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ABSTRACT

Under certain conditions, inlets with a Borda type geometry have been shown to exhibit sufficiently strong separation effects to permit the working fluid to flow through the duct as if it were a "free jet."

Mass limiting flow data and associated pressure profiles for tubes of 14, 53, 64, 73, and 105 L/D with a Borda type inlet were taken to determine bounds of the "free jet" phenomena. For a given tube roughness, the limits appear to be one dimensional and dependent only on inlet stagnation conditions. For smooth tubes the upper L/D boundary is related by

$$P_R \approx CT_R^7$$

$$C \approx 1.7\times10^{-4}\ (L/D)^{2.5}$$

where $P_R = P/P_c$ is reduced pressure and $T_R = T/T_c$ is reduced temperature (for fluid nitrogen, T_c = 126.3 K and P_c = 3.417 MPa). The lower bound appears to be saturation conditions at the inlet.

Similar "free jet" effects were found for fluid hydrogen indicating that fluid jetting may be common to all fluids. While limited data on surface roughness show a decrease in the upper L/D limit, nevertheless fluid jetting still occurred.

INTRODUCTION

The stability of seals, bearings and shaft dampers depends critically on the pressure profiles within the clearance passages. The pressure profiles in some passages are in turn critically dependent on inlet geometry and fluid stagnation pressure and temperature. In nearly all cases, simple geometries or combinations of simple geometries are used.

One of the simple inlet geometries which causes a full reversal in the streamline and represents the strongest degree of discontinuity is called the Borda inlet.

Potential flow solutions for several simple two dimensional geometries can be found in references 1 and 2. The pressure profiles and mass limiting flow characteristics for a 53 L/D Borda tube were investigated in reference 3 using fluid nitrogen over a large range of inlet stagnation conditions. Under certain conditions (P_0, T_{0_1}), the discontinuity (separation) was sufficiently strong to permit the fluid to flow through the tube as if it were a free jet for 53 L/D, see figure 1. Under these conditions, the pressure plummets to below the saturation pressure followed by an initial recompression (recovery) (recovery and recompression will be used interchangeably until the physical mechanism is better understood) and remains nearly constant throughout the remainder of the tube - actually the pressure increased over the length to nearly $P_{sat}(T_{0_1})$ at the exit. The contrast with the conventional gaseous case is substantial. For other conditions (P_0, T_{0_2}) the pressure would plummet and recover as before but then a zone of secondary recompression (recovery) would occur somewhere within the tube and the pressure would drop to near $P_{sat}(T_{0_2})$ at the exit.

Since the occurrence of the free jet and the movement of the secondary recompression zone can affect large charges in axial pressure profiles (large changes in forces) it is necessary to know under what conditions one can expect the pressure profile to be (i) "flat" (ii) recompressed within the tube or (iii) behave like a gas. In reference 3 it was found that gas like behavior can be expected where $T_R > 1.2$, and a criterion was proposed to determine where secondary recompression occurred within the 53 L/D Borda tube. The expression for this locus was given as:

$$P_{R_0} = CT_{R_0}^{7} \tag{1}$$

where

$$C(L/D,\varepsilon) = 3.6 \tag{2}$$

It should be noted that the occurrance of the secondary recompression zone within the tube depends only on inlet stagnation conditions and the geometric parameter C. Although C = 3.6 in reference 3, it was assumed that C would be a function of the tube length and surface roughness. Since surface roughness can be related to an equivalent L/D, i.e., through friction factor

$$\lambda(L/D,Re)_{equivalent} = \lambda(L/D,Re)_{smooth} + \lambda(\varepsilon/D,Re)_{roughness} \tag{3}$$

in this paper we elected to study the effect of L/D in smooth (polished) tubes.

In terms of inlet stagnation conditions two constraints will be proposed, L/D and minimum pressure, and a third constraint, roughness will be discussed, as they relate to fluid jetting in a Borda tube. The primary working fluid is nitrogen with some runs made with fluid hydrogen. These data will enable one to extend some results to other fluids.

APPARATUS AND INSTRUMENTATION

The basic flow facility was of the blowdown type and is described in detail in reference 4. A photograph of the installed test section (fig. 2) illustrates the pressure taps and associated plumbing. The flow was upward, around the U and downward through the test section. The flow rates were metered using a venturi flowmeter located in the bottom of the storage tank. Inlet stagnation conditions were measured in the mixing chamber shown immediately behind the scale in figure 2.

The test sections consisted of three components, the Borda inlet (fig. 3), an extension piece and the fixed diffuser, which were very carefully assembled to form a tube (fig. 4). The length of the extension tube was varied to produce the desired L/D. Photographs of these test sections are given as figures 5(a) through (e). The Borda inlet and fixed diffuser are those used and described in reference 3; the extension tube was not instrumented, so the apparatus and instrumentation is essentially that used in reference 3. Only a brief description will be given here for convenience. All test sections except the 14 L/D had eighteen local pressure taps, three stagnation pressures, and a backpressure which were used to establish the axial pressure profiles. The tap locations are given in table I.

The bore of test section was hand lapped using fine emery paper and cutting oil. The surface was smooth but eccentricities and discontinuities at the joints were evident. It was felt that the fixed diffuser was more important, so the joints were tolerated.

RESULTS AND DISCUSSION

The procedure will be to first establish an L/D constraint as the upper limit to free jet flow in terms of the locii for incipient secondary recompression (recovery); then determine a lower limit to free jet flow in terms of the minimum pressure constraint; this is followed by a brief discussion of the third constraint, surface roughness. Finally some results will be extended to other fluids.

L/D Constraint

For each of the four test sections (L/D = 53, 64, 73, and 105), see figures 2 through 5 and table I, critical mass flow rate and pressure profiles will be used to determine the range of inlet stagnation conditions where incipient secondary recompression (recovery) occurs within the Borda tube. Each of the figures will be generalized through the use of reducing parameters or corresponding states parameters.

53 L/D Borda Tube

The most extensive set of critical mass flux and pressure profile data are for the 53 L/D Borda tube as they can combine those of reference 3 and the extended set taken herein. Figure 6 shows the variation of reduced critical mass flux as a function of reduced pressure for several isotherms ranging to $T_{R_0} = 1.5$ and gas. For a given inlet stagnation isotherm, the initial departure of the pressure profiles from the "flat" monotone rise throughout the tube length signals the incipience or appearance of the zone of secondary recompression for that isotherm; care must be taken to determine these inlet stagnation conditions under which incipience occurs. Such a typical profile set is illustrated in figure 7. For the nominal 118 K isotherm, the pressure drops to $P_{sat}(T_0)/4$ followed by an initial recompression to $3P_{sat}(T_0)/4$, and increases in a monotone manner toward $P_{sat}(T_0)$ at the exit. Entropy is a more satisfactory criteria but more difficult to visualize. As the inlet stagnation pressure is decreased, the zone of secondary recompression occurs within the tube; further decreases in stagnation pressure force the merger of the initial and secondary zones of recompression.

From a multiplicity of such pressure profile sets as figure 7 (one set for each isotherm), the locus of incipient secondary recompression can then be constructed as shown in figure 6. Above the locus a free jet occurs and below the locus, secondary recompression occurs somewhere within the tube. It is quite evident that while the pressure profiles can change significantly, there appears little change in the critical mass flux. The data set is given as table II.

64 L/D Borda Tube

Inserting a 5.38 cm uninstrumented tube between the Borda inlet and the fixed diffuser geometry increased the L/D from 53 to 64, see figures 3 to 5. Typical critical mass flux and pressure profiles are given as figures 8 and 9, respectively. As our main goal is to determine the locus of incipient secondary recompression, these data are limited but sufficient to construct the locus on figure 8. The data set is given as table III.

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73 L/D Borda Tube

Inserting a 9.98 cm extenstion tube increased the L/D from 53 to 73, see figures 3 to 5. Pressure profiles and critical mass flux at given stagnation isotherms were again used to establish the incipient secondary recompression locus. The locus was then constructed on figure 10. The data set is given as table IV.

105 L/D Borda Tube

At that time, preliminary Borda tube results indicated that for the 85 K isotherm, a tube of 120 L/D could not sustain a free jet at the pressure limit of our facility.* Because one needs several isotherms in order to establish the incipient locus, it was decided to install a 25.1 cm extension tube which increased the L/D from 53 to 105. Typical pressure profiles are illustrated in figures 11 and 12. In each case, the zone of initial recompression is shown; however, 30.5 cm of the profile is missing. Nevertheless the zone where incipient secondary recompression occurred was quite evident near the Borda tube exit (L = 0 on the figures). Using these data and the critical mass flux data of figure 13, an incipient secondary recompression locus was estimated for the 105 L/D Borda tube. The data are given in table V.

Using figures 6, 8, 10, and 13, one can now construct figure 14 which represents the relation between incipient secondary recompression and inlet stagnation, pressure, and temperature. The reader is first cautioned that exact point of incipience were not possible; and second that the stagnation pressure range between incipience and no incipience was usually large, giving a certain arbitrariness to the selection of the points on figure 14. These selected results are best represented by the form

$$P_{R_0} = C(L/D,\varepsilon)T^{n}_{R_0} \tag{4}$$

where $6.5 < n < 8.5$ and based on these data we selected $n = 7$. Using the intercepts of figure 14, the values of C can be found as a function of L/D for smooth tubes. Figure 15 depicts this relation

$$C(L/D,\varepsilon) = C_1(L/D)^m \tag{5}$$

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*We now feel that 127 would be the limit but even higher L/D should be attained at elevated P_R. $L/D_{system} = \left[2.25/((0.67)^7 \times 1.7\times10^{-4})\right]^{1/2.5} = 137$. As it were, we only have two isotherms.

where $2.5 < m < 3.5$ and selecting $m = 2.5$ gives $C_1 = 1.7\times10^{-4}$. Equations (4) and (5) established an L/D constraint on inlet stagnation conditions for smooth Borda tubes; however, it now appears that roughness plays a greater role than perceived, and is discussed later.

Minimum Pressure Constraint

Consider now the question of how small can the inlet stagnation pressure become and still preserve the jet effect?

