.F.	= TRE	,, 0210			м. н	· · · · · · · · · · · · · · · · · · ·	TC		
т.(	с. 	۸ħ	٨P	Co	1	г.с.	٨h	٨Ρ	Co
11 -	1	2.18	22.3	0.813	11	- 1	4.70	14.6	0.774
	2	1.69	17.3	0.923	-	2	3.67	11.4	0.876
	2	1 54	15.8	0 967		- 3	3.58	11.1	0.888
	5	1 61	16 5	0.046		5	4 00	12 /	0.860
	с <del>,</del>	1 76	19.0	0.940		5	4.00	14 6	0.775
	ر د	2 17	10.0	0.905		5	4.09	14.0	0.775
<b>.</b> .	0	2.1/	22.2	0.013	· ·	1	6.01	12.0	0.000
21 -	1	1.94	19.9	0.862	21	- 1	4,19	13.0	0.820
	2	1.59	10.3	0.952		2	3.01	11.2	0.884
	3	1.48	15.1	0.987		3	3.5/	11.1	0.889
	4	1.48	15.1	0.987		4	4.05	12.6	0.834
	5	1.64	16.8	0.937		5	4.80	14.9	0.766
	6	2.05	21.0	0.838		6	5.51	17.1	0.715
31 -	1	2.27	23.2	0.797	31	- 1	5.15	16.0	0.740
	2	1.81	18.5	0.892		2	4.21	13.1	0.818
	3	1.79	18.3	0.897		3	4.10	12.7	0.829
	4	1.80	18.4	0.895		4	4.59	14.3	0.784
	5	1.98	20.3	0.853		5	5.17	16.0	0.738
	6	2.37	24.3	0.780		6	6.61	20.5	0.653
Run 1 B	Number = $0.8$	18	V =	0.0353	Rur β T	$\begin{array}{r} \mathbf{Numb} \\ = 0 \\ - 8 \end{array}$	er 19 1.8	V =	0.0264
Run l β T	$\begin{array}{l} \text{Number} \\ = 0.8 \\ = 86. \\ = 1 \end{array}$	18 0	V = u =	0.0353 3.90	Rur β T	n Numb = 0 = 8	er 19 .8 6.0	V = u =	0.0264 2.91
Run l β T T.F.	Number = $0.8$ = $86.$ = $1.5$	18 0 % CMC	V = u = Re =	0.0353 3.90 143	Rur β T T.I	$\begin{array}{r} \text{Numb} \\ = 0 \\ = 8 \\ \hline \\$	er 19 .8 .6.0 .5% CMC	V = u = Re =	0.0264 2.91 94.6
Run 1 B T T.F. M.F.	Number = 0.8 = 86. = 1.5 = TBE	18 0 % CMC	V = u = Re =	0.0353 3.90 143	Rur β T T.I M.I	n Numb = 0 = 8 7. = 1 7. = 0	er 19 0.8 66.0 .5% CMC TC	V = u = Re = AR	0.0264 2.91 94.6
Run ] β Τ Τ.F. M.F. Τ.6	Number = $0.8$ = $86.$ = $1.5$ = TBE C.	18 0 % CMC Δh	$V = u = Re = \Delta P$	0.0353 3.90 143	Rur β Τ Τ.Ι Μ.Ι	$ \begin{array}{rcl} n & \text{Numb} \\ &= & 0 \\ &= & 8 \\ \hline \hline$	er 19 	$V = u = Re = \Delta P$	0.0264 2.91 94.6 Co
Run 1 T T.F. M.F. T.( 1' -	Number = $0.8$ = $86.$ = $1.5$ = TBE C. 1	18 0 % CMC Δh 1.40	V = u = Re = ΔP 14.3	0.0353 3.90 143 Co 0.782	Rur β Τ.Ι Μ.Ι Ί'	$ \begin{array}{rcl} n & \text{Numb} \\ &= & 0 \\ &= & 8 \\ \hline \hline$	er 19 	$V = u = Re = \Delta P$ 9.75	0.0264 2.91 94.6 Co 0.707
Run 1 β T.F. M.F. 1'-	Number = $0.8$ = $86.$ = $1.5$ = TBE C. 1 2	18 0 % CMC Δh 1.40 1.08	V = u = Re = ΔP 14.3 11.0	0.0353 3.90 143 Co 0.782 0.890	Rur β Τ.Ι Μ.Ι Ί	$ \begin{array}{rcl} n & \text{Numb} \\ &= & 0 \\ &= & 8 \\ \hline \hline$	er 19 0.8 66.0 5% CMC TC Δh 3.14 2.55 2.62	$V = u = Re = \Delta P$ 9.75 7.92	0.0264 2.91 94.6 0.707 0.785
Run 1 β T.F. M.F. 1'-	Number = 0.8 = 86. = 1.5 = TBE C. 1 2 3	18 0 % CMC Δh 1.40 1.08 1.08	V = u = Re = ΔP 14.3 11.0 11.0	0.0353 3.90 143 Co 0.782 0.890 0.890	Rur β Τ Τ.Ι Μ.Ι Ί	$ \begin{array}{rcl} n & \text{Numb} \\ &= & 0 \\ &= & 8 \\ \hline &= & 1 \\ \hline &: & = & 0 \\ \hline &: & C \\ &: & C \\ &: & 1 \\ &: & 2 \\ &: & 3 \\ &: & 4 \\ \end{array} $	er 19 0.8 66.0 5% CMC TC Δh 3.14 2.55 2.63 2.05	$V = u = Re = \Delta P$ 9.75 7.92 8.17	0.0264 2.91 94.6 0.707 0.785 0.773
Run 1 β T.F. M.F. 1'-	Number = 0.8 = 86. = 1.5 = TBE C. 1 2 3 4	18 0 % CMC Δh 1.40 1.08 1.08 1.19	V = u = Re = △P 14.3 11.0 11.0 12.2	0.0353 3.90 143 Co 0.782 0.890 0.890 0.848 0.848	Rur β Τ.Ι Μ.Ι Ί	$ \begin{array}{rcl} n & \text{Numb} \\ &= & 0 \\ &= & 8 \\ \hline &= & 1 \\ \hline &: & - & 1 \\ &: & - & 1 \\ &: & 2 \\ &: & 3 \\ &: & 4 \\ &: & 5 \\ \end{array} $	er 19 .8 .5% CMC TC Δh 3.14 2.55 2.63 3.05 2.70	$V = u = Re = \Delta P$ 9.75 7.92 8.17 9.47	0.0264 2.91 94.6 0.707 0.785 0.773 0.718
Run ] β Τ.F. M.F. 1.	Number = 0.8 = 86. = 1.5 = TBE C. 1 2 3 4 5	18 0 % CMC Δh 1.40 1.08 1.08 1.19 1.38	V = u = Re = $\Delta P$ 14.3 11.0 11.0 12.2 14.1	0.0353 3.90 143 Co 0.782 0.890 0.890 0.848 0.788	Rur β Τ Τ.Ι Μ.Ι Ί	$ \begin{array}{rcl} n & \text{Numb} \\ &= & 0 \\ &= & 8 \\ \hline &= & 1 \\ \hline &: & = & 0 \\ \hline &: & C \\ &: & 1 \\ &: & 2 \\ &: & 3 \\ &: & 4 \\ &: & 5 \\ \end{array} $	er 19 .8 .5% CMC TC Δh 3.14 2.55 2.63 3.05 3.70 (.20)	$V = u = Re = \Delta P$ 9.75 7.92 8.17 9.47 11.49	0.0264 2.91 94.6 0.707 0.785 0.773 0.718 0.652
Run ] β Τ.F. M.F. 1'-	Number = 0.8 = 86. = 1.5 = TBE C. 1 2 3 4 5 6	18 0 % CMC Δh 1.40 1.08 1.08 1.19 1.38 1.80	V = u = Re = $\Delta P$ 14.3 11.0 11.0 12.2 14.1 18.4	0.0353 3.90 143 Co 0.782 0.890 0.890 0.848 0.788 0.788 0.690	Rur β Τ.Ι Μ.Ι Ί'	$ \begin{array}{rcl} n & \text{Numb} \\ &= & 0 \\ &= & 8 \\ \hline &= & 1 \\ \hline &: & = & 0 \\ \hline &: & & 1 \\ \hline &: & & 1 \\ &: & 1 \\ &: $	er 19 	V = u = Re = ΔP 9.75 7.92 8.17 9.47 11.49 15.22	0.0264 2.91 94.6 0.707 0.785 0.773 0.718 0.652 0.566
Run 1 β T.F. M.F. 1'-	Number = 0.8 = 86. = 1.5 = TBE C. 1 2 3 4 5 6 1	18 0 % CMC Δh 1.40 1.08 1.08 1.19 1.38 1.80 1.25	$V = u = Re = \Delta P$ 14.3 11.0 11.0 12.2 14.1 18.4 12.8	0.0353 3.90 143 Co 0.782 0.890 0.890 0.848 0.788 0.690 0.827	Rur β Τ.Ι Μ.Ι Ί'	$ \begin{array}{rcl} n & \text{Numb} \\ &= & 0 \\ &= & 8 \\ \hline &= & 1 \\ \hline &: & = & 0 \\ \hline &: & - & 1 \\ &: & - & 1 \\ &: & 2 \\ &: & 3 \\ &: & 4 \\ &: & 5 \\ &: & 6 \\ &: & - & 1 \\ &: & & 6 \\ &: & & - & 1 \\ &: & & & 6 \\ &: & & & - & 1 \\ &: & & & & & 6 \\ &: & & & & & & & 6 \\ &: & & & & & & & & & & & \\ &: & & & & & & & & & & & \\ &: & & & & & & & & & & & \\ &: & & & & & & & & & & & \\ &: & & & & & & & & & & & \\ &: & & & & & & & & & & & \\ &: & & & & & & & & & & & \\ &: & & & & & & & & & & & & \\ &: & & & & & & & & & & & & \\ &: & & & & & & & & & & & & \\ &: & & & & & & & & & & & \\ &: & & & & & & & & & & & \\ &: & & & & & & & & & & & \\ &: & & & & & & & & & & \\ &: & & & & & & & & & & \\ &: & & & & & & & & & & & \\ &: & & & & & & & & & & & \\ &: & & & & & & & & & & & \\ &: & & & & & & & & & & & \\ &: & & & & & & & & & & & \\ &: & & & & & & & & & & & \\ &: & & & & & & & & & & & \\ &: & & & & & & & & & & & \\ &: & & & & & & & & & & & \\ &: & & & & & & & & & & \\ &: & & & & & & & & & & \\ &: & & & & & & & & & & \\ &: & & & & & & & & & & \\ &: & & & & & & & & & & \\ &: & & & & & & & & & & \\ &: & & & & & & & & & & \\ &: & & & & & & & & & & \\ &: & & & & & & & & & & & \\ &: & & & & & & & & & & & \\ &: & & & & & & & & & & & \\ &: & & & & & & & & & & & \\ &: & & & & & & & & & & & \\ &: & & & & & & & & & & & \\ &: & & & & & & & & & & & \\ &: & & & & & & & & & & & \\ &: & & & & & & & & & & & \\ &: & & & & & & & & & & & \\ &: & & & & & & & & & & & \\ &: & & & & & & & & & & & \\ &: & & & & & & & & & & & \\ &: & & & & & & & & & & & & \\ &: & & & & & & & & & & & & & \\ &: & & & & & & & & & & & & & & \\ &: & & & & & & & & & & & & & & & \\ &: & & & & & & & & & & & & & & & & & & $	er 19 	V = u = Re = ΔP 9.75 7.92 8.17 9.47 11.49 15.22 8.23	0.0264 2.91 94.6 0.707 0.785 0.773 0.718 0.652 0.566 0.770
Run 1 <sup>3</sup> T.F. M.F. 1' -	Number = 0.8 = 86. = 1.5 = TBE C. 1 2 3 4 5 6 1 2	18 0 % CMC Δh 1.40 1.08 1.08 1.19 1.38 1.80 1.25 1.09	$V = u = Re = \Delta P$ 14.3 11.0 11.0 12.2 14.1 18.4 12.8 11.2	0.0353 3.90 143 Co 0.782 0.890 0.890 0.848 0.788 0.690 0.827 0.886	Rur β Τ.Ι Μ.Ι 1'	$ \begin{array}{rcl} n & \text{Numb} \\ &= & 0 \\ &= & 8 \\ \hline &= & 1 \\ \hline &: & = & 0 \\ \hline &: & - & 1 \\ &: & - & 1 \\ &: & & - & 1 \\ &: & & & - & 1 \\ &: & & & & - & 1 \\ &: & & & & & - & 1 \\ &: & & & & & & - & 1 \\ &: & & & & & & & - & 1 \\ &: & & & & & & & & - & 1 \\ &: & & & & & & & & & & - & 1 \\ &: & & & & & & & & & & & & - & 1 \\ &: & & & & & & & & & & & & & & & & & & $	er 19 	V = u = Re = ΔP 9.75 7.92 8.17 9.47 11.49 15.22 8.23 6.46	0.0264 2.91 94.6 0.707 0.785 0.773 0.718 0.652 0.566 0.770 0.869
Run 1 <sup>3</sup> T.F. M.F. 1' -	Number = 0.8 = 86. = 1.5 = TBE C. 1 2 3 4 5 6 1 2 3	18 0 % CMC Δh 1.40 1.08 1.08 1.19 1.38 1.80 1.25 1.09 1.07	$V = u = Re = \Delta P$ 14.3 11.0 11.0 12.2 14.1 18.4 12.8 11.2 10.9	0.0353 3.90 143 Co 0.782 0.890 0.890 0.848 0.788 0.690 0.827 0.886 0.894	Rur β Τ.Ι Μ.Ι Ί'	$ \begin{array}{rcl} n & \text{Numb} \\ &= & 0 \\ &= & 8 \\ \hline &= & 1 \\ \hline &: & = & 0 \\ \hline &: & - & 1 \\ &: & - & 1 \\ &: & - & 1 \\ &: & - & 1 \\ &: & & - & 1 \\ &: & & - & 1 \\ &: & & - & 1 \\ &: & & & - & 1 \\ &: & & & & - & 1 \\ &: & & & & & - & 1 \\ &: & & & & & - & 1 \\ &: & & & & & & - & 1 \\ &: & & & & & & & - & 1 \\ &: & & & & & & & & - & 1 \\ &: & & & & & & & & & - & 1 \\ &: & & & & & & & & & & - & 1 \\ &: & & & & & & & & & & & & & & - & 1 \\ &: & & & & & & & & & & & & & & & & & & $	er 19 .8 .6.0 .5% CMC TC Δh 3.14 2.55 2.63 3.05 3.70 4.90 2.65 2.08 2.26	V = u = Re = ΔP 9.75 7.92 8.17 9.47 11.49 15.22 8.23 6.46 7.02	0.0264 2.91 94.6 Co 0.707 0.785 0.773 0.718 0.652 0.566 0.770 0.869 0.834
Run 1 <sup>3</sup> T.F. M.F. 1' -	Number = 0.8 = 86. = 1.5 = TBE C. 1 2 3 4 5 6 1 2 3 4 5 6 1 2 3	18 0 % CMC Δh 1.40 1.08 1.08 1.19 1.38 1.80 1.25 1.09 1.07 1.21	$V = u = Re = \Delta P$ 14.3 11.0 11.0 12.2 14.1 18.4 12.8 11.2 10.9 12.4	0.0353 3.90 143 Co 0.782 0.890 0.890 0.848 0.788 0.690 0.827 0.886 0.894 0.841	Rur β Τ.Ι Μ.Ι Ί' 2'	$ \begin{array}{rcl} n & \text{Numb} \\ &= & 0 \\ &= & 8 \\ \hline &= & 1 \\ \hline &: & - & 1 \\ &: & - & 1 \\ &: & - & 1 \\ &: & & - & 1 \\ &: & & & - & 1 \\ &: & & & & - & 1 \\ &: & & & & & - & 1 \\ &: & & & & & & - & 1 \\ &: & & & & & & - & 1 \\ &: & & & & & & & - & 1 \\ &: & & & & & & & & - & 1 \\ &: & & & & & & & & & - & 1 \\ &: & & & & & & & & & & & - & 1 \\ &: & & & & & & & & & & & & & - & 1 \\ &: & & & & & & & & & & & & & & & & & & $	er 19 .8 .6.0 .5% CMC TC Δh 3.14 2.55 2.63 3.05 3.70 4.90 2.65 2.08 2.26 2.70	$V = u = Re = \Delta P$ 9.75 7.92 8.17 9.47 11.49 15.22 8.23 6.46 7.02 8.39	0.0264 2.91 94.6 0.707 0.785 0.773 0.718 0.652 0.566 0.770 0.869 0.834 0.763
Run ] β Τ.F. M.F. 1'-	Number = 0.8 = 86. = 1.5 = TBE C. 1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5	18 0 % CMC Δh 1.40 1.08 1.08 1.19 1.38 1.80 1.25 1.09 1.07 1.21 1.45	$V = u = Re = \Delta P$ 14.3 11.0 11.0 12.2 14.1 18.4 12.8 11.2 10.9 12.4 14.8	0.0353 3.90 143 Co 0.782 0.890 0.890 0.848 0.788 0.690 0.827 0.886 0.894 0.841 0.768	Rur β Τ.Ι Μ.Ι 1'	$ \begin{array}{rcl} n & \text{Numb} \\ &= & 0 \\ &= & 8 \\ \hline &= & 1 \\ \hline &: & = & 0 \\ \hline &: & = & 1 \\ \hline &: & & 1 \\ &: & 1 \\ &:$	er 19 .8 .5% CMC TC Δh 3.14 2.55 2.63 3.05 3.70 4.90 2.65 2.08 2.26 2.70 3.34	V = u = Re = ΔP 9.75 7.92 8.17 9.47 11.49 15.22 8.23 6.46 7.02 8.39 10.37	0.0264 2.91 94.6 0.707 0.785 0.773 0.718 0.652 0.566 0.770 0.869 0.834 0.763 0.686
Run ] β Τ.F. Μ.F. 1'-	Number = 0.8 = 86. = 1.5 = TBE C. 1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6	18 0 % CMC Δh 1.40 1.08 1.08 1.08 1.19 1.38 1.80 1.25 1.09 1.07 1.21 1.45 1.66	$V = u = Re = \Delta P$ 14.3 11.0 11.0 12.2 14.1 18.4 12.8 11.2 10.9 12.4 14.8 17.0	0.0353 3.90 143 Co 0.782 0.890 0.890 0.848 0.788 0.690 0.827 0.886 0.894 0.841 0.768 0.718	Rur β Τ.Ι Μ.Ι Ί'	$ \begin{array}{rcl} n & \text{Numb} \\ &= & 0 \\ &= & 8 \\ \hline &= & 1 \\ \hline &= & 1 \\ \hline &= & 2 \\ &= & 1 \\ &= & 2 \\ &= & 1 \\ &= & 2 \\ &= & 1 \\ &= & 2 \\ &= & 1 \\ &= & 2 \\ &= & 1 \\ &= & 2 \\ &= & 1 \\ &= & 2 \\ &= & 1 \\ &= & 2 \\ &= & 1 \\ &= & 2 \\ $	er 19 .8 .6.0 .5% CMC TC Δh 3.14 2.55 2.63 3.05 3.70 4.90 2.65 2.08 2.26 2.70 3.34 4.41	$V = u = Re = \Delta P$ 9.75 7.92 8.17 9.47 11.49 15.22 8.23 6.46 7.02 8.39 10.37 13.70	0.0264 2.91 94.6 0.707 0.785 0.773 0.718 0.652 0.566 0.770 0.869 0.834 0.763 0.686 0.597
Run 1 p T.F. M.F. 1'-	Number = 0.8 = 86. = 1.5 = TBE C. 1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6 1	18 0 % CMC Δh 1.40 1.08 1.08 1.19 1.38 1.80 1.25 1.09 1.07 1.21 1.45 1.66 1.53	$V = u = Re = \Delta P$ 14.3 11.0 11.0 12.2 14.1 18.4 12.8 11.2 10.9 12.4 14.8 17.0 15.6	0.0353 3.90 143 Co 0.782 0.890 0.890 0.848 0.788 0.690 0.827 0.886 0.894 0.841 0.768 0.718 0.718 0.748	Rur β Τ.Ι Μ.Ι Ί' 2'	$ \begin{array}{rcl} n & \text{Numb} \\ &= & 0 \\ &= & 8 \\ \hline &= & 1 \\ \hline &: & = & 0 \\ \hline &: & = & 1 \\ \hline &: & & 1 \\ &: & 1 \\ $	er 19 .8 .6.0 .5% CMC TC Δh 3.14 2.55 2.63 3.05 3.70 4.90 2.65 2.08 2.26 2.70 3.34 4.41 3.50	$V = u = Re = \Delta P$ 9.75 7.92 8.17 9.47 11.49 15.22 8.23 6.46 7.02 8.39 10.37 13.70 10.87	0.0264 2.91 94.6 0.707 0.785 0.773 0.718 0.652 0.566 0.770 0.869 0.834 0.763 0.686 0.597 0.670
Run 1 <sup>β</sup> T.F. M.F. 1' -	Number = 0.8 = 86. = 1.5 = TBE C. 1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6 1 2 3	18 0 % CMC Δh 1.40 1.08 1.08 1.19 1.38 1.80 1.25 1.09 1.07 1.21 1.45 1.66 1.53 1.27	$V = u = Re = \Delta P$ 14.3 11.0 11.0 12.2 14.1 18.4 12.8 11.2 10.9 12.4 14.8 17.0 15.6 13.0	0.0353 3.90 143 Co 0.782 0.890 0.890 0.848 0.788 0.690 0.827 0.886 0.894 0.841 0.768 0.718 0.748 0.748 0.821	Rur β Τ.Ι Μ.Ι 1' 2'	$ \begin{array}{r} \text{Numb} \\ = 0 \\ = 8 \\ \hline \\ \hline \\ \hline \\ \hline \\ - 1 \\ 2 \\ \hline \\ \\ - 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \\ - 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \\ - 1 \\ 2 \end{array} $	er 19 .8 6.0 .5% CMC TC Δh 3.14 2.55 2.63 3.05 3.70 4.90 2.65 2.08 2.26 2.70 3.34 4.41 3.50 2.95	V = u = Re = ΔP 9.75 7.92 8.17 9.47 11.49 15.22 8.23 6.46 7.02 8.39 10.37 13.70 10.87 9.16	0.0264 2.91 94.6 Co 0.707 0.785 0.773 0.718 0.652 0.566 0.770 0.869 0.834 0.763 0.686 0.597 0.670 0.730
Run 1 <sup>β</sup> T.F. M.F. 1' -	Number = 0.8 = 86. = 1.5 = TBE C. 1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6 7 8 6 7 8 6 7 8 6 7 8 6 7 8 6 7 8 6 7 8 6 7 8 6 7 8 6 7 8 6 7 8 6 7 8 6 7 8 6 7 8 6 7 8 6 7 8 7 8	18 0 % CMC Δh 1.40 1.08 1.08 1.08 1.19 1.38 1.80 1.25 1.09 1.07 1.21 1.45 1.66 1.53 1.27 1.22	$V = u = Re = \Delta P$ 14.3 11.0 11.0 12.2 14.1 18.4 12.8 11.2 10.9 12.4 14.8 17.0 15.6 13.0 12.5	0.0353 3.90 143 Co 0.782 0.890 0.890 0.848 0.788 0.690 0.827 0.886 0.894 0.821 0.718 0.718 0.748 0.748 0.748	Rur β Τ.Ι Μ.Ι 1' 2'	$ \begin{array}{rcl} n & \text{Numb} \\ &= & 0 \\ &= & 8 \\ \hline &= & 1 \\ \hline &= & 1 \\ \hline &= & 2 \\ &= & 1 \\ &= & 2 \\ &= & 1 \\ &= & 2 \\ &= & 1 \\ &= & 2 \\ &= & 1 \\ &= & 2 \\ &= & 1 \\ &= & 2 \\ &= & 1 \\ &= & 2 \\ &= & 1 \\ &= & 2 \\ &= & 1 \\ &= & 2 \\ &= & 1 \\ &= & 2 \\ &= & 1 \\ &= & 2 \\ &= & 1 \\ &= & 2 \\ &= & 2 \\ &= & 1 \\ &= & 2 \\ $	er 19 .8 6.0 .5% CMC TC Δh 3.14 2.55 2.63 3.05 3.70 4.90 2.65 2.08 2.26 2.70 3.34 4.41 3.50 2.95 3.08	V = u = Re = AP 9.75 7.92 8.17 9.47 11.49 15.22 8.23 6.46 7.02 8.39 10.37 13.70 10.87 9.16 9.57	0.0264 2.91 94.6 Co 0.707 0.785 0.773 0.718 0.652 0.566 0.770 0.869 0.834 0.763 0.686 0.597 0.670 0.730 0.714
Run 1 <sup>3</sup> <sup>7</sup> <sup>7</sup> <sup>7</sup> <sup>7</sup> <sup>7</sup> <sup>7</sup> <sup>7</sup> <sup>7</sup>	Number = 0.8 = 86. = 1.5 = TBE C. 1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6 1 5 5 6 7 8 6 7 8 6 7 8 6 7 8 6 7 8 6 7 8 6 7 8 6 7 8 6 7 8 6 7 8 6 7 8 6 7 8 6 7 8 6 7 8 6 7 8 6 7 8 7 8	18 0 % CMC Δh 1.40 1.08 1.08 1.09 1.38 1.80 1.25 1.09 1.07 1.21 1.45 1.66 1.53 1.27 1.22 1.38	$V = u = Re = \Delta P$ 14.3 11.0 11.0 12.2 14.1 18.4 12.8 11.2 10.9 12.4 14.8 17.0 15.6 13.0 12.5 14.1	0.0353 3.90 143 Co 0.782 0.890 0.890 0.848 0.788 0.690 0.827 0.886 0.894 0.821 0.748 0.748 0.748 0.748 0.748 0.748	Rur β Τ.Ι Μ.Ι Ί' 2'	$ \begin{array}{c} n & \text{Numb} \\ & = & 0 \\ & = & 8 \\ \hline & & = & 1 \\ \hline & & & \\ \hline \\ & & & \\ \hline \\ \hline$	er 19 .8 6.0 .5% CMC TC Δh 3.14 2.55 2.63 3.05 3.70 4.90 2.65 2.08 2.26 2.70 3.34 4.41 3.50 2.95 3.08 3.53	$V = u = Re = \Delta P$ 9.75 7.92 8.17 9.47 11.49 15.22 8.23 6.46 7.02 8.39 10.37 13.70 10.87 9.16 9.57 10.96	0.0264 2.91 94.6 Co 0.707 0.785 0.773 0.718 0.652 0.566 0.770 0.869 0.834 0.763 0.686 0.597 0.670 0.730 0.714 0.667
Run 1 <sup>3</sup> T.F. M.F. T.G 1' -	Number = 0.8 = 86. = 1.5 = TBE C. 1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6 1 5 6 1 5 6 1 5 6 5 6 5 7 8 6 1 5 5 7 8 6 1 5 5 7 8 6 1 5 5 5 7 8 6 1 5 5 7 8 6 1 5 5 5 7 8 6 1 5 5 7 8 6 1 5 5 7 8 6 1 5 5 7 8 6 1 5 5 7 8 6 1 5 5 7 8 6 1 5 5 7 8 6 1 5 5 7 8 6 1 5 5 7 8 6 1 5 5 7 8 6 5 7 8 6 1 5 5 7 8 6 5 7 8 6 5 7 8 5 7 8 7 8 5 7 8 7 8 7 8 7 8 7 8 7	18 0 % CMC Δh 1.40 1.08 1.08 1.08 1.08 1.09 1.38 1.80 1.25 1.09 1.07 1.21 1.45 1.66 1.53 1.27 1.22 1.38 1.56	$V = u = Re = \Delta P$ 14.3 11.0 11.0 12.2 14.1 18.4 12.8 11.2 10.9 12.4 14.8 17.0 15.6 13.0 12.5 14.1 16.0	0.0353 3.90 143 Co 0.782 0.890 0.848 0.788 0.690 0.827 0.886 0.894 0.821 0.748 0.748 0.748 0.748 0.748	Rur β Τ.Ι Μ.Ι 1' 2' 3'	$ \begin{array}{c} \text{Numb} \\ = & 8 \\ = & 1 \\ \hline & 1 \\ \hline & & 1 \\ \hline \hline \hline & 1 \\ \hline \hline \hline & 1 \\ \hline \hline & 1 \\ \hline \hline \hline & 1 \\ \hline \hline \hline \hline \hline \hline & 1 \\ \hline \hline$	er 19 .8 6.0 .5% CMC TC Δh 3.14 2.55 2.63 3.05 3.70 4.90 2.65 2.08 2.26 2.70 3.34 4.41 3.50 2.95 3.08 3.53 4.10	$V = u = Re = \Delta P$ 9.75 7.92 8.17 9.47 11.49 15.22 8.23 6.46 7.02 8.39 10.37 13.70 10.87 9.16 9.57 10.96 12.73	0.0264 2.91 94.6 Co 0.707 0.785 0.773 0.718 0.652 0.566 0.770 0.869 0.834 0.763 0.686 0.597 0.670 0.730 0.714 0.667 0.619