Using the same Borda inlet a 14 L/D tube was assembled, see figures 3 to 5. Typical pressure and critical mass flux profiles are shown in figures 16 and 17. The data are given as table VI. The profiles are not as well defined as for the highly instrumented larger L/D sections; but the difference between gas and fluid profiles is quite pronounced. Also note that even for $T_R \rightarrow 1.15$ jetting occurs, however, the locus of incipient secondary recompression is illdefined. It was felt that a small joint imperfection, in assembling the test section was to blame so the apparatus was repolished. The repolishing nearly removed the first pressure tap and made the Borda inlet slightly conical. The tap P_1 now reads between stagnation and separation. See the pressure profiles of figure 18. A correspondingly higher critical mass flux was found, see figure 17. However, the inlet diameter increased 8 percent as estimated from known geometric relations and 4 percent as measured between locations P_1 and P_2 for an average 6 percent. Thus the upper locus of figure 17 must be multiplied by 0.89 to correct G to the proper area. Note that a 6 percent change in inlet diameter with no change in exit diameter (slightly conical inlet) still exhibits a free jet effect. From these data it became evident that a lower L/D limit did not exist but rather the limit was on pressure - the saturation pressure. When the stagnation pressure approached the saturation pressure, there was a significant alteration of the pressure profiles and as such represents the minimum pressure constraint. However, it also appears that fluid jetting can be sustained at conditions above the thermodynamic critical point where the minimum pressure constraint can be represented by the pseudo critical locus. But the extent of application is unclear.

$$P_0\Big|_{min} = \begin{cases} P_{sat} & \text{for } T_R \le 1 \\ P_{pseudo} & \text{for } T_R > 1 \end{cases} \qquad (6)$$

Equation (6) is plotted on figure 14.

Surface Roughness Constraint

All the above criteria are based on the tubes being uniformly smooth; however, the "tubes" had up to two joints, certain eccentricities and to some degree different roughness. While roughness effects can be related to the smooth tube data by equation (3), the L/D and Reynolds numbers required by equation (3) are not available. So such a relation remains academic. Some data for the 23.8 cm extension section (105 L/D test section) in the unpolished condition were taken. Surface roughness increased the effective L/D from 105 to about 128, see figure 14. With more data such a change could then be reflected in equation (5) through the value of ϵ, but only one point is available and indicated on figure 15. It appears that roughness is quite important at large L/D, but with such limited data, only a qualitative statement can be made; surface roughness will diminish the free jet effect and trigger secondary recompression. The effect of friction requires further effort.

Extension to Other Fluids

Although implied but not investigated in reference 3, the extension of these results to other fluids is a necessary step toward any general analysis. In an attempt toward generalization several data points were taken with fluid hydrogen in the 53 L/D Borda tube, see table VII. Figure 20 indicates typical pressure profiles which have the general form as for fluid nitrogen, indicating that a fluid jet can be sustained in fluid hydrogen. Further, using the corresponding states arguments of references 5 to 7, it is implied that such jetting phenomena are characteristic of all single fluids. Figure 20 also indicates that the jetting effect is quite strong even where the inlet stagnation temperature is close to the thermodynamic critical temperature (for hydrogen, $P_c = 1.293$ MPa, $T_c = 33$ K). It should be noted however that the reduced inlet stagnation pressure is quite high i.e., to 6, which is over 2 1/2 times larger than our system will permit for fluid nitrogen. This of course is another reason to operate with fluid hydrogen, namely to at least double the range of application of the reduced results determined with fluid nitrogen.

The reduced critical mass flux data appear as figure 21, as a function of reduced stagnation pressure for selected stagnation isotherms. A comparison of the hydrogen and nitrogen data indicate that the phenomena encountered in the 53 L/D Borda tube follow the applied principles of corresponding states. As such, results determined with fluid nitrogen are applicable to fluid hydrogen and vice versa.

With fluid hydrogen at $P_{R_0} < 1$ system control and measurement become quite difficult. Near $T_{R_0} \sim 1$, the incipient secondary recompression locus appears to behave as a corresponding states parameter but at the lower temperatures and $P_{R_0} < 1$, it does not. Possibly the corresponding states approach may need to be modified to accommodate changes in friction factor. For example, the Reynolds number ratio can be expressed in terms of G* and ξ as

$$\zeta = \frac{Re_{H_2}}{Re_{N_2}} = \frac{G^*_{H_2}}{G^*_{N_2}} \frac{\xi_{H_2}}{\xi_{N_2}} \approx 1.1\ F_Q \tag{7}$$

With the friction factor ratio related by $\zeta^{-1/4}$, and assuming $\lambda\left(\frac{L}{D}\right)_{H_2} = \lambda\left(\frac{L}{D}\right)_{N_2}$,

$$\left(\frac{L}{D}\right)_{H_2} \sim \zeta^{-1/4} \left(\frac{L}{D}\right)_{N_2} \tag{8}$$

F_Q varies from 1.4 near $T_R = 0.65$ to 1.1 near $T_R = 1$, and the effective L/D would increase from 53 to 66 and 58, respectively. Possibly such a trend exists in the data, figure 21, but system control at these low pressures is difficult. While unresolved it appears that the effective L/D should be increased by 10 percent.

SYMBOLS

A	area, cm^2
C	constant of eq. (4)
C_1	constant of eq. (5)
D	tube diameter, cm
F	viscosity correction factor
G	flow rate, g/cm^2-s
G	reduced flow rate, $G_R = G/G^*$
G*	flow normalizing parameter, $\sqrt{P_c \rho_c / Z_c}$, 6010 g/cm^2-s, for nitrogen 1158 g/cm^2-s, for hydrogen
L	tube length, cm
IL	extension length, cm
P	pressure, MPa
P_R	reduced pressure, P/P_c
R	Gas constant, MPa-cm^2/g-K
Re	Reynolds number
T	temperature, K

T_R	reduced temperature, T/T_c
V	specific volume, cm^2/g
Z	compressibility, PV/RT
ρ	density, g/cm
ε	surface roughness ratio
$\xi = \frac{T_c^{1/6}}{\sqrt{m}\,P_c^{2/3}}$	viscosity normalization parameter, where P_c in atmospheres
η	viscosity, g/cm-sec
$\eta^* = \eta\xi$	normalized viscosity
λ	coefficient of friction
Subscripts:	
c	critical
H	hydrogen
N	nitrogen
0	stagnation

REFERENCES

1. Birkhoff, G. and Zarantonello, E. H., Jets, Wakes, and Cavities, Applied Mathematics and Mechanics, Vol. II, Academic Press, New York, (1957).
2. Gurevich, M. I., Theory of Jets in Ideal Fluids, Academic Press, New York, (1965).
3. Hendricks, R. C. and R. J. Simoneau, "Some Flow Phenomena in a Constant Area Duct with a Borda Type Inlet Including the Critical Region." ASME Paper 78-WA/HT-37, (Dec. 1978).
4. Hendricks, R. C., et al., Experimental Heat Transfer Results for Cryogenic Hydrogen Flowing in Tubes at Subcritical and Supercritical Pressures to 800 Pounds Per Square Inch Absolute. NASA Technical Note D-3095, (1966).
5. Hendricks, R. C.,"Normalizing Parameters for the Critical Flow Rate of Simple Fluids through Nozzles," Paper J10 Presented at the Proc. Fifth International Cryogenic Engineering Conference, Kyoto, Japan, (May 1974), pp. 278-281.
6. Hendricks, R. C. and Simoneau, R. J., "Application of the Principle of Corresponding States to Two-Phase Choked Flow," Presented at the 74th National AIChE Meeting, New Orleans, (Mar. 1973), NASA Technical Memo X-68193, (1973).
7. Hendricks, R. C., Simoneau, R. J., and Barrows, R. F., "Two-Phase Choked Flow of Subcooled Oxygen and Nitrogen," NASA Technical Note D-8169, (1976).

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SUMMARY

In this paper, two of three major constraints involved in the Borda tube free jet phenomena, jetting, have been established.

1. Jetting can occur when the inlet stagnation pressures are greater than the incipient secondary recompression locus. For smooth tubes, this locus is defined by

$$P_{R_0} = C(L/D,\varepsilon)T_{R_0}^{n}$$

where

$$C(L/D,\varepsilon) = C_1(L/D)^{m}$$

For fluid nitrogen data, the selected values of n, m, and C_1 are $n = 7$, $m = 2.5$, $C_1 = 1.7\times10^{-4}$. To use this relation for fluid hydrogen, it appears that the actual L/D should be increased by 10 percent, but the question is not yet resolved.

2. Jetting can also occur provided the inlet stagnation pressures are greater than saturation for $T_{R_0} \leq 1$ and pseudocritical where $T_{R_0} > 1$,

$$P_{0_{min}} = \begin{cases} P_{sat}(T_0) & T_{R_0} < 1 \\ P_{pseudo} & T_{R_0} > 1 \end{cases}$$

3. The third constraint, surface roughness, was not established but limited data indicate that it will play a major role. Increased roughness diminishes the free jet phenomena by triggering secondary recompression. At large L/D, small changes in surface roughness can affect significant changes in jetting.

Using fluids nitrogen and hydrogen, the 53 L/D Borda tube results, and the principle of corresponding states, the following three propositions are given:

1. The free jet phenomena appear to be common to all simple fluids in tubes with Borda type inlets with the primary control at the inlet.
2. The phenomena are completely characterized by inlet stagnation conditions and tube geometry.
3. The reduced critical mass flux, $G_R = G/G^*$, follows

the applied corresponding states principles and results attained for fluid nitrogen (or hydrogen) are applicable to all simple fluids.

The latter implies that using fluid hydrogen results, the range of applicability of G_R for fluid nitrogen can be at least doubled, e.g., to $P_R \approx 6$ for $T_R = 0.67$.

TABLE I. - PRESSURE TAP LOCATIONS FOR BORDA TUBES, SEE ALSO FIG. 2

Pressure tap	53 L/D		64 L/D		73 L/D		105 L/D		14 L/D	
	Location		Location		Location		Location		Location	
	cm	in.	cm	in.	cm	in.	cm	in.	cm	in.
	5.38	2.12	10.8	4.25	15.4	6.05	30.5	12		
P_0	Mixing chamber		← Same location →							
P_{01}	Line at top of U									
[a]P_{02}	-23.7	-9.34	-29.2	11.47	-33.8	-13.27	-48.9	-19.22	-5.16	-2.03
P_1	-25.4	-9.98	-30.7	-12.08	-35.3	-13.88	-50.4	-19.8	-6.71	-2.64
P_2	-24.7	-9.73	-30.1	-12.33	-34.7	-14.1	-49.8	-20.1	-6.10	-2.4
P_3	-23.2	-9.12	-28.6	-11.25	-33.2	-13.05	-48.3	-19.0	-4.62	-1.82
P_4	-17.8	-7	P_4 - P_{18} - the same for each L/D						-.97	-.38
P_5	-15.2	-6							-.30	-.12
P_7	-10.2	-4								
P_8	-7.6	-3								
P_9	-5.1	-2								
P_{10}	-2.5	-1								
P_{11}	-1.3	-.5								
P_{12}	.64	-.125								
P_{13}	-.32	-.125								
P_{14}	.32	.125								
P_{15}	.64	.25								
P_{16}	1.3	.5								
P_{17}	2.5	1								
P_{18}	5.1	2								
P_{back}	Immediately upstream of backpressure control valve for all test sections									

[a]At Borda inlet.