Run Numb	er 19			Run Number	20
β = 0	.8	V =	0.0264	β	0.8
T = 8	6.0	u =	2.91	Т	86.0
T.F. = 1	.5% CMC	Re =	94.6	T.F.	1.5%CMC
M.F. = T	BE			M.F.	TBE
T.C.	∆h	∆P	Со	v	0.0218
1' - 1	0.90	9.21	0.728	u	2.42
2	0.72	7.37	0.814	Re	71.7
3	0.76	7.78	0.792	T.C.	1' - 1
4	0.86	9.11	0.732	∆h	0.750
5	1.08	11.05	0.664	ΔP	7.68
6	1.44	14.74	0.576	Co	0.661
21 - 1	0.79	8.08	0.777		
2	0.60	6.14	0.892		
3	0.66	6.75	0.850		
4	0.79	8.08	0.777		
5	1.00	10.23	0.691		
6	1.31	13.41	0.603		
3' - 1	1.05	10.74	0.674		
2	0.89	9.11	0.732		
3	0.91	9.31	0.724		
4	1.04	10.64	0.677		
5	1.22	12.48	0.625		
6	1.56	15.96	0.553		

# TABLE I (Continued)

Run Number	20	21	21	22	22
β	0.8	0,8	0.8	0.8	0.8
Т	86.0	86.0	86.0	86.0	86.0
Τ.Γ.	1.5%CMC	1.5%CMC	1.5%CMC	1.5%CMC	1.5%CMC
M.F.	CTC	CTC	TBE	CTC	TBE
V	0.0218	0.0192	0.0192	0.0116	0.0116
u	2.42	2.12	2.12	1.29	1.29
Re	71.7	59.5	59.5	29.4	29.4
т.с.	1' = 1	1º ~ 1	1' - 1	1: - 1	1' - 1
∆h	2.46	2.06	0.630	1.100	0.310
∆P	7.64	6.40	6.45	3 <b>.42</b>	3.17
Со	0.662	0.635	0.632	0.528	0.548

TABLE I (Continued)

Run Number	23	23	24	24		25
ß	0.8	0.8	0.8	0.8		0.8
Ť	86.0	86.0	86.0	86.0	8	86.0
Τ.Γ.	1.5%CMC	1.5%CMC	1.5%CMC	1.5%CMC	1.5%	CMC
M.F.	CTC	TBE	CTC	TBE		CTC
V	0.0266	0.0266	0.0221	0.0221	0.0	) <b>1</b> 86
u	2.94	2.94	2.44	2.44	2	2.05
Re	93.2	93.2	71.8	71.8	5	56.0
T.C.	1' - 1	1! - 1	1! - 1	1! - 1	11	- 1
∆h	3.45	1.02	2.69	0.80	2	2.05
∆P	10.7	10.4	8.36	8.19	6	5.37
Со	0.680	0.689	0.641	0.648	Ó.	616
Run Number	25	26	26	27		27
в	0.8	0.8	0.8	0.8		0.8
T	86.0	86.0	86.0	86.0	Ę	36.0
T.F.	1.5%CMC	1.5%CMC	1.5%CMC	1.5%CMC	1.5%	%CMC
M.F.	TBE	CTC	TBE	CTC		TBE
V	0.0186	0.0147	0.0147	0.0115	0.0	0115
u	2.05	1.62	1.62	1,27		1.27
Re	56.0	40.2	40.2	28.2	2	28.2
T.C.	11 - 1	1! - 1	1! - 1	1! - 1	11	- 1
Λh	0.62	1.55	0.46	1.28	- 1	1.27
ΛP	6.34	4.81	4.71	3,98		3.68
Co	0.618	0.562	0.568	0,482	0.	.501
					•	
Run Number	28		Run Numbe	er 28		
$\beta = 0.6$	V =	• 0.0866	$\beta = 0$	• 6	V =	= 0.0866
T = 86.0	u =	= 17.0	T = 80	6.0	u =	= 17.0
T.F. = 1.5%	, CMC R <b>e</b> =	= 9 <b>51</b>	T.F. = 1	.5% CMC	Re =	= 951
M.F. = TBE			M.F. = M			
<b>T.C.</b>	∆h ∆P	Со	T.C.	∆h	$\Delta \mathbf{P}$	Co
1' - 1 47	.36 485	0.711	1' - 1	7.39	48 <b>2</b>	0.713
2 47	<b>.</b> 16 482	0.713	2	7.35	480	0.715
3 46	.51 476	0.718	3	7.24	473	0.720
4 45	.43 465	0.726	4	7.07	46 <b>2</b>	0.729
5 42	.61 436	0.750	5	6.63	433	0.752
6 34	.20 350	0.837	6	5.34	348	0.838
2' - 1 47	<b>.21</b> 483	0.712	21 - 1	7.36	480	0.714
2 47	.01 481	0.714	2	7.32	478	0.716
3 46	•29 474	0.719	3	7.21	470	0.722
4 45	.22 462	0.728	4	7.04	460	0.730
5 42	<b>.</b> 59 436	0.750	5	6.64	433	0.752
6 34	<b>15</b> 349	0.837	6	5.34	348	0.838
3' - 1 47	.35 484	0.711	3' - 1	7.38	481	0.713
2 47	.11 482	0.713	2	7.33	478	0.716
3 46	.47 476	0.718	3	7.24	472	0.720
4 45	<b>.28</b> 463	0.727	4	7.04	460	0.730
5 42				-		
J 42	.77 438	0.748	5	6.65	434	0.751