TABLE II. - DATA FOR FLUID NITROGEN FLOWING THROUGH A 53 L/D TUBE WITH A BORDA TYPE INLET

All pressures in MPa

Run NO.	w, g/s	T_0, K	P_0, MPa	P_{01}	P_{02}	P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8	P_9	P_{10}	P_{11}	P_{12}	P_{13}	P_{14}	P_{15}	P_{16}	P_{17}	P_{18}	P_{BACK}, MPa	T_R	P_R	C_R
1065	89.4	281.6	2.64	2.82	2.83	1.41	1.84	2.04	1.93	1.85	1.79	1.72	1.62	1.51	1.37	1.25	1.18	1.11	0.56	0.41	0.28	0.13	0.10	0.13	2.230	0.826	0.813E-01
1066	149.0	280.6	4.64	4.60	4.66	2.27	2.98	3.34	3.16	6.47	2.92	2.82	2.65	2.49	2.25	2.06	1.95	1.82	0.93	0.68	0.46	0.21	0.10	0.20	2.222	1.355	0.136
1067	194.0	277.6	5.93	5.88	5.96	2.85	3.77	4.25	4.01	3.84	3.71	3.56	3.35	3.13	2.84	2.61	2.47	2.32	1.20	0.46	0.58	0.28	0.10	0.26	2.198	1.732	0.177
1068	792.0	85.0	4.15	4.06	4.11	0.10	0.11	0.17	0.21	0.21	0.21	0.22	0.21	0.22	0.23	0.23	0.23	0.23	0.19	0.20	0.19	0.16	0.11	0.19	0.673	1.195	0.721
1069	790.0	85.1	4.14	4.05	4.10	0.11	0.11	0.18	0.21	0.22	0.22	0.22	0.22	0.22	0.24	0.24	0.24	0.23	0.19	0.21	0.36	0.78	1.23	1.31	0.674	1.193	0.719
1070	788.0	85.5	4.13	4.04	4.10	0.12	0.12	0.19	0.22	0.23	0.23	0.23	0.23	0.23	0.25	0.25	0.25	0.24	0.19	0.21	0.20	0.70	1.16	1.24	0.677	1.191	0.717
1071	783.0	85.9	4.10	4.02	4.08	0.12	0.13	0.20	0.23	0.24	0.24	0.24	0.24	0.24	0.25	0.27	0.26	0.25	0.20	0.21	0.20	0.17	0.08	0.20	0.680	1.184	0.712
1072	751.0	94.1	4.07	3.99	4.04	0.21	0.22	0.37	0.44	0.46	0.46	0.45	0.46	0.47	0.48	0.50	0.50	0.49	0.40	0.40	0.38	0.31	0.14	0.26	0.745	1.175	0.683
1073	721.0	101.5	4.10	4.02	4.08	0.32	0.34	0.62	0.72	0.75	0.76	0.76	0.76	0.79	0.81	0.83	0.82	0.82	0.65	0.63	0.60	0.46	0.21	0.30	0.804	1.185	0.656
1074	668.0	112.3	4.16	4.09	4.15	0.61	0.62	2.09	2.08	1.98	1.90	1.82	1.72	1.63	1.56	1.52	1.47	1.39	1.02	0.97	0.88	0.64	0.25	0.34	0.889	1.205	0.608
1075	534.0	123.0	4.42	4.37	4.44	1.79	2.04	3.02	2.89	2.82	2.76	2.68	2.62	2.55	2.46	2.36	2.24	2.13	1.67	1.42	1.10	0.58	0.17	0.32	0.974	1.289	0.486
1076	436.0	128.6	4.56	4.53	4.59	2.40	3.06	3.48	3.35	3.31	3.25	3.18	3.13	3.04	2.78	2.61	2.47	2.34	1.53	1.21	0.91	0.46	0.12	0.29	1.018	1.334	0.397
1077	358.0	133.4	4.67	4.64	4.71	2.59	3.24	3.64	3.52	3.45	3.35	3.21	3.07	2.87	2.62	2.46	2.33	2.22	1.34	1.05	0.78	0.39	0.11	0.26	1.056	1.368	0.326
1078	793.0	84.1	4.14	4.04	4.07	0.10	0.10	0.16	0.20	0.20	0.20	0.20	0.20	0.20	0.21	0.21	0.22	0.21	0.17	0.17	0.17	0.15	0.10	0.18	0.666	1.187	0.722
1079	739.0	98.4	4.14	4.06	4.09	0.27	0.28	0.50	0.60	0.61	0.62	0.62	0.63	0.65	0.66	0.67	0.67	0.67	0.53	0.52	0.51	0.40	0.21	0.29	0.779	1.191	0.672
1080	727.0	101.3	4.15	4.06	4.10	0.32	0.33	0.61	0.72	0.73	0.75	0.75	0.76	0.78	0.80	0.81	0.81	0.81	0.63	0.62	0.59	0.46	0.22	0.30	0.802	1.195	0.662
1081	710.0	105.2	4.16	4.08	4.11	0.40	0.41	0.78	0.93	0.95	0.97	0.98	0.99	1.02	1.04	1.05	1.05	1.02	0.79	0.77	0.73	0.55	0.24	0.32	0.833	1.199	0.646
1082	688.0	110.0	4.19	4.11	4.15	0.51	0.52	1.02	1.23	1.54	1.71	1.66	1.56	1.47	1.40	1.35	1.31	1.25	0.90	0.87	0.80	0.60	0.26	0.34	0.871	1.209	0.626
1083	625.0	116.6	4.29	4.23	4.26	1.04	1.11	2.50	2.38	2.29	2.21	2.13	2.04	1.97	1.90	1.84	1.77	1.68	1.22	1.15	1.01	0.67	0.24	0.34	0.923	1.243	0.569
1084	580.0	120.2	4.39	4.33	4.37	1.44	1.60	2.78	2.65	2.56	2.50	2.42	2.35	2.28	2.20	2.12	2.02	1.93	1.40	1.29	1.14	0.65	0.21	0.33	0.952	1.272	0.528
1085	495.0	125.7	4.53	4.48	4.52	2.09	2.60	3.22	3.11	3.04	2.99	2.93	2.86	2.80	2.69	2.59	2.49	2.40	1.63	1.35	1.03	0.55	0.17	0.31	0.995	1.317	0.450
1086	419.0	130.2	4.65	4.61	4.64	2.51	3.18	3.57	3.45	3.39	3.34	3.28	3.22	3.00	2.75	2.59	2.46	2.33	1.46	1.16	0.88	0.46	0.15	0.28	1.031	1.354	0.380
1087	297.0	140.5	4.69	4.64	4.68	2.33	3.04	3.40	3.21	3.11	3.01	2.91	2.79	2.66	2.51	2.33	2.18	2.06	1.24	0.98	0.72	0.34	0.12	0.22	1.112	1.363	0.270
1088	789.0	84.1	4.08	3.97	4.00	0.10	0.10	0.16	0.19	0.19	0.20	0.20	0.19	0.20	0.21	0.21	0.22	0.21	0.17	0.17	0.17	0.15	0.10	0.18	0.666	1.166	0.718
1089	757.0	92.6	4.05	3.95	3.98	0.19	0.19	0.33	0.39	0.39	0.40	0.41	0.40	0.42	0.43	0.43	0.44	0.43	0.35	0.35	0.35	0.28	0.15	0.25	0.733	1.160	0.689
1090	687.0	109.3	4.13	4.04	4.08	0.49	0.50	0.98	1.18	1.20	1.42	1.60	1.51	1.42	1.35	1.30	1.26	1.20	0.87	0.84	0.78	0.59	0.28	0.33	0.865	1.187	0.625
1091	660.0	110.2	4.11	4.02	4.06	0.52	0.53	1.03	1.26	1.78	1.73	1.67	1.56	1.48	1.41	1.36	1.31	1.24	0.90	0.88	0.80	0.60	0.27	0.33	0.873	1.181	0.619
1092	659.0	112.6	4.13	4.04	4.09	0.67	0.68	2.15	2.09	2.00	1.92	1.84	1.74	1.67	1.60	1.55	1.49	1.42	1.03	0.99	0.90	0.64	0.25	0.34	0.893	1.189	0.600
1093	632.0	115.3	4.18	4.10	4.14	0.91	0.95	2.37	2.26	2.17	2.09	2.02	1.93	1.85	1.79	1.73	1.66	1.58	1.15	1.10	0.97	0.66	0.23	0.34	0.913	1.206	0.575
1094	305.0	136.9	4.58	4.53	4.58	2.35	3.10	3.42	3.27	3.16	3.11	3.02	2.86	2.67	2.44	2.29	2.17	2.06	1.22	0.98	0.70	0.34	0.11	0.22	1.084	1.333	0.278
1095	260.0	137.8	4.39	4.35	4.39	2.21	2.91	3.23	3.06	2.97	2.89	2.80	2.69	2.55	2.29	2.14	2.04	1.94	1.15	0.93	0.67	0.32	0.10	0.21	1.091	1.270	0.255
1096	214.0	152.0	4.12	4.06	4.10	1.98	2.60	2.93	2.75	2.64	2.53	2.42	2.29	2.11	1.92	1.78	1.69	1.58	0.86	0.67	0.49	0.25	0.10	0.18	1.203	1.194	0.195
1097	190.0	166.0	4.03	3.97	4.01	1.94	2.55	2.87	2.69	2.59	2.49	2.38	2.24	2.08	1.86	1.74	1.64	1.53	0.83	0.60	0.41	0.22	0.10	0.18	1.314	1.168	0.173
1098	171.0	186.9	4.03	3.97	4.01	1.93	2.55	2.86	2.69	2.58	2.49	2.38	2.24	2.07	1.88	1.73	1.64	1.53	0.82	0.60	0.40	0.18	0.11	0.18	1.480	1.168	0.156
1099	940.0	84.0	5.65	5.53	5.55	0.09	0.10	0.15	0.18	0.19	0.20	0.19	0.19	0.20	0.21	0.20	0.21	0.20	0.16	0.16	0.16	0.14	0.10	0.20	0.665	1.621	0.655
1100	826.0	84.0	4.43	4.33	4.34	0.10	0.10	0.16	0.19	0.20	0.21	0.20	0.20	0.21	0.22	0.22	0.22	0.21	0.17	0.17	0.17	0.15	0.10	0.18	0.665	1.269	0.752
1101	731.0	84.2	3.53	3.46	3.46	0.11	0.11	0.17	0.20	0.20	0.21	0.20	0.20	0.21	0.22	0.23	0.23	0.22	0.18	0.18	0.18	0.15	0.09	0.17	0.667	1.012	0.665
1102	579.0	83.8	2.28	2.27	2.26	0.11	0.12	0.18	0.20	0.20	0.21	0.20	0.20	0.20	0.22	0.23	0.23	0.21	0.17	0.17	0.17	0.15	0.08	0.15	0.663	0.664	0.527
1103	496.0	83.7	1.72	1.69	1.69	0.12	0.13	0.18	0.20	0.20	0.21	0.20	0.20	0.20	0.21	0.23	0.22	0.21	0.17	0.17	0.17	0.15	0.08	0.13	0.663	0.493	0.451
1104	439.0	83.9	1.39	1.36	1.35	0.13	0.14	0.18	0.20	0.21	0.22	0.20	0.20	0.21	0.22	0.23	0.23	0.21	0.17	0.17	0.18	0.15	0.08	0.13	0.664	0.398	0.399
1105	399.0	84.1	1.19	1.18	1.17	0.14	0.15	0.18	0.21	0.21	0.23	0.20	0.21	0.21	0.22	0.23	0.23	0.21	0.19	0.18	0.18	0.15	0.08	0.12	0.666	0.143	0.363
1106	898.0	102.0	5.83	5.71	5.73	0.27	0.29	0.59	0.70	0.72	0.74	0.75	0.76	0.78	0.80	0.81	0.82	0.80	[illegible]	0.62	0.60	0.46	0.26	0.36	0.808	1.674	0.817
1107	787.0	101.5	4.68	4.60	4.60	0.31	0.31	0.61	0.71	0.73	0.75	0.75	0.76	0.79	0.80	0.82	0.82	0.80	0.64	0.62	0.60	0.46	0.24	0.32	0.804	1.346	0.716
1108	651.0	103.0	3.45	3.40	3.40	0.39	0.39	0.71	0.83	0.86	0.87	0.87	0.89	0.91	0.93	0.94	0.93	0.90	0.70	0.68	0.65	0.50	0.22	0.28	0.816	0.994	0.592
1109	537.0	103.5	2.56	2.53	2.52	0.46	0.46	0.77	0.97	1.14	1.16	1.11	1.06	1.00	0.96	0.95	0.91	0.84	0.63	0.61	0.57	0.44	0.19	0.23	0.819	0.740	0.489
1110	418.0	104.0	1.91	1.91	1.89	0.63	0.64	1.20	1.15	1.13	1.10	1.06	1.02	0.98	0.96	0.94	0.89	0.82	0.64	0.61	0.56	0.40	0.13	0.19	0.823	0.556	0.380
1111	324.0	104.2	1.54	1.53	1.52	0.79	0.83	1.13	1.09	1.06	1.06	1.02	1.02	0.98	0.94	0.91	0.85	0.80	0.64	0.60	0.53	0.32	0.10	0.15	0.825	0.447	0.295
1112	262.0	104.1	1.34	1.33	1.32	0.86	0.90	1.07	1.04	1.04	1.02	1.00	0.98	0.93	0.89	0.86	0.81	0.76	0.61	0.56	0.45	0.24	0.09	0.13	0.824	0.388	0.238
1113	855.0	115.4	5.98	5.86	5.86	0.52	0.55	1.23	1.51	1.74	2.30	2.21	2.06	1.93	1.80	1.74	1.70	1.62	1.14	1.07	1.00	0.73	0.37	0.38	0.914	1.716	0.778
1114	736.0	114.7	4.80	4.70	4.71	0.67	0.67	2.42	2.35	2.24	2.15	2.06	1.94	1.84	1.75	1.70	1.65	1.56	1.12	1.05	0.98	0.69	0.31	0.37	0.908	1.377	0.670
1115	595.0	113.9	3.69	3.64	3.63	0.98	1.02	2.19	2.09	2.02	1.95	1.89	1.82	1.75	1.69	1.64	1.56	1.47	1.09	1.02	0.91	0.61	0.23	0.31	0.902	1.063	0.541
1116	419.0	113.1	2.59	2.56	2.55	1.27	1.36	1.87	1.79	1.77	1.73	1.70	1.67	1.62	1.54	1.47	1.39	1.31	1.00	0.92	0.77	0.42	0.14	0.22	0.895	0.748	0.381
1117	263.0	113.3	1.93	1.93	1.91	1.44	1.51	1.62	1.53	1.50	1.46	1.40	1.35	1.27	1.18	1.12	1.05	0.98	0.67	0.54	0.43	0.22	0.09	0.15	0.897	0.563	0.239
1118	1078.0	84.9	7.32	7.22	7.30	0.09	0.09	0.15	0.19	0.19	0.19	0.20	0.19	0.20	0.21	0.22	0.22	0.22	0.17	0.16	0.16	0.14	0.10	0.22	0.672	2.125	0.981
1119	987.0	85.0	6.27	6.15	6.22	0.10	0.10	0.16	0.20	0.21	0.21	0.21	0.20	0.21	0.23	0.23	0.24	0.22	0.17	0.17	0.17	0.15	0.10	0.21	0.673	1.811	0.898

TABLE II. - Continued.

All pressures in MPa

Run NO.	w, g/s	T_0, K	P_0, MPa	P_{0_1}	P_{0_2}	P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8	P_9	P_{10}	P_{11}	P_{12}	P_{13}	P_{14}	P_{15}	P_{16}	P_{17}	P_{18}	P_{BACK}, MPa	T_R	P_R	G_R
1120	839.0	65.1	4.61	4.52	4.57	0.11	0.11	0.18	0.22	0.22	0.22	0.22	0.21	0.23	0.24	0.25	0.25	0.23	0.18	0.18	0.18	0.16	0.09	0.19	0.674	1.330	0.763
1121	651.0	85.3	3.22	3.15	3.18	0.12	0.13	0.19	0.23	0.24	0.23	0.24	0.22	0.24	0.25	0.26	0.26	0.24	0.19	0.20	0.20	0.17	0.08	0.17	0.675	0.927	0.629
1122	610.0	84.9	2.54	2.49	2.51	0.12	0.13	0.19	0.22	0.23	0.23	0.23	0.22	0.23	0.24	0.25	0.25	0.24	0.19	0.19	0.19	0.16	0.08	0.16	0.672	0.730	0.555
1123	561.0	85.2	2.19	2.15	2.16	0.13	0.14	0.20	0.23	0.23	0.23	0.23	0.23	0.23	0.24	0.26	0.26	0.24	0.19	0.20	0.20	0.17	0.08	0.15	0.675	0.631	0.510
1124	532.0	85.8	2.01	1.98	1.98	0.14	0.14	0.21	0.24	0.24	0.24	0.24	0.24	0.24	0.25	0.27	0.27	0.25	0.21	0.21	0.21	0.17	0.08	0.15	0.679	0.579	0.484
1125	479.0	86.6	1.69	1.67	1.67	0.15	0.16	0.23	0.25	0.26	0.26	0.26	0.25	0.26	0.27	0.29	0.29	0.27	0.22	0.22	0.22	0.18	0.09	0.14	0.686	0.488	0.436
1126	978.0	109.4	7.14	7.05	7.12	0.35	0.39	0.89	1.05	1.08	1.11	1.13	1.15	1.19	1.22	1.23	1.27	1.24	0.96	0.93	0.87	0.64	0.34	0.45	0.866	2.073	0.890
1127	894.0	109.3	6.18	6.06	6.13	0.39	0.42	0.91	1.09	1.12	1.15	1.16	1.18	1.22	1.25	1.27	1.29	1.26	0.96	0.93	0.87	0.64	0.32	0.42	0.865	1.784	0.813
1128	749.0	108.6	4.63	4.55	4.59	0.45	0.46	0.94	1.12	1.15	1.17	1.18	1.20	1.24	1.29	1.28	1.27	1.20	0.91	0.90	0.84	0.62	0.27	0.35	0.860	1.337	0.682
1129	606.0	110.3	3.51	3.46	3.49	0.65	0.65	1.88	1.82	1.74	1.68	1.61	1.53	1.46	1.40	1.38	1.32	1.24	0.91	0.87	0.79	0.57	0.22	0.30	0.873	1.016	0.551
1131	370.0	109.9	2.14	2.14	2.15	1.09	1.16	1.58	1.51	1.49	1.47	1.43	1.40	1.36	1.30	1.25	1.18	1.10	0.86	0.80	0.68	0.38	0.11	0.19	0.870	0.626	0.337
1130	481.0	110.3	2.72	2.70	2.72	0.93	0.98	1.75	1.66	1.62	1.58	1.52	1.47	1.43	1.39	1.34	1.27	1.16	0.90	0.65	0.76	0.51	0.16	0.24	0.873	0.793	0.438
1132	262.0	109.6	1.72	1.71	1.72	1.20	1.27	1.43	1.40	1.38	1.35	1.31	1.27	1.20	1.13	1.09	1.03	0.96	0.70	0.59	0.46	0.24	0.08	0.14	0.868	0.502	0.238
1133	882.0	124.6	7.53	7.42	7.50	1.02	1.33	1.89	3.48	3.33	3.20	3.06	2.86	2.69	2.54	2.46	2.42	2.30	1.61	1.58	1.44	0.88	0.37	0.50	0.987	2.184	0.803
1134	827.0	124.6	6.97	6.87	6.95	1.11	1.44	1.97	3.42	3.26	3.14	3.01	2.83	2.69	2.55	2.47	2.42	2.30	1.64	1.61	1.44	0.85	0.34	0.48	0.987	2.023	0.753
1135	708.0	123.6	5.72	5.64	5.71	1.37	1.64	3.37	3.15	3.03	2.93	2.82	2.69	2.58	2.49	2.42	2.35	2.22	1.63	1.59	1.33	0.75	0.27	0.41	0.979	1.661	0.644
1136	538.0	123.2	4.42	4.37	4.42	1.84	2.10	3.04	2.90	2.83	2.77	2.70	2.63	2.56	2.46	2.37	2.26	2.13	1.64	1.40	1.09	0.56	0.17	0.32	0.975	1.285	0.490
1137	300.0	124.0	3.14	3.14	3.16	2.09	2.35	2.52	2.39	2.32	2.26	2.16	2.07	1.95	1.79	1.69	1.60	1.49	0.93	0.74	0.57	0.28	0.08	0.19	0.982	0.922	0.273
1138	253.0	119.9	2.46	2.46	2.46	1.82	1.95	1.96	1.84	1.79	1.74	1.66	1.60	1.49	1.38	1.31	1.23	1.15	0.74	0.59	0.46	0.22	0.11	0.16	0.949	0.719	0.230
1139	212.0	115.5	1.97	1.96	1.96	1.44	1.52	1.53	1.44	1.42	1.37	1.30	1.26	1.18	1.08	1.03	0.97	0.90	0.59	0.47	0.37	0.18	0.11	0.14	0.914	0.574	0.193
1140	505.0	141.6	6.17	6.11	6.18	2.93	3.85	4.46	4.21	4.05	3.97	3.85	3.72	3.57	3.44	3.39	3.36	3.20	1.74	1.39	1.01	0.50	0.18	0.32	1.123	1.799	0.460
1141	301.0	143.5	4.63	4.59	4.64	2.21	2.91	3.31	3.09	2.97	2.86	2.73	2.59	2.41	2.22	2.11	2.04	1.95	1.11	0.95	0.71	0.33	0.11	0.21	1.136	1.350	0.274
1142	219.0	140.9	3.65	3.64	3.65	1.78	2.32	2.62	2.44	2.34	2.26	2.15	2.03	1.88	1.71	1.60	1.52	1.40	0.13	0.70	0.49	0.24	0.11	0.17	1.116	1.066	0.199
1143	122.0	143.6	2.33	2.32	2.31	1.10	1.48	1.66	1.54	1.49	1.44	1.35	1.29	1.18	1.07	1.01	0.95	0.88	0.47	0.34	0.24	0.13	0.12	0.12	1.137	0.677	0.111
1144	74.0	145.1	1.52	1.51	1.49	0.74	0.95	1.07	0.99	0.95	0.92	0.67	0.67	0.75	0.68	0.65	0.61	0.56	0.30	0.21	0.15	0.07	0.12	0.11	1.149	0.438	0.673E-
1145	108.0	229.1	3.03	3.01	3.02	1.48	1.95	2.16	2.04	1.95	1.88	1.81	1.70	1.58	1.43	1.31	1.26	1.17	0.62	0.44	0.30	0.14	0.10	0.16	1.814	0.882	0.983E-
1146	161.0	234.7	4.52	4.49	4.52	2.19	2.69	3.26	3.04	2.91	2.80	2.71	2.53	2.36	2.13	1.96	1.87	1.75	0.92	1.18	1.71	2.09	2.31	2.35	1.858	1.319	0.146