Run Number 29 $\beta = 0.6$ T = 86.0 T.F. = 1.5% CMC M.F. = TBE $T.C. \Delta h$ 1' - 1 22.12 2 21.75 3 21.25 4 20.24 5 19.05 6 16.99	V = 0.0611 u = 12.0 Re = 559 $\Delta P  Co$ 226 0.734 222 0.740 217 0.749 207 0.767 195 0.791 174 0.838	Run Number 29 $\beta = 0.6$ T = 86.0 T.F. = 1.5% CMC M.F. = M $T.C. \Delta h$ $1^{*} - 1$ 3.44 2 3.38 3 3.31 4 3.15 5 2.97 6 2.65	V = 0.0611 u = 12.0 Re = 559 $\Delta P  Co$ 224  0.737 221  0.744 216  0.751 206  0.770 194  0.793 173  0.840
Run Number 30		Run Number 30	
B = 0.6	V = 0.0370	B = 0.6	V = 0.0370
T = 86.0	u = 7.28	T = 86.0	u = 7.28
T.F. = 1.5% CMC M.F. = TBE	R <b>e = 27</b> 4	T.F. = 1.5% CMC M.F. = M	Re = 274
T.C. ∆h	∆P Co	T.C. ∆h	∆P Co
1' - 1 8.28	84.7 0.728	1 - 1 1.30	84.8 0.728
2 7.97	82.0 0.742	2 1.25	81.6 0.742
3 7.33	75.0 0.774	3 1.13	73.8 0.780
4 6.58	67.3 0.816	4 1.03	67.2 0.817
5 6.06	62.0 0.851	5 0.93	60.7 0.860
0 5.82	00.0 0.808	0 0.90	58.8 0.874
Run Number 31		Run Number 31	
β = 0.6	V = 0.0115	$\beta = 0.6$	V = 0.0115
T = 86.0	u = 2.26	T = 86.0	u = 2.26
T.F. = 1.5% CMC	Re = 52.1	T.F. = 1.5% CMC	Re = 52.1
M.F. = TBE		M.F. = CTC	
T.C. $\Delta h$		T.C. $\Delta h$	
1' = 1 = 0.98	10.02 0.038		
2 0.84	0.00 0.710	2 2.72	9.00 0.092
4 0.95	9.72 0.668	5 5.05 6 3.31	10 28 0 649
5 1.07	10.94 0.630	5 3.74	11.62 0.611
6 1.29	13.20 0.574	6 4.48	13.91 0.558
• • • • • • •		• • • • •	
Run Number 32		Run Number 32	
β = 0.6	V = 0.0686	$\beta = 0.6$	V = 0.0686
T = 86.0	u = 13.5	T = 86.0	u = 13.5
T.F. = 1.5% CMC	Re = 673	T.F. = 1.5% CMC	$\mathbf{Re} = 673$
M.F. = TBE		M.F. = M	A.D
T.C. $\Delta h$		T.C. $\Delta h$	
1' - 1 29+18	298 0./18	I'∝I 4.54	290 0./20

•

•

TABLE I (Continued)