1147	162.0	235.2	4.52	4.50	4.53	2.20	2.90	3.26	3.05	2.92	2.81	2.71	2.54	2.36	2.14	1.96	1.87	1.75	0.92	0.65	0.45	0.20	0.09	0.20	1.862	1.321	0.147
1148	210.0	243.0	5.93	5.89	5.94	2.85	3.77	4.27	4.00	3.82	3.68	3.55	3.33	3.11	2.80	2.57	2.45	2.29	1.20	0.85	0.58	0.26	0.09	0.26	1.924	1.731	0.191
1149	257.0	250.0	7.29	7.25	7.33	3.49	4.63	5.25	4.91	4.70	4.52	4.36	4.09	3.82	3.44	3.16	3.01	2.82	1.47	1.05	0.71	0.31	0.10	0.32	1.979	2.133	0.234
1150	282.0	251.0	7.99	7.97	8.05	3.82	5.06	5.76	5.38	5.16	4.95	4.78	4.49	4.19	3.78	3.47	3.30	3.08	1.62	1.16	0.78	0.34	0.10	0.35	1.987	2.345	0.257
1151	1037.	92.7	7.27	7.14	7.22	0.15	0.17	0.30	0.36	0.37	0.38	0.39	0.39	0.40	0.42	0.41	0.43	0.42	0.33	0.33	0.33	0.27	0.16	0.33	0.734	2.101	0.944
1152	924.0	93.0	5.91	5.80	5.86	0.17	0.19	0.33	0.39	0.40	0.41	0.41	0.41	0.43	0.44	0.45	0.46	0.44	0.35	0.35	0.34	0.28	0.15	0.30	0.736	1.706	0.841
1153	784.0	93.1	4.36	4.28	4.32	0.19	0.21	0.35	0.40	0.42	0.43	0.43	0.42	0.45	0.46	0.47	0.48	0.46	0.36	0.37	0.36	0.29	0.14	0.26	0.737	1.258	0.713
1154	679.0	93.4	3.36	3.31	3.33	0.22	0.23	0.37	0.42	0.44	0.45	0.44	0.44	0.46	0.47	0.49	0.49	0.47	0.38	0.37	0.37	0.29	0.13	0.23	0.740	0.972	0.618
1155	542.0	92.7	2.24	2.20	2.22	0.24	0.24	0.37	0.42	0.43	0.44	0.43	0.43	0.44	0.46	0.47	0.47	0.45	0.36	0.35	0.35	0.28	0.12	0.18	0.734	0.647	0.493
1156	538.0	93.1	2.23	2.19	2.20	0.24	0.25	0.38	0.43	0.44	0.45	0.44	0.44	0.45	0.46	0.48	0.48	0.46	0.37	0.37	0.36	0.29	0.12	0.18	0.737	0.643	0.490
1157	436.0	93.4	1.59	1.58	1.58	0.27	0.28	0.40	0.45	0.46	0.47	0.46	0.46	0.47	0.48	0.49	0.49	0.46	0.37	0.37	0.36	0.28	0.12	0.16	0.740	0.461	0.397
1158	362.0	94.0	1.24	1.23	1.23	0.31	0.31	0.42	0.48	0.49	0.50	0.51	0.53	0.51	0.50	0.50	0.48	0.44	0.34	0.34	0.33	0.27	0.11	0.14	0.744	0.360	0.329
1159	929.0	116.7	7.32	7.20	7.28	0.47	0.53	1.24	1.51	1.57	1.60	1.64	1.68	1.76	1.84	1.82	1.82	1.75	1.29	1.24	1.16	0.82	0.39	0.49	0.924	2.119	0.845
1160	893.0	117.0	6.89	6.77	6.84	0.50	0.55	1.29	1.57	1.63	1.67	1.96	2.20	2.07	1.93	1.86	1.82	1.73	1.20	1.13	1.07	0.78	0.37	0.47	0.926	1.992	0.813
1161	893.0	117.0	6.89	6.77	6.84	0.50	0.55	1.29	1.57	1.63	1.67	1.96	2.20	2.07	1.93	1.86	1.82	1.73	1.20	1.13	1.07	0.78	0.37	0.47	0.926	1.992	0.813
1162	934.0	122.6	7.90	7.81	7.89	0.71	0.87	1.55	1.91	3.13	3.06	2.93	2.71	2.53	2.36	2.29	2.24	2.14	1.44	1.34	1.24	0.93	0.36	0.52	0.971	2.257	0.850
1163	823.0	135.4	8.34	8.25	8.35	1.71	2.99	4.95	4.44	4.26	4.09	3.92	3.72	3.53	3.34	3.26	3.24	3.18	2.36	2.03	1.60	0.87	0.31	0.52	1.072	2.428	0.749
1164	674.0	136.0	7.14	7.06	7.15	2.24	3.71	4.64	4.26	4.13	4.00	3.86	3.71	3.57	3.42	3.37	3.35	3.31	2.26	1.85	1.42	0.74	0.25	0.44	1.077	2.079	0.613
1165	457.0	135.6	5.48	5.45	5.51	2.77	3.56	4.10	3.89	3.82	3.73	3.64	3.57	3.47	3.24	3.04	2.89	2.73	1.62	1.29	0.96	0.49	0.15	0.31	1.074	1.603	0.416
1166	258.0	135.4	3.99	3.97	3.99	2.03	2.66	2.95	2.76	2.69	2.62	2.52	2.44	2.26	2.04	1.91	1.84	1.73	1.02	0.81	0.61	0.28	0.12	0.19	1.072	1.164	0.235
1167	68.0	136.2	1.35	1.33	1.31	0.65	0.83	0.90	0.87	0.84	0.81	0.75	0.73	0.66	0.60	0.58	0.54	0.50	0.26	0.19	0.14	0.07	0.12	0.11	1.078	0.387	0.619E-01
1168	768.0	85.1	3.91	3.82	3.87	0.11	0.11	0.18	0.22	0.22	0.22	0.22	0.22	0.23	0.24	0.24	0.25	0.24	0.19	0.19	0.19	0.16	0.10	0.18	0.674	1.126	0.699
1169	565.0	84.1	2.20	2.15	2.16	0.12	0.12	0.18	0.21	0.21	0.21	0.21	0.21	0.22	0.23	0.23	0.24	0.23	0.18	0.18	0.18	0.15	0.09	0.14	0.666	0.631	0.514
1170	467.0	84.1	1.56	1.52	1.53	0.13	0.13	0.18	0.21	0.21	0.21	0.21	0.21	0.21	0.23	0.23	0.23	0.23	0.18	0.18	0.18	0.15	0.09	0.13	0.666	0.446	0.425
1171	467.0	84.1	1.57	1.53	1.53	0.13	0.13	0.18	0.20	0.21	0.21	0.21	0.21	0.22	0.22	0.23	0.23	0.22	0.18	0.18	0.18	0.15	0.09	0.13	0.666	0.448	0.425
1172	400.0	84.3	1.20	1.17	1.17	0.14	0.14	0.19	0.21	0.21	0.21	0.21	0.21	0.21	0.22	0.23	0.23	0.22	0.18	0.18	0.18	0.15	0.08	0.12	0.667	0.342	0.364
1173	371.0	84.6	1.06	1.04	1.04	0.14	0.15	0.19	0.21	0.22	0.22	0.22	0.22	0.21	0.23	0.23	0.24	0.23	0.19	0.19	0.19	0.16	0.08	0.12	0.670	0.305	0.338
1174	335.0	85.0	0.91	0.90	0.89	0.15	0.15	0.20	0.22	0.23	0.23	0.22	0.23	0.22	0.23	0.24	0.24	0.23	0.19	0.19	0.19	0.16	0.09	0.12	0.673	0.262	0.305
1175	844.0	126.5	7.69	7.55	7.67	1.18	1.61	2.05	3.66	3.49	3.35	3.22	3.02	2.86	2.70	2.60	2.55	2.45	1.81	1.77	1.50	0.89	0.36	0.51	1.002	2.228	0.768

TABLE II. - Continued.

All pressures in MPa

Run NO.	w, g/s	T_0, K	P_0, MPa	P_{01}	P_{02}	P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8	P_9	P_{10}	P_{11}	P_{12}	P_{13}	P_{14}	P_{15}	P_{16}	P_{17}	P_{18}	P_{BACK}, MPa	T_R	P_R	G_R
1176	733.0	126.9	6.59	6.48	6.58	1.41	1.91	3.86	3.54	3.38	3.27	3.16	3.01	2.89	2.76	2.69	2.62	2.51	1.95	1.79	1.44	0.80	0.30	0.45	1.005	1.911	0.667
1177	526.0	126.8	4.90	4.84	4.91	2.09	2.73	3.44	3.28	3.20	3.13	3.06	2.99	2.91	2.82	2.73	2.64	2.57	1.75	1.45	1.11	0.57	0.19	0.34	1.004	1.426	0.479
1178	332.0	125.7	3.58	3.55	3.59	2.26	2.69	2.90	2.76	2.69	2.61	2.51	2.42	2.27	2.09	1.96	1.86	1.75	1.09	0.88	0.67	0.33	0.11	0.22	0.995	1.044	0.302
1179	149.0	122.6	2.78	2.77	2.80	1.81	1.98	2.15	2.04	1.98	1.91	1.84	1.76	1.65	1.52	1.43	1.35	1.27	0.77	-0.42	0.48	0.23	0.09	0.17	0.971	0.814	0.136
1180	122.0	120.2	2.49	2.47	2.49	1.72	1.86	1.93	1.83	1.78	1.72	1.65	1.59	1.49	1.37	1.29	1.22	1.14	0.71	0.57	0.44	0.22	0.10	0.16	0.952	0.726	0.111
1181	208.0	116.5	2.06	2.05	2.06	1.50	1.60	1.62	1.53	1.49	1.44	1.38	1.33	1.24	1.14	1.08	1.02	0.95	0.61	0.49	0.38	0.19	0.10	0.14	0.922	0.502	0.189
1182	177.0	111.7	1.60	1.60	1.59	1.21	1.27	1.27	1.19	1.16	1.12	1.07	1.04	0.96	0.69	0.84	0.80	0.74	0.48	0.40	0.31	0.16	0.10	0.13	0.884	0.466	0.161
1183	569.0	150.0	7.92	7.84	7.96	3.10	4.38	5.37	4.99	4.78	4.60	4.40	4.17	3.91	3.61	3.44	3.37	3.30	0.11	1.79	1.32	0.65	0.24	0.41	1.188	2.311	0.518
1184	411.0	154.2	6.65	6.57	6.67	2.97	4.02	4.67	4.34	4.16	3.99	3.82	3.60	3.35	3.03	2.82	2.69	2.53	0.24	1.35	0.95	0.49	0.16	0.31	1.221	1.937	0.374
1185	345.0	150.0	5.66	5.61	5.69	2.64	3.51	4.04	3.75	3.60	3.46	3.31	3.13	2.91	2.64	2.46	2.35	2.24	1.37	1.16	0.84	0.41	0.12	0.26	1.188	1.654	0.314
1186	222.0	148.9	4.10	4.06	4.11	2.00	2.62	2.95	2.75	2.64	2.55	2.43	2.30	2.13	1.93	1.80	1.71	1.59	0.12	0.73	0.53	0.26	0.11	0.19	1.179	1.195	0.202
1187	103.0	151.2	2.16	2.13	2.14	1.06	1.38	1.54	1.44	1.38	1.33	1.26	1.20	1.11	1.00	0.93	0.89	0.82	0.12	0.31	0.22	0.11	0.12	0.12	1.197	0.626	0.937E-01
1236	1159.0	85.5	8.59	8.48	8.58	0.08	0.10	0.16	0.23	0.20	0.20	0.20	0.20	0.21	0.22	0.22	0.22	0.22	0.18	0.17	0.17	0.14	0.13	0.24	0.677	2.497	1.05
1237	1145.0	86.0	8.44	8.34	8.44	0.05	0.11	0.17	0.24	0.22	0.22	0.22	0.21	0.22	0.23	0.24	0.24	0.23	0.19	0.18	0.18	0.15	0.09	0.25	0.681	2.456	1.04
1238	1028.0	86.0	6.87	6.72	6.81	0.10	0.12	0.18	0.24	0.23	0.23	0.23	0.22	0.23	0.25	0.26	0.26	0.24	0.19	0.19	0.19	0.16	0.08	0.23	0.681	1.979	0.935
1239	970.0	86.1	4.98	4.87	4.93	0.12	0.13	0.20	0.25	0.24	0.25	0.24	0.24	0.24	0.26	0.27	0.28	0.25	0.21	0.20	0.20	0.17	0.07	0.21	0.682	1.435	0.792
1240	1070.0	104.2	8.11	7.95	8.04	0.26	0.29	0.62	0.74	0.77	0.79	0.79	0.81	0.84	0.87	0.88	0.89	0.87	0.70	0.69	0.65	0.49	0.29	0.45	0.825	2.340	0.974
1241	968.0	103.6	6.91	6.76	6.84	0.28	0.31	0.65	0.76	0.79	0.80	0.81	0.82	0.86	0.87	0.89	0.91	0.89	0.71	0.69	0.66	0.50	0.27	0.41	0.820	1.990	0.881
1242	801.0	102.9	4.94	4.84	4.89	0.32	0.33	0.67	0.77	0.80	0.82	0.82	0.83	0.86	0.88	0.89	0.91	0.88	0.69	0.67	0.65	0.49	0.24	0.34	0.815	1.424	0.729
1243	1023.0	111.9	8.12	7.92	8.01	0.36	0.41	0.98	1.16	1.20	1.23	1.24	1.28	1.33	1.35	1.38	1.41	1.38	1.08	1.04	0.97	0.70	0.37	0.50	0.886	2.331	0.931
1244	883.0	111.2	6.39	6.26	6.33	0.41	0.45	1.00	1.20	1.23	1.27	1.27	1.31	1.35	1.38	1.40	1.42	1.38	1.06	1.02	0.96	0.69	0.34	0.44	0.880	1.842	0.809
1245	716.0	110.3	4.44	4.35	4.39	0.50	0.51	1.04	1.23	1.34	1.76	1.69	1.60	1.50	1.42	1.38	1.34	1.26	0.91	0.87	0.82	0.61	0.29	0.35	0.873	1.278	0.652
1246	1032.0	114.0	8.83	8.76	8.86	0.45	0.54	1.32	1.60	1.66	1.71	1.73	1.80	1.87	1.92	1.95	1.98	1.90	1.42	1.37	1.27	0.87	0.38	0.55	0.903	2.579	0.939
1247	912.0	118.0	7.16	7.01	7.10	0.51	0.57	1.33	1.64	1.69	2.26	2.48	2.32	2.15	2.00	1.94	1.90	1.80	1.24	1.15	1.11	0.79	0.36	0.49	0.934	2.064	0.830
1248	792.0	117.2	5.74	5.62	5.69	0.62	0.65	2.80	2.69	2.55	2.44	2.31	2.18	2.05	1.94	1.89	1.84	1.74	1.22	1.15	1.08	0.74	0.31	0.43	0.928	1.656	0.721
1249	1259.0	86.2	10.13	9.95	10.07	0.08	0.10	0.17	0.21	0.21	0.20	0.20	0.20	0.21	0.22	0.22	0.23	0.22	0.17	0.17	0.17	0.14	0.10	0.26	0.683	2.929	1.15
1250	1169.0	86.5	9.15	8.98	9.10	0.09	0.11	0.18	0.23	0.23	0.22	0.23	0.22	0.23	0.24	0.25	0.25	0.24	0.18	0.18	0.18	0.15	0.08	0.26	0.685	2.646	1.08