β         0.6         0.6         0.6         0.6           T         86.0         86.0         86.0         86.0           T.F.         1.5%CMC         1.5%CMC         1.5%CMC         1.5%CMC         1.5%CMC           M.F.         TBE         M         CTC         TBE         V         0.0485         0.0288         <	0.6
T       86.0       86.0       86.0       86.0         T.F.       1.5%CMC       1.5%CMC       1.5%CMC       1.5%CMC       1.5%CMC         M.F.       TBE       M       CTC       TBE         V       0.0485       0.0288       0.0288       0.0288	86.0
T.F.     1.5%CMC     1.5%CMC     1.5%CMC     1.5%CMC       M.F.     TBE     M     CTC     TBE       V     0.0485     0.0288     0.0288     0.0288	0010
M.F. TBE M CTC TBE V 0.0485 0.0495 0.0288 0.0288 0.	5%CMC
$\mathbf{V}$ 0.0485 0.0495 0.0288 0.0288 0.	М
• • • • • • • • • • • • • • • • • • • •	.0288
u 9.7 9.7 5.6 5.6	5.6
Re 422 422 194 194	194
T.C. $1^{i} - 1$	- 1
Δh 14.15 2.19 15.8 4.82	0.75
ΔP 144 142 48.9 49.3	48.9
Co 0.744 0.748 0.745 0.742 (	0.744
Run Number 35 35 36 36	
β 0.6 0.6 0.6 0.6	
T 86.0 86.0 86.0 86.0	
T.F. 1.5%CMC 1.5%CMC 1.5%CMC 1.5%CMC	
M.F. CTC TBE CTC TBE	
V 0.0214 0.0214 0.0070 0.0070	
u 4.2 4.2 1.4 1.4	
Re 126 126 25.8 25.8	
T.C. $1^{i} - 1$ $1^{i} - 1$ $1^{i} - 1$ $1^{i} - 1$	
Δh 8.32 2.58 1.75 0.53	
ΔP 26.0 26.4 5.44 5.42	
Co 0.762 0.753 0.547 0.548	
Co         0.762         0.753         0.547         0.548           Run Number 37         Run Number 37         Run Number 37         Run Number 37	
Co $0.762$ $0.753$ $0.547$ $0.548$ Run Number 37       Run Number 37       B $= 0.6$ V $= 0.6$ $V$	0.0154
Co $0.762$ $0.753$ $0.547$ $0.548$ Run Number 37Run Number 37 $\beta = 0.6$ $V = 0.0154$ $\beta = 0.6$ $V =$ $T = 86.0$ $u = 3.04$ $T = 86.0$ $u =$	0.0154
Co $0.762$ $0.753$ $0.547$ $0.548$ Run Number 37 $\beta$ $= 0.6$ $V = 0.0154$ $\beta$ $= 0.6$ $V = 1.57$ T $= 86.0$ u $= 3.04$ T $= 86.0$ u $= 1.57$ TF $= 1.57$ CMCRe $= 79.9$ TF $= 1.57$	0.0154 3.04 79.9
Co $0.762$ $0.753$ $0.547$ $0.548$ Run Number 37Run Number 37 $\beta$ = 0.6VT= 86.0uT.F.= 1.5%CMCRe= 79.9T.F.M.F.= CTC	0.0154 3.04 79.9
Co $0.762$ $0.753$ $0.547$ $0.548$ Run Number 37 $\beta$ $= 0.6$ $V$ $= 0.6154$ $\beta$ $= 0.6$ $V$ T $= 86.0$ u $= 3.04$ T $= 86.0$ u $= 1.5\%$ CMCReT.F. $= 1.5\%$ CMCRe $= 79.9$ T.F. $= 1.5\%$ CMCReM.F. $= CTC$ M.F. $= TBE$ T	0.0154 3.04 79.9
Co $0.762$ $0.753$ $0.547$ $0.548$ Run Number 37 $\beta$ $= 0.6$ $V = 0.0154$ $\beta$ $= 0.6$ $V = 0.0154$ T $= 86.0$ u $= 3.04$ T $= 86.0$ uT.F. = 1.5% CMCRe = 79.9T.F. = 1.5% CMCRe =M.F. = CTCM.F. = TBEM.F. = TBET.C. $\Delta h$ $\Delta P$ CoT.C. $\Delta h$ $\Delta P$ CoT.C. $\Delta h$ $\Delta P$	0.0154 3.04 79.9 Co
Co $0.762$ $0.753$ $0.547$ $0.548$ Run Number 37 $\beta$ $= 0.6$ $V = 0.0154$ $\beta$ $= 0.6$ $V =$ T $= 86.0$ u $= 3.04$ T $= 86.0$ u $=$ T.F. = 1.5%CMCRe = 79.9T.F. = 1.5%CMCRe =M.F. = CTCM.F. = TBET.C. $\Delta P$ CoT.C. $\Delta h$ $\Delta P$ 1' - 15.3316.60.6861' - 11.6016.424.7314.60.72921.4214.5	0.0154 3.04 79.9 Co 0.690 0.733
Co $0.762$ $0.753$ $0.547$ $0.548$ Run Number 37 $\beta$ $= 0.6$ $V = 0.0154$ $\beta$ $= 0.6$ $V =$ T $= 86.0$ u $= 3.04$ T $= 86.0$ u $=$ T.F. = 1.5%CMCRe = 79.9T.F. = 1.5%CMCRe =M.F. = CTCM.F. = TBET.C. $\Delta h$ $\Delta P$ CoT.C. $\Delta h$ $\Delta P$ 1' - 15.3316.60.6861' - 11.6016.424.7314.60.72921.4214.533.5511.00.86231.2612.6	0.0154 3.04 79.9 Co 0.690 0.733 0.786
Co $0.762$ $0.753$ $0.547$ $0.548$ Run Number 37 $\beta$ $= 0.6$ $V = 0.0154$ $\beta$ $= 0.6$ $V =$ T $= 86.0$ u $= 3.04$ T $= 86.0$ u $=$ T.F. $= 1.5\%$ CMCRe $= 79.9$ T.F. $= 1.5\%$ CMCRe $=$ M.F. $=$ CTCM.F. $=$ TBET.C. $\Delta h$ $\Delta P$ CoT.C. $\Delta h$ $\Delta P$ CoT.C. $\Delta h$ $\Delta P$ 1' - 15.3316.60.6861' - 11.6016.424.7314.60.72921.4214.533.5511.00.84231.2412.642.5811.10.83841.2612.9	0.0154 3.04 79.9 Co 0.690 0.733 0.784
Co $0.762$ $0.753$ $0.547$ $0.548$ Run Number 37 $\beta$ $= 0.6$ $V = 0.0154$ $\beta$ $= 0.6$ $V = 1$ T $= 86.0$ u $= 3.04$ T $= 86.0$ u $= 1.5\%$ CMCT.F. $= 1.5\%$ CMCRe $= 79.9$ T.F. $= 1.5\%$ CMCRe $= 79.9$ T.F. $= 1.5\%$ CMCRe $= 1.5\%$ CMCM.F. $= CTC$ M.F. $= TBE$ T.C. $\Delta h$ $\Delta P$ CoT.C. $\Delta h$ $\Delta P$ CoT.C. $\Delta h$ $\Delta P$ 1' - 15.3316.60.6861' - 11.6016.424.7314.60.72921.4214.533.5511.00.84231.2412.643.5811.10.83841.2612.954.3813.60.75851.3316.0	0.0154 3.04 79.9 Co 0.690 0.733 0.784 0.780 0.760
Co $0.762$ $0.753$ $0.547$ $0.548$ Run Number 37 $\beta$ $= 0.6$ $V$ $= 0.0154$ $\beta$ $= 0.6$ $V$ T $= 86.0$ u $= 3.04$ T $= 86.0$ u $=$ T.F. = 1.5%CMCRe $= 79.9$ T.F. = 1.5%CMCReM.F. = CTCM.F. = TBET.C. $\Delta h$ $\Delta P$ CoT.C. $\Delta h$ $\Delta P$ 1' - 15.3316.60.6861' - 11.6016.424.7314.60.72921.4214.533.5511.00.84231.2412.643.5811.10.83841.2612.954.3813.60.75851.3314.0652716.60.69061.5816.2	0.0154 3.04 79.9 Co 0.690 0.733 0.784 0.780 0.760 0.694
Co $0.762$ $0.753$ $0.547$ $0.548$ Run Number 37 $\beta$ $= 0.6$ $V = 0.0154$ $\beta$ $= 0.6$ $V =$ T $= 86.0$ u $= 3.04$ T $= 86.0$ u $=$ T.F. = 1.5%CMCRe = 79.9T.F. = 1.5%CMCRe =M.F. = CTCM.F. = TBET.C. $\Delta h$ $\Delta P$ CoT.C. $\Delta h$ $\Delta P$ 1' - 15.3316.60.6861' - 11.6016.424.7314.60.72921.4214.533.5511.00.84231.2412.643.5811.10.83841.2612.954.3813.60.75851.3314.065.2716.40.69061.5816.2	0.0154 3.04 79.9 Co 0.690 0.733 0.784 0.780 0.760 0.694
Co $0.762$ $0.753$ $0.547$ $0.548$ Run Number 37 $\beta$ = 0.6V = 0.0154 T= 0.6V = 7T= 86.0u = 3.04 TT= 86.0u = 7T.F. = 1.5%CMCRe = 79.9 M.F. = CTCT.F. = 1.5%CMCRe = 7T.C. $\Delta h$ $\Delta P$ CoT.F. = 1.5%CMCRe = 7M.F. = CTCM.F. = TBET.C. $\Delta h$ $\Delta P$ CoT.C. $\Delta h$ $2$ $4.73$ $14.6$ $0.729$ $2$ $1.42$ $14.5$ $3$ $3.55$ $11.0$ $0.842$ $4$ $3$ $1.24$ $12.6$ $4$ $3.58$ $11.1$ $0.838$ $5$ $4$ $1.26$ $12.9$ $5$ $4.38$ $13.6$ $0.758$ $6$ $5$ $1.33$ $14.0$ $6$ $5.27$ $16.4$ $0.690$ Run Number 41	0.0154 3.04 79.9 Co 0.690 0.733 0.784 0.780 0.760 0.694
Co $0.762$ $0.753$ $0.547$ $0.548$ Run Number 37 $\beta$ $= 0.6$ $V = 0.0154$ $\beta$ $= 0.6$ $V =$ T $= 86.0$ u $= 3.04$ T $= 86.0$ u $=$ T.F. = 1.5%CMCRe = 79.9T.F. = 1.5%CMCRe =M.F. = CTCM.F. = TBET.C. $\Delta h$ $\Delta P$ CoT.C. $\Delta h$ $\Delta P$ 1' - 15.3316.60.6861' - 11.6016.424.7314.60.72921.4214.533.5511.00.84231.2412.643.5811.10.83841.2612.954.3813.60.75851.3314.065.2716.40.69061.5816.2Run Number 39 $\beta$ $= 0.2$ $V = 0.0183$ $\beta$ $= 0.2$ $V =$	0.0154 3.04 79.9 Co 0.690 0.733 0.784 0.780 0.760 0.694 0.0114
Co $0.762$ $0.753$ $0.547$ $0.548$ Run Number 37 $\beta$ $= 0.6$ $V = 0.0154$ $\beta$ $= 0.6$ $V =$ T $= 86.0$ $u = 3.04$ T $= 86.0$ $u =$ T.F. = 1.5%CMCRe = 79.9T.F. = 1.5%CMCRe =M.F. = CTCM.F. = TBET.C. $\Delta h$ $\Delta P$ CoT.C. $\Delta h$ $\Delta P$ 1' - 15.3316.6 $0.686$ 1' - 11.6016.424.7314.6 $0.729$ 21.4214.533.5511.0 $0.842$ 31.2412.643.5811.1 $0.838$ 41.2612.954.3813.6 $0.758$ 51.3314.065.2716.4 $0.690$ 61.5816.2Run Number 39 $\beta$ $= 0.2$ $V = 0.0183$ $\beta$ $= 0.2$ $V =$ T $= 86.0$ $u = 32.3$ T $= 86.0$ $u =$	0.0154 3.04 79.9 Co 0.690 0.733 0.784 0.780 0.760 0.694 0.0114 20.3
Co $0.762$ $0.753$ $0.547$ $0.548$ Run Number 37 $\beta$ = 0.6V= 0.0154 $\beta$ = 0.6V=T= 86.0u= 3.04T= 86.0u=T.F. = 1.5%CMCRe = 79.9T.F. = 1.5%CMCRe =M.F. = CTCM.F. = TBET.C. $\Delta h$ $\Delta P$ CoT.C. $\Delta h$ $\Delta P$ 1' - 15.3316.60.6861' - 11.6016.424.7314.60.72921.4214.533.5511.00.84231.2412.643.5811.10.83841.2612.954.3813.60.75851.3314.065.2716.40.69061.5816.2Run Number 39Number 39Run Number 41 $\beta$ = 0.2V=T= 86.0u= 32.3T= 86.0u=T.F.= 1.5%CMCRe= 1290T.F.= 1.5%CMCRe	0.0154 3.04 79.9 Co 0.690 0.733 0.784 0.780 0.760 0.694 0.0114 20.3 928
Co $0.762$ $0.753$ $0.547$ $0.548$ Run Number 37 $\beta$ $= 0.6$ $V = 0.0154$ $\beta$ $= 0.6$ $V =$ T $= 86.0$ $u = 3.04$ T $= 86.0$ $u =$ T.F. = 1.5% CMCRe = 79.9T.F. = 1.5% CMCRe =M.F. = CTCT.C. $\Delta h$ $\Delta P$ CoT.C. $\Delta h$ $\Delta P$ CoT.C. $\Delta h$ $\Delta P$ CoT.C. $\Delta h$ $2$ $4.73$ $14.6$ $0.729$ $2$ $3$ $3.55$ $11.0$ $0.842$ $3$ $4$ $3.58$ $11.1$ $0.838$ $4$ $4$ $3.58$ $11.1$ $0.838$ $4$ $4$ $3.6$ $0.758$ $5$ $1.33$ $6$ $5.27$ $16.4$ $0.690$ $6$ Run Number 39 $\beta$ $= 0.2$ $V = 0.0183$ $T$ $= 86.0$ $u = 32.3$ $T$ $= 86.0$ T.F. $= 1.5\%$ CMCRe $= 1290$ $T.F. = 1.5\%$ CMCRe $=$ M.F. $= M$ M.F. $= M$ M.F. $= M$	0.0154 3.04 79.9 Co 0.690 0.733 0.784 0.780 0.760 0.694 0.0114 20.3 928
Co $0.762$ $0.753$ $0.547$ $0.548$ Run Number 37 $\beta$ $= 0.6$ $V = 0.0154$ $\beta$ $= 0.6$ $V =$ T $= 86.0$ u $= 3.04$ T $= 86.0$ u $=$ T.F. = 1.5% CMCRe = 79.9T.F. = 1.5% CMCRe = $M.F. = 1.5\%$ CMCRe =M.F. = CTCM.F. = TBET.C. $\Delta h$ $\Delta P$ CoT.C. $\Delta h$ $\Delta P$ 1' - 15.3316.60.6861' - 11.6016.424.7314.60.72921.4214.533.5511.00.84231.2412.643.5811.10.83841.2612.954.3813.60.75851.3314.065.2716.40.69061.5816.2Run Number 39 $\beta$ $= 0.2$ $V = 0.0183$ $\beta$ $= 0.2$ $V =$ T.F. $= 1.5\%$ CMCRe $= 1290$ T.F. $= 1.5\%$ CMCRe $=$ M.F. $= M$ T.C. $\Delta h$ $\Delta P$ CoT.C. $\Delta h$ $\Delta P$	0.0154 3.04 79.9 Co 0.690 0.733 0.784 0.780 0.760 0.694 0.0114 20.3 928 Co
Co $0.762$ $0.753$ $0.547$ $0.548$ Run Number 37Run Number 37Run Number 37 $\beta$ $= 0.6$ V $= 0.0154$ $\beta$ $= 0.6$ VT $= 86.0$ u $= 3.04$ T $= 86.0$ uT.F. = 1.5% CMCRe = 79.9T.F. = 1.5% CMCRe =M.F. = CTCM.F. = TBET.C. $\Delta h$ $\Delta P$ Co1' - 1 $5.33$ $16.6$ $0.686$ $1' - 1$ $1.60$ $16.4$ $2$ $4.73$ $14.6$ $0.729$ $2$ $1.42$ $14.5$ $3$ $3.55$ $11.0$ $0.842$ $3$ $1.24$ $12.6$ $4$ $3.58$ $11.1$ $0.838$ $4$ $1.26$ $12.9$ $5$ $4.38$ $13.6$ $0.758$ $5$ $1.33$ $14.0$ $6$ $5.27$ $16.4$ $0.690$ $6$ $1.58$ $16.2$ Run Number 39Run Number 41 $\beta$ $= 0.2$ $V$ $= 0.0183$ $\beta$ $= 0.2$ $V$ $= 1.5\%$ CMC $Re$ $T.F.$ $= 1.5\%$ CMC $Re$ $1290$ $T.F.$ $= 1.5\%$ CMC $Re$ $= 1290$ M.F. $= M$ $T.C.$ $\Delta h$ $\Delta P$ $Co$ $T.C.$ $\Delta h$ $\Delta P$ $T.C.$ $\Delta h$ $\Delta P$ $Co$ $T.C.$ $\Delta h$ $\Delta P$ $1' - 1$ $37.60$ $2454$ $0.642$ $1' - 1$ $14.33$ $953$	0.0154 3.04 79.9 Co 0.690 0.733 0.784 0.780 0.760 0.694 0.0114 20.3 928 Co 0.654
Co $0.762$ $0.753$ $0.547$ $0.548$ Run Number 37 $\beta$ $= 0.6$ $V = 0.0154$ $\beta$ $= 0.6$ $V =$ T $= 86.0$ $u = 3.04$ T $= 86.0$ $u =$ T.F. = 1.5% CMCRe = 79.9T.F. = 1.5% CMCRe =M.F. = CTCT.C. $\Delta h$ $\Delta P$ CoT.C.T.C. $\Delta h$ $\Delta P$ CoT.C. $\Delta h$ $2$ $4.73$ $14.6$ $0.729$ $2$ $1.42$ $3$ $3.55$ $11.0$ $0.842$ $3$ $1.24$ $3$ $3.55$ $11.0$ $0.842$ $3$ $1.24$ $4$ $3.58$ $11.1$ $0.838$ $4$ $1.26$ $4$ $3.58$ $11.1$ $0.838$ $4$ $1.26$ $5$ $4.38$ $13.6$ $0.758$ $5$ $1.33$ $6$ $5.27$ $16.4$ $0.690$ $6$ $1.58$ Run Number 39Run Number 41 $\beta$ $= 0.2$ $V$ $\beta$ $= 0.2$ $V$ $= 0.0183$ $T$ $= 86.0$ $u =$ $T.F.$ $= 1.5\%$ CMCRe = 1290 $T.F.$ $= 1.5\%$ CMCRe = $M.F.$ $M$ $\Delta P$ $Co$ $T.C.$ $\Delta h$ $\Delta P$ $1'$ $-1$ $37.60$ $2454$ $0.642$ $1'$ $-1$ $14.33$ $953$ $2$ $37.60$ $2454$ $0.642$ $1'$ $-1$ $14.27$ $932$	0.0154 3.04 79.9 Co 0.690 0.733 0.784 0.780 0.760 0.694 0.0114 20.3 928 Co 0.654 0.655
Co $0.762$ $0.753$ $0.547$ $0.548$ Run Number 37 $\beta$ $= 0.6$ $V = 0.0154$ $\beta$ $= 0.6$ $V =$ T $= 86.0$ u = $3.04$ $\beta$ $= 0.6$ $V =$ T.F. = $1.5\%$ CMCRe = 79.9 $T.F. = 1.5\%$ CMCRe =M.F. = CTCT.C. $\Delta h$ $\Delta P$ CoT.F. = $1.5\%$ CMCRe =T.C. $\Delta h$ $\Delta P$ CoT.C. $\Delta h$ $\Delta P$ 1' - 1 $5.33$ $16.6$ $0.686$ $1' - 1$ $1.60$ $16.4$ 2 $4.73$ $14.6$ $0.729$ $2$ $1.42$ $14.5$ 3 $3.55$ $11.0$ $0.842$ $3$ $1.24$ $12.6$ 4 $3.58$ $11.1$ $0.838$ $4$ $1.26$ $12.9$ $5$ $4.38$ $13.6$ $0.758$ $5$ $1.33$ $14.0$ $6$ $5.27$ $16.4$ $0.690$ $6$ $1.58$ $16.2$ Run Number 39 $Kun Number 41$ $\beta$ $= 0.2$ $V =$ $T = 86.0$ $u =$ $T.F. = 1.5\%$ CMCRe = 1290 $T.F. = 1.5\%$ CMCRe = $M.F. = M$ $T.C.$ $\Delta h$ $\Delta P$ $T.C.$ $\Delta h$ $\Delta P$ $Co$ $T.C.$ $\Delta h$ $\Delta P$ $1' - 1$ $14.33$ $953$ $2$ $37.60$ $2454$ $0.642$ $2$ $14.27$ $932$ $3$ $14.14$ $923$	0.0154 3.04 79.9 Co 0.690 0.733 0.784 0.780 0.760 0.694 0.0114 20.3 928 Co 0.654 0.655 0.658
Co $0.762$ $0.753$ $0.547$ $0.548$ Run Number 37 $\beta$ $= 0.6$ $V = 0.0154$ $\beta$ $= 0.6$ $V =$ T $= 86.0$ u $= 3.04$ T $= 86.0$ u $=$ T.F. = 1.5%CMCRe = 79.9T.F. = 1.5%CMCRe =M.F. = CTCT.C. $\Delta h$ $\Delta P$ CoT.F. = 1.5%CMCRe =T.C. $\Delta h$ $\Delta P$ CoT.C. $\Delta h$ $\Delta P$ 1' - 15.3316.60.6861' - 11.6016.424.7314.60.72921.4214.533.5511.00.84231.2412.643.5811.10.83841.2612.954.3813.60.75851.3314.065.2716.40.69061.5816.2Run Number 39Run Number 41 $\beta$ $= 0.2$ $V =$ T.F. $= 1.5\%$ CMCRe $= 1290$ T.F. $= 1.5\%$ CMCRe $=$ M.F. $= M$ T.C. $\Delta h$ $\Delta P$ 1' $- 1$ 14.33T. 137.6024540.642214.27337.5524510.643314.14923437.4824460.643414.11921	0.0154 3.04 79.9 Co 0.690 0.733 0.784 0.780 0.760 0.694 0.0114 20.3 928 Co 0.654 0.655 0.658 0.658 0.659
Co $0.762$ $0.753$ $0.547$ $0.548$ Run Number 37 $\beta$ $= 0.6$ $V = 0.0154$ $\beta$ $= 0.6$ $V = 1$ T $= 86.0$ $u = 3.04$ T $= 86.0$ $u = 3.04$ T.F. = 1.5% CMCRe = 79.9T.F. = 1.5% CMCRe =M.F. = CTCT.C. $\Delta h$ $\Delta P$ CoT.C. $\Delta h$ $\Delta P$ CoT.C. $\Delta h$ $\Delta P$ CoT.C. $\Delta h$ $2$ $4.73$ $14.6$ $0.729$ $2$ $3$ $3.55$ $11.0$ $0.842$ $3$ $3$ $3.55$ $11.0$ $0.842$ $3$ $4$ $3.58$ $11.1$ $0.838$ $4$ $4$ $3.58$ $11.1$ $0.838$ $4$ $6$ $5.27$ $16.4$ $0.690$ $6$ Run Number 39Run Number 41 $\beta$ $= 0.2$ $\gamma$ $= 1290$ T.F. $= 1.5\%$ CMCRe =M.F. = MT.C. $\Delta h$ $\Delta P$ $Co$ T.F. = 1.5% CMCRe = 1290T.F. $1.5\%$ CMCRe =M.F. = MT.C. $\Delta h$ $\Delta P$ $Co$ $T.C.$ $\Delta h$ $\Delta P$ $Co$ $T.C.$ $\Delta h$ $\Delta P$ $1' - 1$ $37.60$ $2454$ $0.642$ $1' - 1$ $14.33$ $2$ $37.60$ $2454$ $0.643$ $3$ $14.14$ $923$ $3$ $37.48$ $2446$ $0.643$ $4$ $14.11$ $921$ $5$ $37.37$ $2439$ $0.644$ $5$ $1$	0.0154 3.04 79.9 Co 0.690 0.733 0.784 0.780 0.760 0.694 0.0114 20.3 928 Co 0.654 0.655 0.658 0.659 0.660