1251	1097.0	86.7	7.85	7.71	7.81	0.11	0.12	0.20	0.24	0.24	0.23	0.24	0.23	0.24	0.26	0.27	0.27	0.25	0.20	0.19	0.19	0.16	0.07	0.25	0.686	2.271	0.998
1252	1100.0	119.1	10.11	9.89	10.01	0.41	0.51	1.28	1.53	1.59	1.63	1.67	1.73	1.80	1.85	1.87	1.91	1.88	1.43	1.38	1.24	0.86	0.43	0.60	0.943	2.913	1.00
1253	1047.0	118.9	9.34	9.16	9.28	0.43	0.52	1.29	1.55	1.62	1.66	1.70	1.77	1.82	1.87	1.89	1.93	1.89	1.42	1.36	1.24	0.86	0.40	0.57	0.941	2.699	0.953
1254	955.0	118.1	7.89	7.75	7.85	0.48	0.55	1.31	1.59	1.65	1.69	1.72	1.78	1.86	1.95	1.93	1.92	1.83	1.33	1.28	1.20	0.84	0.37	0.52	0.935	2.283	0.870
1255	881.0	117.5	6.85	6.73	6.82	0.52	0.57	1.33	1.62	1.69	2.46	2.43	2.27	2.11	1.97	1.91	1.87	1.76	1.22	1.13	1.08	0.77	0.34	0.47	0.930	1.981	0.802
1256	1052.0	127.8	10.45	10.30	10.43	0.91	1.34	1.89	2.13	2.21	3.02	3.51	3.26	3.02	2.77	2.64	2.62	2.50	1.78	1.75	1.58	1.00	0.40	0.62	1.012	3.034	0.957
1257	988.0	128.2	9.73	9.57	9.70	1.04	1.52	2.02	2.21	3.71	3.69	3.52	3.26	3.03	2.80	2.70	2.66	2.54	1.87	1.82	1.59	0.98	0.37	0.59	1.015	2.820	0.899
1291	1265.0	91.7	10.40	10.26	10.41	0.11	0.14	0.25	0.32	0.30	0.31	0.32	0.32	0.33	0.34	0.34	0.35	0.34	0.27	0.26	0.26	0.21	0.13	0.36	0.726	3.025	1.15
1292	1104.0	90.4	8.09	7.94	8.06	0.13	0.14	0.24	0.31	0.30	0.31	0.31	0.32	0.32	0.34	0.35	0.35	0.33	0.27	0.26	0.26	0.21	0.11	0.31	0.716	2.342	1.00
1293	906.0	89.7	5.52	5.41	5.49	0.14	0.15	0.26	0.31	0.32	0.31	0.32	0.32	0.33	0.34	0.36	0.36	0.34	0.27	0.27	0.27	0.22	0.10	0.26	0.710	1.595	0.824
1294	1122.0	121.7	10.53	10.37	10.52	0.43	0.56	1.40	1.69	1.75	1.80	1.85	1.91	2.00	2.06	2.08	2.14	2.10	1.57	1.50	1.33	0.92	0.42	0.62	0.964	3.058	1.02
1295	1027.0	122.7	9.38	9.23	9.37	0.55	0.69	1.48	1.84	1.91	1.95	2.07	2.66	2.60	2.39	2.28	2.25	2.15	1.47	1.35	1.27	0.96	0.40	0.58	0.971	2.722	0.934
1296	954.0	122.3	8.33	8.19	8.33	0.62	0.76	1.51	1.87	2.66	3.09	2.98	2.75	2.55	2.36	2.26	2.23	2.13	1.44	1.33	1.23	0.94	0.37	0.54	0.968	2.417	0.868
1297	853.0	121.4	6.96	6.85	6.95	0.71	0.83	1.57	3.22	3.06	2.91	2.78	2.60	2.43	2.29	2.21	2.18	2.07	1.41	1.31	1.20	0.69	0.32	0.48	0.961	2.020	0.776
1298	1011.0	134.5	10.86	10.77	10.92	1.29	2.09	2.29	4.91	4.67	4.43	4.20	3.86	3.58	3.28	3.13	3.11	3.01	2.35	2.21	1.74	1.03	0.38	0.63	1.065	3.174	0.920
1299	1036.0	125.1	9.85	9.66	9.80	0.75	1.01	1.64	1.98	2.05	2.22	3.20	3.04	2.82	2.58	2.45	2.42	1.71	1.58	1.49	1.41	0.98	0.45	0.60	0.990	2.847	0.943
1300	1043.0	126.2	10.12	10.01	10.15	0.81	1.13	1.73	2.03	2.11	2.28	3.27	3.13	2.91	2.66	2.53	2.50	2.40	1.63	1.58	1.47	0.99	0.44	0.61	0.999	2.951	0.949
1301	1040.0	128.5	10.43	10.34	10.48	0.97	1.45	1.98	2.18	2.63	3.75	3.63	3.35	3.10	2.83	2.70	2.67	2.58	1.87	1.83	1.61	1.00	0.42	0.62	1.017	3.047	0.946
1302	1025.0	130.5	10.53	10.46	10.60	1.09	1.70	2.12	2.31	4.12	4.02	3.82	3.53	3.26	2.98	2.85	2.82	2.71	2.06	1.99	1.64	1.01	0.41	0.62	1.033	3.081	0.933
1303	926.0	132.5	9.55	9.41	9.56	1.33	2.05	2.24	4.42	4.24	4.05	3.86	3.60	3.36	3.12	3.02	2.99	2.90	2.27	2.11	1.67	0.98	0.37	0.58	1.049	2.776	0.843
1304	798.0	134.4	8.35	8.24	8.37	1.60	2.42	4.86	4.42	4.21	4.02	3.86	3.66	3.48	3.28	3.20	3.18	3.11	2.42	2.04	1.61	0.89	0.31	0.52	1.064	2.430	0.726
1305	644.0	135.6	7.05	6.97	7.06	2.19	3.71	4.59	4.25	4.11	3.97	3.84	3.71	3.56	3.42	3.36	3.35	3.30	2.31	1.85	1.41	0.74	0.24	0.44	1.074	2.053	0.586
1306	388.0	133.7	4.92	4.90	4.95	2.67	3.37	3.81	3.65	3.59	3.52	3.44	3.33	3.11	2.84	2.68	2.55	2.40	1.44	1.14	0.84	0.42	0.12	0.28	1.059	1.442	0.353
1307	727.0	88.9	3.63	3.55	3.57	0.15	0.14	0.25	0.28	0.31	0.30	0.29	0.31	0.31	0.31	0.33	0.33	0.32	0.26	0.26	0.64	1.09	1.31	1.35	0.704	1.042	0.662
1308	723.0	89.2	3.61	3.53	3.57	0.15	0.14	0.26	0.28	0.32	0.31	0.29	0.32	0.32	0.32	0.35	0.35	0.33	0.37	0.55	1.02	1.29	1.46	1.51	0.706	1.039	0.658
1309	721.0	89.5	3.60	3.53	3.56	0.16	0.15	0.27	0.29	0.33	0.32	0.30	0.33	0.33	0.32	0.36	0.36	0.34	0.56	0.87	1.17	1.37	1.53	1.58	0.709	1.037	0.656
1310	719.0	90.4	3.59	3.52	3.55	0.17	0.17	0.29	0.31	0.35	0.34	0.32	0.35	0.35	0.35	0.41	0.49	0.58	0.99	1.15	1.35	1.50	1.64	1.71	0.716	1.035	0.654
1311	715.0	91.4	3.59	3.51	3.55	0.18	0.18	0.32	0.34	0.38	0.37	0.35	0.63	0.84	0.94	0.95	0.93	0.90	1.11	1.29	1.50	1.67	1.77	1.83	0.724	1.034	0.651
1312	699.0	93.5	3.61	3.54	3.59	0.33	0.30	1.79	1.65	1.58	1.49	1.40	1.33	1.24	1.17	1.17	1.15	1.12	1.31	1.49	1.68	1.85	1.94	2.02	0.740	1.043	0.636