•

Run Numbe	r 38		Run Nur	nb <b>er 4</b> 6		
$\beta = 0.$	2 V	= 0.0214	β =	0.2	V =	0.0201
T = 86	.0 u	= 37.8	T ==	86.0	u =	35.5
T.F. = 1.	5% CMC Re	e = 1643	T.F. =	1.5% CMC	Re =	2441
M.F. = M			M.F. =	М		
<b>T.C.</b>	∆h ∆l	P Co	T . C.	∆h	ΔP	Co
1' - 1	52.25 341	L1 0.6384	1' - 1	47.32	3089	0.628
2	52.24 341	10 0.6385	2	47.32	3089	0.628
3	52.23 340	0.6386	3	47.11	3075	0.630
4	52.18 340	0.6389	4	47.07	3072	0.630
5	52.14 340	0.6391	5	47.03	3070	0.630
6	51.00 331	L6 0.6475	6	45.80	2990	0.639
$2^{+} - 1$	52.43 342	0.6374	Run Nur	nber 47		
2	52.50 342	0.6372	8 =	0.2	V =	0.0161
3	52.30 341	14 0.6381	т =	86.0	u =	28.5
4	52.24 341	LO 0.6385	$\overline{T}$ .F. =	1.5% CMC	Re =	1734
5	52.04 339	97 0.6397	M.F. =	M		
6	50.65 330	0.6484	Τ.С.	Λh	ΛP	Co
3! - 1	52.23 340	0.6386	1! - 1	29.39	1918	0.641
2	52.23 340	0.6386	2	29.37	1917	0.641
3	52.10 340	0.6394	- 3	29.34	1915	0.642
4	52.03 339	0.6398	4	29.30	1913	0.642
5	52.00 339	94 0.6400	5	29.24	1909	0.643
6	51.00 331	L9 0.6472	6	28.80	1880	0.648
Run Number	40	42	43	44		45
β	0.2	0.2	0.2	0.2		0.2
T	86.0	86.0	86.0	86.0	8	6.0
T.F.	1.5%CMC	1.5%CMC	1.5%CMC	1.5%CMC	1.5%	CMC
M.F.	М	M	M	М		TBE
v	0.0146	0.0131	0.0169	0.0192	0.0	052
u	25.9	23.2	29.9	34.00	9	. 22
Re	939	1114	1575	1882	31	3.8
т.с.	1' - 1	11 - 1	1' - 1	11 - 1	1 '	- 1
∆h	22.91	18.98	33.00	43.44	17	.10
∆P	1495	1239	2154	2836	17	5.0
Co	0.659	0.6491	0.633	0.629	0 ~	686

### TABLE II

### VISCOSITY DATA ANALYSIS AND

### SPECIFIC GRAVITY

### Nomenclature

Т	= Temperature	:	°F
T.F.	= Test fluid		
S.G.	= Specific gravity	:	<b>Ga</b> .
S	= Rotation speed of cylinder	:	RPM
М	= Deflection	:	degree
s.s.	= Shear stress	:	dyne/cm <sup>2</sup>
S.R.	= Shear rate	:	1/sec
K	= Consistency index	:	lb <sub>f</sub> -sec <sup>n'</sup> /ft <sup>2</sup>
γ	= Viscosity index	:	$1b_{f}/ft-sec^{2-n}$

Sample Number 1 (Run Number 1 and 2)

Т	= 78.8	S	M	S.S.	S.R.	K	Ŷ
T.F.	= 0.7% CMC	600	100.0	1204	1042	2.45	1.55
S.G.	= 1.003	300	61.5	740	521	2.53	1.61
n۱	= 0.753	200	45.0	542	348	2.52	1.60
γ	= 1.58	100	26.0	313	174	2,45	1.56

Sample Number 2 (Run Number 4)

Т	= 78.8	S	М	S.S.	S.R.	ĸ	Ŷ
T.F.	= 0.7% CMC	600	88.1	1108	1039	1.73	1.16
s.G.	= 1.002	300	52.7	663	520	1.78	1.20
n'	= 0.785	200	38.2	480	346	1.77	1.20
γ	= 1.18	100	21.6	272	173	1.73	1.16

Sample Number 3 (Run Number 6 and 7)

Т	= 78.8	S	М	S.S.	S.R.	K	γ
T.F.	= 0.7% CMC	600	84.9	1081	1038	1.57	1.07
S.G.	= 1.002	300	50.5	643	519	1.62	1.11
n'	= 0.794	200	36.4	463	346	1.61	1.10
γ	= 1.09	100	20.5	261	173	1.57	1.07

### TABLE II (Continued)

Sample	Number	4	(Run	Number	8)	
--------	--------	---	------	--------	----	--

Т	-	78.8	S	М	S.S.	S.R.	K	Y
T.F.	=	0.7% CMC	600	84.4	1085	1038	1.48	1.03
S.G.	=	1.002	300	49.8	640	519	1.53	1.06
n†	=	0.801	200	36.0	463	346	1.53	1.06
γ	=	1.04	100	20.1	258	173	1.48	1.03

### Sample Number 5 (Run Number 9,10 and 11)

Т	=	78.8	S	М	S.S.	S.R.	K	γ
T.F.	=	0.7% CMC	600	83.8	1076	1038	1.48	1.02
S.G.	=	1.002	300	49.8	639	519	1.53	1.06
n'	=	0.800	200	35.9	461	346	1.53	1.06
γ	=	1.04	100	20.0	256	173	1.48	1.03

# Sample Number 6 (Run Number 13)

Т	= 78.8	S	М	s.s.	S.R.	K	γ
T.F.	= 0.7% CMC	600	79.8	1048	1036	1.26	0.90
S.G.	= 1.002	300	46.8	615	518	1.30	0.93
n'	= 0.816	200	33.5	440	345	1.30	0.93
γ	= 0.92	100	18.5	243	173	1.26	0.90

# Sample Number 7 (Run Number 14)

Т	=	78.8	S	М	S.S.	S.R.	K	γ
T.F.	=	0.7% CMC	600	78.9	1036	1035	1.25	0.89
S.G.	=	1.002	300	46.1	605	518	1.29	0.92
n¹	=	0.816	200	33.0	433	345	1.28	0.91
γ	=	0.90	100	18.3	240	173	1.25	0.90

Sample Number 8 (Run Number 15)

т	= 86.0	S	М	S.S.	S.R.	K	γ
T.F.	= 1.5% CMC	300	223	1018	534	25.6	11.9
S.G.	= 1.001	200	177	810	356	25.8	12.0
n¹	= 0.586	100	117	535	178	25.6	12.0
γ	= 12.0						

Sample Number 9 (Run Number 16)

Т	= 86.0	S	М	s.s.	S.R.	K	γ
T.F.	= 1.5% CMC	300	223	1018	534	25.2	11.8
S.G.	= 1.001	200	176	803	356	25.2	11.8
n'	= 0.590	100	116	533	178	25.2	11.8
Υ	= 11.8						

Sample Number 10 (Run Number 17)

Т	= 86.0	S	м	S.S.	S.R.	K	γ
T.F.	= 1.5% CMC	300	222	1016	534	25.2	11.8
S.G.	= 1.002	200	177	810	356	25.5	11.9
n¹	= 0.590	100	116	533	178	25.2	11.8
γ	= 11.8						

Samp	le	Number 11	(Run Number	18)				
т	=	86.0	S	м	s.s.	S.R.	ĸ	γ
T.F.	<b>1</b> 22	1.5% CMC	300	224	1023	534	26.1	12.1
S.G.	==	1.002	200	178	812	356	26.3	12.2
nt	=	0.584	100	118	539	178	26.2	12.1
Y	=	12.1						

Sample Number 12 (Run Number 19)

Т	= 86.0	S	М	s.s.	S.R.	K	Y
T.F.	= 1.5% CMC	300	223	1021	535	26.6	12.2
S.G.	= 1.002	200	178	815	356	26.8	12.4
nt	= 0.581	100	118	540	178	26.6	12.2
γ	= 12.3						

Sample Number 13 (Run Number 20, 21 and 22)

Т	= 86.0	S	M	s.s.	S.R.	K	Ŷ
T.F.	= 1.5% CM(	300	225	1031	535	27.0	12.4
S.G.	= 1.002	200	180	823	356	27.2	12.5
n¹	= 0.580	100	119	546	178	27.0	12.4
Y	= 12.4						

# TABLE II (Continued)

Samp	le	Number	14	(Run	Number	23, 2	24,	25, 2	26 and	27)			
T T.F. S.G. n <sup>†</sup> Y		86.0 1.5% CM 1.002 0.577 12.8	С		S 300 200 100	M 228 182 121		S.S. 1041 835 554		S.R. 535 357 178		K 27.8 28.1 27.9	γ 12.7 12.9 12.7
Samp	le	Number	15	(Run	Number	28)							
Τ Τ.F. S.G. n' Υ		86.0 1.5% CM 1.000 0.578 12.9	C		S 300 200 100	M 231 183 122		S.S. 1057 838 561		S.R. 535 357 178		K 28.1 28.1 28.1	γ 12.9 12.9 12.9
Sampl	le	Number	16	(Run	Number	29 an	nd 3	0)					
Τ Τ.F. S.G. n <sup>1</sup> Υ		86.0 1.5% CM 1.000 0.576 13.4	С ,		S 300 200 100	M 239 190 127		S.S. 1094 870 581		S.R. 535 357 178		K 29.3 29.4 29.3	Y 13.4 13.4 13.4
Sampl	le	Number	17	(Run	Number	31, 3	32,	33, 3	34, 35	and	36)		
T.F. S.G. n <sup>1</sup> Y		86.0 1.5% CM 1.000 0.565 13.9	С		S 300 200 100	M 236 189 127		S.S. 1080 865 581		S.R. 536 357 178		K 31.0 31.2 31.0	Y 13.8 14.0 13.9
Sampl	le	Number	18	(Run	Number	37							
T T.F. S.G. n' Y		86.0 1.5% CM 1.000 0.567 13.7	С		S 300 200 100	M 235 188 126		S.S. 1075 858 577		S.R. 536 357 179		K 30.4 30.6 30.4	Υ 13.7 13.7 13.7

Sample Number 19 (Run Number 38)

= 86.0 S S.S. S.R. ĸ Т Μ Y 28.4 12.8 300 224 T.F. = 1.5% CMC 1028 536 S.G. = 1.002200 180 822 357 28.6 12.9 n۱ = 0.571 100 120 549 178 28.4 12.8 = 12.9γ

Sample Number 20 (Run Number 39 and 40)

Т	= 86.0	S	M	S.S.	S.R.	ĸ	γ
T.F.	= 1.5% CMC	300	226	1032	535	27.8	12.7
S.G.	= 1.001	200	180	824	357	28.0	12.8
nï	= 0.575	100	120	549	178	27.8	12.7
γ	= 12.7						

### Sample Number 21 (Run Number 41, 42, 43, 44 and 45)

Т	= 86.0	S	М	S.S.	S.R.	K	γ
T.F.	= 1.5% CMC	600	224	1025	1060	12.9	6.50
S.G.	= 0.999	300	141	645	530	12.6	6.33
n۱	= 0.628	200	111	508	353	12.8	6.42
γ	= 6.4	100	72	332	177	12.9	6.48

### Sample Number 22 (Run Number none)

т	= 86.0	S	М	S.S.	S.R.	K	γ
T.F.	= 1.5% CMC	600	222	1014	1060	12.6	6.38
S.G.	= 0.998	300	140	638	530	12.3	6.21
ni	= 0.629	<b>2</b> 00	110	501	353	12.4	6.29
Ŷ	= 6.3	100	72	327	177	12.6	6.36

Sample Number 23 (Run Number 46)

Т	= 86.0	S	М	S.S.	S.R.	ĸ	γ
T.F.	= 1.5% CMC	600	192	881	1067	14.1	6.65
S.G.	= 0.999	300	132	606	533	14.7	6.91
n¹	= 0.593	200	102	469	356	14.4	6.80
γ	= 6.8	100	67	300	178	14.2	6.68

# TABLE II (Continued)

# Sample Number 24 (Run Number 47)

Т	æ	86.0	S	М	S.S.	S.R.	K	γ
T.F.	=	1.5% CMC	600	194	890	1064	13.2	6.35
S.G.	=	0.999	300	134	613	532	13.8	6.65
nt	=	0.604	200	102	467	355	13.4	6.47
γ	=	б.5	100	66	303	177	13.3	6.40

### SAMPLE CALCULATIONS

### Pressure Drop, Reynolds Number, and

### Orifice Coefficient

These were calculated from the manometer reading, flow rate, and viscometer data as follows:

 $\Delta P = \Delta h$  (Sp. Gr. of manometer fluid - 0.998) (62.43) (in./12 ft.)

$$C_{o} = \frac{u_{o}}{\left[\frac{2 g_{c} \Delta P}{\rho (1 - \beta^{4})}\right]^{1/2}}$$

$$Re_{o} = \frac{Dn^{\gamma} u_{o}^{2 - n^{\gamma}} \rho}{\gamma}$$

where Sp. Gr. of manometer fluids available in the literature were

1.595 for carbon tetrachloride

2.965 for tetrabromoethane

13,546 for mercury

at 20°C and for consistency, 0.998 was used for Sp. Gr. of water at 20°C.

From Table I, Run No. 2, tap connection l'-1 and from corresponding Table II, Run No. 2:

 $\Delta h = 7.86$  inches, Manometer Fluid = Mercury

$$D_{o} = (1.610) (0.6) (1/12) ft_{\circ}, \beta = 0.6$$

$$u_{o} = 16.9 ft_{\circ}/sec_{\circ}, g_{c} = 32.17 lb_{\circ m} - ft_{\circ}/lb_{\circ f} - sec_{\circ}^{2}$$

$$\rho = (1.003) (62.43) lb_{\circ m}/ft_{\circ}^{3}, \gamma = (1.58) (0.00672) lb_{\circ m}/ft_{\circ} - sec_{\circ}$$

$$n^{\circ} = 0.753$$

$$\Delta P = (7.86) (13.546 - 0.998) (62.43) (1/12)$$

$$= 513 lb_{\circ f}/ft_{\circ}^{2}$$

$$C_{o} = (16.9) \left(\frac{2 (32.17) (513)}{(1.003) (62.43) (1 - 0.13)}\right)^{1/2} = 0.688$$

$$Re_{o} = \left(\frac{0.688 \times 1.610}{12}\right)^{0.753} \left(\frac{1}{1.58 \times 0.00672}\right) (16.9)^{2-0.753} (1.003)$$

$$= 3020$$

### Viscosity Data Analysis

These calculations were executed by the IBM 7040 computer by means of the least square method to find n' from shear stress versus shear rate plots on log-log coordinates and then obtain  $\gamma_{\circ}$  Shear stress and shear rate are calculated by

$$\tau = \frac{K_{s}M}{2\pi r^{2} L}$$

$$\frac{du}{dy} = \frac{2r_{2}^{2/n^{2}}\Omega}{n^{2}(r_{2}^{2/n^{2}} - r_{1}^{2/n^{2}})}$$

where

K<sub>s</sub> = spring constant of viscometer, dyne-cm./deg. M = angular deflection read from viscometer, deg. r<sub>1</sub> = outer radius of inner cylinder of viscometer, cm. r<sub>2</sub> = inner radius of outer cylinder of viscometer, cm. L = length of the inner cylinder, cm.  $\Omega$  = rotation speed of outer cylinder, radians/sec.

From Table II, Run No. 2:

SPEED 3Ω/π (R.P.M.)	DEFLECTION M (deg.)	SHEAR STRESS τ (dyne/cm. <sup>2</sup> )	SHEAR RATE du/dy (l/sec.)
600,00	100.0	1204	1043
300,00	61.5	740	521
200.00	45.0	542	348
100.00	26.0	313	174

Determining the best straight line fitting the shear stress-shear rate plots on log-log coordinates, find the slope

n' = 0.753 .

Calculating K and K' for each shear rate by Equations 10, 13, 14, and 17:

$$K = \frac{\tau}{\left(\frac{du}{dy}\right)^n}$$
(10)

$$\mathbf{n'} = \mathbf{n} \tag{13}$$

$$K^{*} = K \left(\frac{3n+1}{4n}\right)^{n}$$
(14)

$$\gamma = g_c \ K' \ 8^{n'-1} \tag{17}$$

g/cm. sec. <sup>1-n'</sup>	g/cm. sec. l-n'
2.45	2.60
2.54	2,69
2,52	2.67
2.45	2,60

Taking the average of these four values of K' to obtain finally,

$$\gamma = g_c K' 8^{n'-1} = (980) (2.64) (8)^{0.753-1}$$
  
= 1.59 Poise (g/cm. sec.<sup>1-n'</sup>) .

### TABLE III

### COMPARISON OF COEFFICIENTS AT LIKE REYNOLDS

### NUMBERS IN DISSIMILAR CONDITIONS

β		0.6		0.6
Run Number	8	28	9	29
Reo	894	950	606	559
Concentration (%CMC)	0.7	1.5	0.7	1.5
Orifice Velocity,u <sub>o</sub>	5.39	17.0	3.89	12.0
n'	0.801	0.578	0.800	0.576
Y	1.04	12.9	1.00	13.4
Co	0.721	0.711	0.730	0.734
Difference in Co		1.4%	-	0.55%

β		0.2	1	0.2		
Run Number	11	44	14	42		
Reo	1980	1880	1130	1110		
Concentration (%CMC)	0.7	1.5	0.7	1.5		
Orifice Velocity,u <sub>o</sub>	21.7	34.0	13.1	23.2		
n <sup>t</sup>	0.800	0.628	0.816	0 <b>.62</b> 8		
Y	1.04	6.44	0.904	6.44		
Co	0.623	0.629	0.653	0.649		
Difference in Co		-0.98%	0	.61%		

### TABLE IV

### IMPACT PRESSURE DATA

β	Run No.	Concentration % CMC	Reo	$\Delta P_1$	$\begin{array}{c} \Delta P_2 \\ \text{at } 2! - 1 \end{array}$
		10 0110			
0.8	15	1.5	501	75.56	73.82
0.8	16	1.5	324	44.70	38.05
0.8	17	1.5	209	22.76	20.34
0.8	18	1.5	143	14.60	13.01
0.8	19	1.5	94.6	9.752	8.230
0.6	2	0.7	3020	513.1	522.9
0.6	4	0.7	2560	321.4	321.9
0.6	6	0.7	1910	178.5	178.6
0.6	7	0.7	1200	79.35	79.07
0.6	8	0.7	894	47.39	47.30
0.6	9	0.7	606	23.98	25.47
0.6	28	1.5	951	484.6	483.1
0.2	1	0.7	3700	3429.1	3421.2
0.2	10	0.7	2800	2172.5	2173.8
0.2	11	0.7	1980	· 1174.4	1173.1
0.2	14	0.7	1130	389.2	388.0
0.2	38	1.5	1640	3411.0	3422.5
	· .				
β	Run No.	∆P3	Impàct: P	ressure P	er cent $\Delta P^{i}$ to
β	Run No.	∆P3 at 3' - 1	Impàct:P: !∆P!	ressure Po Δ	er cent ∆P; to P <sub>min</sub> , %
β 0.8	Run No. 15	∆P3 at 3' ∞ 1 77.09	Impact: P: AP: 1.74	ressure Po Δ	er cent ∆P <sup>?</sup> to <sup>P</sup> min. % 2.36
β 0.8 0.8	Run No. 15 16	ΔP3 at 3' - 1 77.09 40.96	Impact: P: !∆P! 1.74 6.05	ressure Po	er cent ∆P <sup>1</sup> to <sup>P</sup> min. <sup>%</sup> 2.36 15.9
β 0.8 0.8 0.8	Run No. 15 16 17	ΔP3 at 3' = 1 77.09 40.96 23.85	Impact: P:	ressure Po	er cent ∆P <sup>1</sup> to <sup>P</sup> min. <sup>%</sup> 2.36 15.9 11.9
β 0.8 0.8 0.8 0.8	Run No. 15 16 17 18	ΔP3 at 3 <sup>1</sup> - 1 77.09 40.96 23.85 10.87	Impact: P: \[\Delta P] 1.74 6.05 2.42 1.59	ressure Ρα Δ	er cent ∆P <sup>?</sup> to <sup>P</sup> min. % 2.36 15.9 11.9 12.2
β 0.8 0.8 0.8 0.8 0.8	Run No. 15 16 17 18 19	ΔP <sub>3</sub> at 3' - 1 77.09 40.96 23.85 10.87 10.87	Impact: P:	ressure Ρα Δ	er cent ∆P <sup>1</sup> to <sup>P</sup> min. % 2.36 15.9 11.9 12.2 17.5
β 0.8 0.8 0.8 0.8 0.8 0.8	Run No. 15 16 17 18 19 2	ΔP <sub>3</sub> at 3' - 1 77.09 40.96 23.85 10.87 10.87 528.8	Impact: P: \[\Delta P! 1.74 6.05 2.42 1.59 1.52 -15.7	ressure Pa	er cent ∆P <sup>1</sup> to Pmin. % 2.36 15.9 11.9 12.2 17.5 -3.05
β 0.8 0.8 0.8 0.8 0.8 0.8 0.6 0.6	Run No. 15 16 17 18 19 2 4	ΔP <sub>3</sub> at 3' - 1 77.09 40.96 23.85 10.87 10.87 528.8 321.0	Impact: P:	ressure Po A 2	er cent $\Delta P^{?}$ to Pmin. % 2.36 15.9 11.9 12.2 17.5 -3.05 0.3
β 0.8 0.8 0.8 0.8 0.8 0.6 0.6 0.6	Run No. 15 16 17 18 19 2 4 6	ΔP <sub>3</sub> at 3' - 1 77.09 40.96 23.85 10.87 10.87 528.8 321.0 178.6	Impact: P:	ressure Po A 2	er cent △P <sup>1</sup> to <sup>P</sup> min. <sup>%</sup> 2.36 15.9 11.9 12.2 17.5 -3.05 0.3 -0.06
β 0.8 0.8 0.8 0.8 0.8 0.6 0.6 0.6	Run No. 15 16 17 18 19 2 4 6 7	ΔP3 at 3' = 1 77.09 40.96 23.85 10.87 10.87 528.8 321.0 178.6 79.04	Impact: P:	ressure Po A 2	er cent △P <sup>1</sup> to Pmin. % 2.36 15.9 11.9 12.2 17.5 -3.05 0.3 -0.06 0.39
β 0.8 0.8 0.8 0.8 0.8 0.6 0.6 0.6 0.6	Run No. 15 16 17 18 19 2 4 6 7 8	ΔP3 at 3' - 1 77.09 40.96 23.85 10.87 10.87 528.8 321.0 178.6 79.04 47.46	Impact: P: △P: 1.74 6.05 2.42 1.59 1.52 -15.7 0.9 -0.1 0.28 0.09	ressure Po A 2	er cent △P <sup>1</sup> to Pmin. % 2.36 15.9 11.9 12.2 17.5 -3.05 0.3 -0.06 0.39 0.2
β 0.8 0.8 0.8 0.8 0.8 0.6 0.6 0.6 0.6 0.6	Run No. 15 16 17 18 19 2 4 6 7 8 9	ΔP <sub>3</sub> at 3' - 1 77.09 40.96 23.85 10.87 10.87 528.8 321.0 178.6 79.04 47.46 24.04	Impact: P:	ressure Pa	er cent $\Delta P^{?}$ to Pmin. % 2.36 15.9 11.9 12.2 17.5 -3.05 0.3 -0.06 0.39 0.2 6.22
β 0.8 0.8 0.8 0.8 0.8 0.6 0.6 0.6 0.6 0.6 0.6	Run No. 15 16 17 18 19 2 4 6 7 8 9 28	ΔP <sub>3</sub> at 3' - 1 77.09 40.96 23.85 10.87 10.87 528.8 321.0 178.6 79.04 47.46 24.04 484.5	Impact: P:	ressure Pa	er cent △P <sup>1</sup> to Pmin. % 2.36 15.9 11.9 12.2 17.5 -3.05 0.3 -0.06 0.39 0.2 6.22 0.30
β 0.8 0.8 0.8 0.8 0.6 0.6 0.6 0.6 0.6 0.6 0.6 0.6 0.2	Run No. 15 16 17 18 19 2 4 6 7 8 9 28 1	ΔP <sub>3</sub> at 3' - 1 77.09 40.96 23.85 10.87 10.87 528.8 321.0 178.6 79.04 47.46 24.04 484.5 3426.5	Impact: P:	ressure Po A 2	er cent △P <sup>1</sup> to Pmin. % 2.36 15.9 11.9 12.2 17.5 -3.05 0.3 -0.06 0.39 0.2 6.22 0.30 0.23
β 0.8 0.8 0.8 0.6 0.6 0.6 0.6 0.6 0.6 0.6 0.6 0.2 0.2	Run No. 15 16 17 18 19 2 4 6 7 8 9 28 1 10	ΔP <sub>3</sub> at 3' = 1 77.09 40.96 23.85 10.87 10.87 528.8 321.0 178.6 79.04 47.46 24.04 484.5 3426.5 2171.2	Impact: P: △P: 1.74 6.05 2.42 1.59 1.52 -15.7 0.9 -0.1 0.28 0.09 1.43 1.5 7.9 2.6	ressure Po 2	er cent $\Delta P^{\dagger}$ to Pmin. % 2.36 15.9 11.9 12.2 17.5 -3.05 0.3 -0.06 0.39 0.2 6.22 0.30 0.23 0.12
β 0.8 0.8 0.8 0.8 0.6 0.6 0.6 0.6 0.6 0.6 0.6 0.2 0.2 0.2	Run No. 15 16 17 18 19 2 4 6 7 8 9 28 1 10 11	ΔP <sub>3</sub> at 3' = 1 77.09 40.96 23.85 10.87 10.87 528.8 321.0 178.6 79.04 47.46 24.04 484.5 3426.5 2171.2 1173.1	Impact: P: <sup>1</sup> △P! 1.74 6.05 2.42 1.59 1.52 -15.7 0.9 -0.1 0.28 0.09 1.43 1.5 7.9 2.6 1.3	ressure Po 2	er cent △P <sup>1</sup> to Pmin. % 2.36 15.9 11.9 12.2 17.5 -3.05 0.3 -0.06 0.39 0.2 6.22 0.30 0.23 0.12 0.11
β 0.8 0.8 0.8 0.6 0.6 0.6 0.6 0.6 0.6 0.6 0.6 0.6 0.2 0.2 0.2 0.2	Run No. 15 16 17 18 19 2 4 6 7 8 9 28 1 10 11 14	ΔP3 at 3' - 1 77.09 40.96 23.85 10.87 10.87 528.8 321.0 178.6 79.04 47.46 24.04 484.5 3426.5 2171.2 1173.1 385.0	Impact: P:	ressure Po 2	er cent △P <sup>1</sup> to Pmin. % 2.36 15.9 11.9 12.2 17.5 -3.05 0.3 -0.06 0.39 0.2 6.22 0.30 0.23 0.12 0.11 0.30
β 0.8 0.8 0.8 0.6 0.6 0.6 0.6 0.6 0.6 0.6 0.6 0.6 0.2 0.2 0.2 0.2	Run No. 15 16 17 18 19 2 4 6 7 8 9 28 1 10 11 14 38	ΔP <sub>3</sub> at 3' - 1 77.09 40.96 23.85 10.87 10.87 528.8 321.0 178.6 79.04 47.46 24.04 484.5 3426.5 2171.2 1173.1 385.0 3409.5	Impact: P:	ressure Pa A 2	er cent △P <sup>1</sup> to Pmin. % 2.36 15.9 11.9 12.2 17.5 -3.05 0.3 -0.06 0.39 0.2 6.22 0.30 0.23 0.12 0.11 0.30 0.382

 $\Delta P^{1} = \text{the greatest value among the differences of } \Delta P_{1} = \Delta P_{2}, \\ \Delta P_{1} = \Delta P_{3}, \text{ and } \Delta P_{2} = \Delta P_{3}.$ 

### VITA

### Kohei Ishihara

#### Candidate for the Degree of

### Master of Science

### Thesis: ORIFICE DISCHARGE COEFFICIENTS FOR CARBOXYMETHYLCELLULOSE SOLUTIONS

Major Field: Chemical Engineering

Biographical:

- Personel Data: Born in Kyoto City, Japan, April 9, 1941, the son of Ujio and Sue Ishihara.
- Education: Attended Takashima High School at Imazu, Shiga, Japan; graduated from Kyoto University, Kyoto, Japan, with the degree of Bachelor of Science in Chemical Engineering, March, 1965; attended Oklahoma State University, Stillwater, Oklahoma, U.S.A., since September, 1965, and completed requirements for Master of Science degree in Chemical Engineering, January, 1967.
- Professional Experience: Employed by Sekaicho Rubber Company, Osaka, Japan, during the month of August, 1964; employed as teaching assistant, School of Chemical Engineering, Oklahoma State University during the school year, 1965-1966.