TABLE II. - Concluded.

All pressures in MPa

Run NO.	w, g/s	T_0, K	P_0, MPa	P_{0_1}	P_{0_2}	P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8	P_9	P_{10}	P_{11}	P_{12}	P_{13}	P_{14}	P_{15}	P_{16}	P_{17}	P_{18}	P_{BACK}, MPa	T_R	P_R	G_R
1409	775.0	85.0	3.93	3.85	3.86	0.11	0.10	0.17	0.20	0.20	0.21	0.20	0.21	0.22	0.22	0.23	0.23	0.23	0.15	0.19	0.19	0.16	0.13	0.31	0.673	1.131	0.705
1410	699.0	105.2	4.02	3.94	3.97	0.40	0.39	0.76	0.91	0.93	0.95	0.95	0.99	1.02	1.04	1.04	1.04	1.00	0.75	0.75	0.72	0.55	0.34	0.49	0.833	1.157	0.636
1411	622.0	115.0	4.15	4.09	4.11	0.99	1.04	2.41	2.26	2.17	2.10	2.02	1.95	1.87	1.79	1.73	1.67	1.58	1.11	1.08	0.97	0.65	0.40	0.54	0.911	1.200	0.566
1412	500.0	124.0	4.37	4.33	4.35	1.99	2.29	3.09	2.95	2.86	2.82	2.76	2.71	2.65	2.53	2.42	2.31	2.21	1.58	1.36	1.05	0.54	0.34	0.53	0.982	1.270	0.455
1413	406.0	129.2	4.50	4.47	4.51	2.50	3.14	3.50	3.37	3.31	3.26	3.20	3.15	2.96	2.71	2.53	2.41	2.28	1.39	1.14	0.87	0.44	0.26	0.49	1.023	1.314	0.365
1414	779.0	85.2	3.96	3.88	3.91	0.11	0.10	0.16	0.20	0.21	0.21	0.20	0.22	0.23	0.23	0.23	0.24	0.23	0.19	0.19	0.20	0.16	0.13	0.37	0.675	1.139	0.706
1415	777.0	85.7	3.97	3.88	3.91	0.11	0.10	0.16	0.21	0.22	0.22	0.21	0.23	0.24	0.24	0.24	0.25	0.24	0.20	0.20	0.21	0.40	1.00	1.06	0.679	1.139	0.707
1416	776.0	86.1	3.97	3.89	3.91	0.12	0.11	0.19	0.22	0.24	0.23	0.23	0.24	0.25	0.25	0.25	0.26	0.26	0.21	0.21	0.46	1.07	1.34	1.38	0.682	1.140	0.706
1417	743.0	86.8	4.05	3.97	4.00	0.51	1.30	2.15	1.93	1.93	1.75	1.67	1.58	1.50	1.42	1.37	1.37	1.35	1.52	1.75	1.96	2.15	2.29	2.32	0.687	1.167	0.676
1418	769.0	88.2	3.97	3.89	3.91	0.14	0.13	0.23	0.26	0.26	0.50	1.31	1.26	1.20	1.11	1.06	1.06	1.04	1.24	1.49	1.71	1.92	2.06	2.09	0.698	1.142	0.700
1533	107.0	231.0	2.72	2.71	2.71	1.35	1.78	1.98	1.84	1.76	1.70	1.64	1.53	1.43	1.29	1.18	1.13	1.06	0.56	0.40	0.27	0.13	0.12	0.28	1.829	0.793	0.974E-01
1534	177.0	237.0	4.57	4.56	4.60	2.26	2.98	3.33	3.11	2.98	2.66	2.76	2.55	2.42	2.18	1.98	1.90	1.78	0.93	0.67	0.45	0.21	0.15	0.40	1.876	1.340	0.161
1535	74.0	231.0	1.93	1.92	1.91	0.97	1.27	1.40	1.31	1.24	1.20	1.15	1.08	1.01	0.91	0.83	0.79	0.75	0.39	0.28	0.19	0.09	0.10	0.22	1.829	0.561	0.673E-01
1536	1038.0	109.9	8.08	7.95	8.04	0.33	0.39	0.88	1.04	1.07	1.09	1.12	1.13	1.18	1.21	1.21	1.24	1.24	0.96	0.93	0.86	0.64	0.36	0.77	0.870	2.339	0.944
1537	1031.0	110.7	8.06	7.96	8.02	0.35	0.40	0.92	1.09	1.12	1.15	1.18	1.20	1.24	1.27	1.28	1.31	1.31	1.00	0.98	0.90	0.66	0.89	1.42	0.876	2.338	0.938
1538	1022.0	111.4	8.05	7.93	7.99	0.36	0.41	0.95	1.13	1.16	1.19	1.22	1.24	1.29	1.32	1.32	1.35	1.35	1.04	1.00	0.92	0.68	1.34	1.79	0.882	2.330	0.930
1539	1018.0	112.1	8.04	7.92	7.99	0.37	0.42	0.96	1.17	1.20	1.23	1.26	1.29	1.33	1.37	1.37	1.41	1.40	1.07	1.04	0.95	0.94	1.80	2.07	0.886	2.328	0.926
1540	1012.0	113.0	8.04	7.92	7.99	0.38	0.44	1.02	1.22	1.26	1.29	1.32	1.34	1.40	1.43	1.43	1.47	1.47	1.12	1.08	0.99	1.75	2.59	2.64	0.895	2.328	0.921
1542	1005.0	112.3	7.85	7.75	7.81	0.36	0.43	1.00	1.20	1.23	1.25	1.29	1.31	1.37	1.40	1.40	1.44	1.42	1.09	1.05	0.97	0.77	1.61	1.95	0.889	2.276	0.914
1543	997.0	113.1	7.83	7.72	7.79	0.39	0.44	1.04	1.24	1.28	1.31	1.34	1.36	1.42	1.46	1.46	1.50	1.48	1.13	1.09	1.00	1.53	2.39	2.46	0.895	2.269	0.907
1544	990.0	113.9	7.82	7.70	7.77	0.40	0.46	1.08	1.29	1.33	1.35	1.40	1.42	1.48	1.52	1.51	1.56	1.54	1.16	1.12	1.04	2.21	2.80	2.84	0.902	2.264	0.901
1545	985.0	114.4	7.81	7.70	7.77	0.41	0.47	1.11	1.32	1.36	1.40	1.43	1.46	1.52	1.56	1.55	1.60	1.58	1.20	1.91	2.68	3.13	3.48	3.52	0.906	2.263	0.896
1547	974.0	116.9	7.86	7.74	7.82	0.45	0.52	1.23	1.50	1.54	1.58	1.62	1.64	1.78	1.83	1.79	1.80	1.75	1.27	1.57	2.66	3.15	3.49	3.53	0.926	2.276	0.886
1548	830.0	104.1	5.15	5.08	5.11	0.32	0.34	0.69	0.82	0.84	0.85	0.87	0.88	0.91	0.92	0.93	0.95	0.93	0.72	0.70	0.67	0.51	0.34	0.62	0.824	1.491	0.755
1549	824.0	104.0	5.14	5.06	5.10	0.32	0.34	0.68	0.81	0.83	0.84	0.86	0.87	0.90	0.91	0.91	0.94	0.93	0.72	0.69	0.66	0.51	0.89	1.19	0.823	1.487	0.750
1551	827.0	104.3	5.17	5.08	5.12	0.33	0.35	0.71	0.83	0.85	0.87	0.89	0.89	0.92	0.94	0.94	0.96	0.95	0.74	0.72	0.98	1.67	1.96	2.00	0.826	1.492	0.753
1552	826.0	104.6	5.17	5.08	5.13	0.34	0.35	0.72	0.84	0.87	0.89	0.90	0.91	0.94	0.95	0.95	0.98	0.98	1.31	1.64	1.93	2.20	2.41	2.45	0.828	1.494	0.752
1553	824.0	105.1	5.18	5.10	5.13	0.34	0.36	0.74	0.87	0.90	0.91	0.93	0.94	0.97	0.99	0.99	1.02	1.02	1.44	1.71	1.99	2.25	2.45	2.50	0.832	1.497	0.750
1554	814.0	105.5	5.21	5.13	5.17	0.51	0.48	2.60	2.41	2.26	2.15	2.06	1.92	1.80	1.69	1.62	1.62	1.62	1.85	2.15	2.41	2.69	2.86	2.90	0.838	1.506	0.741
1556	867.0	97.8	5.28	5.20	5.23	0.23	0.24	0.47	0.54	0.56	0.57	0.58	0.58	0.60	0.62	0.62	0.63	0.63	0.50	0.49	0.47	0.37	0.24	0.51	0.774	1.525	0.789
1557	862.0	98.6	5.27	5.19	5.23	0.24	0.25	0.50	0.57	0.59	0.60	0.61	0.61	0.64	0.65	0.65	0.67	0.66	0.53	0.52	0.50	0.71	1.37	1.46	0.781	1.524	0.784
1558	859.0	99.3	5.28	5.19	5.23	0.25	0.26	0.52	0.60	0.61	0.63	0.63	0.64	0.66	0.68	0.68	0.70	0.69	0.55	0.54	0.53	1.28	1.71	1.77	0.786	1.524	0.782
1559	856.0	99.9	5.28	5.19	5.24	0.26	0.27	0.54	0.62	0.64	0.65	0.66	0.66	0.69	0.71	0.71	0.72	0.72	1.14	1.53	1.85	2.13	2.37	2.42	0.791	1.525	0.779
1560	854.0	100.3	5.29	5.20	5.24	0.27	0.28	0.55	0.64	0.66	0.67	0.68	0.69	0.71	0.73	0.73	0.75	0.75	1.31	1.61	1.91	2.19	2.42	2.46	0.794	1.526	0.777
1561	807.0	101.2	5.42	5.35	5.39	0.96	1.75	3.06	2.78	2.64	2.53	2.44	2.31	2.21	2.10	2.04	2.04	2.02	2.25	2.53	2.78	3.04	3.22	3.24	0.801	1.571	0.734
1579	750.0	100.0	4.20	4.13	4.15	0.28	0.29	0.56	0.65	0.66	0.68	0.69	0.70	0.94	1.09	1.05	1.06	1.04	1.30	1.51	1.74	1.95	2.09	2.13	0.792	1.211	0.682
1574	761.0	97.3	4.18	4.11	4.13	0.28	0.25	0.46	0.54	0.55	0.56	0.57	0.58	0.59	0.60	0.60	0.62	0.62	0.49	0.48	0.47	0.37	0.26	0.49	0.770	1.207	0.692
1575	759.0	97.7	4.18	4.11	4.13	0.25	0.26	0.47	0.55	0.56	0.57	0.58	0.59	0.61	0.62	0.62	0.63	0.63	0.50	0.49	0.76	1.31	1.54	1.58	0.774	1.207	0.691
1576	756.0	98.2	4.18	4.11	4.14	0.26	0.27	0.49	0.57	0.58	0.60	0.61	0.62	0.63	0.64	0.64	0.66	0.66	0.53	0.80	1.33	1.59	1.77	1.81	0.778	1.208	0.688
1577	732.0	98.8	4.24	4.17	4.20	0.57	0.58	2.26	2.07	1.95	1.87	1.80	1.69	1.61	1.53	1.47	1.48	1.47	1.69	1.89	2.10	2.31	2.44	2.47	0.782	1.225	0.666
1578	707.0	99.2	4.31	4.25	4.27	0.87	1.67	2.49	2.29	2.18	2.10	2.03	1.93	1.85	1.78	1.73	1.73	1.72	1.94	2.12	2.32	2.51	2.64	2.66	0.785	1.247	0.643
1579	750.0	100.0	4.20	4.12	4.15	0.28	0.29	0.56	0.65	0.66	0.68	0.69	0.70	0.94	1.09	1.05	1.06	1.04	1.30	1.51	1.74	1.95	2.09	2.13	0.792	1.210	0.682
1580	745.0	101.0	4.20	4.13	4.15	0.30	0.31	0.60	0.70	0.71	0.72	0.74	0.76	1.00	1.11	1.07	1.07	1.06	1.31	1.52	1.75	1.96	2.10	2.14	0.800	1.213	0.678
1581	740.0	96.8	3.96	3.89	3.91	0.24	0.25	0.46	0.53	0.54	0.55	0.56	0.56	0.58	0.59	0.59	0.61	0.60	0.49	0.47	0.46	0.36	0.25	0.45	0.766	1.142	0.673
1582	730.0	96.5	3.95	3.89	3.91	0.27	0.27	0.51	0.59	0.60	0.61	0.62	0.63	0.65	0.66	0.66	0.67	0.67	0.54	0.52	0.51	0.69	1.26	1.31	0.780	1.140	0.664
1583	728.0	99.2	3.96	3.89	3.91	0.28	0.29	0.53	0.62	0.63	0.64	0.65	0.66	0.68	0.69	0.69	0.71	0.70	0.97	1.24	1.46	1.67	1.82	1.85	0.785	1.140	0.662
1584	723.0	100.4	3.96	3.89	3.91	0.30	0.31	0.58	0.67	1.53	1.52	1.47	1.36	1.27	1.19	1.13	1.14	1.13	1.36	1.55	1.75	1.96	2.08	2.12	0.795	1.141	0.658
1585	706.0	103.7	3.97	3.90	3.92	0.36	0.37	0.71	0.82	0.84	0.86	0.99	1.29	1.22	1.15	1.09	1.10	1.09	1.33	1.51	1.73	1.93	2.05	2.09	0.821	1.144	0.642
1708	1128.0	87.1	7.96	7.84	7.92	0.10	0.10	0.19	0.24	0.24	0.24	0.23	0.25	0.26	0.26	0.26	0.27	0.26	0.21	0.20	0.20	0.17	0.12	0.36	0.690	2.305	1.03
1709	701.0	86.7	3.23	3.18	3.20	0.13	0.12	0.21	0.24	0.25	0.25	0.24	0.26	0.27	0.27	0.27	0.29	0.28	0.23	0.23	0.22	0.18	0.13	0.28	0.686	0.932	0.638
1710	470.0	86.0	1.57	1.54	1.53	0.15	0.14	0.21	0.23	0.25	0.25	0.24	0.25	0.26	0.26	0.26	0.27	0.26	0.22	0.21	0.21	0.18	0.15	0.23	0.681	0.450	0.428
1712	338.0	87.4	0.96	0.94	0.94	0.19	0.18	0.24	0.27	0.28	0.28	0.27	0.29	0.30	0.29	0.29	0.29	0.28	0.24	0.24	0.23	0.19	0.18	0.21	0.692	0.275	0.308

TABLE III. - DATA FOR FLUID NITROGEN FLOWING THROUGH A 64 L/D TUBE WITH A BORDA TYPE INLET

All pressures in MPa

Run NO.	w, g/s	T_0, K	P_0, MPa	P_{0_1}	P_{0_2}	P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8	P_9	P_{10}	P_{11}	P_{12}	P_{13}	P_{14}	P_{15}	P_{16}	P_{17}	P_{18}	P_{BACK}, MPa	T_R	P_R	G_R
1188	1057.0	84.8	7.02	6.90	7.00	0.09	0.10	0.16	0.21	0.21	0.21	0.21	0.21	0.21	0.22	0.22	0.23	0.22	0.16	0.19	0.18	0.15	0.11	0.22	0.671	2.034	0.962
1169	993.0	85.2	6.30	6.17	6.27	0.10	0.11	0.17	0.22	0.22	0.22	0.22	0.22	0.23	0.24	0.24	0.24	0.23	0.21	0.20	0.19	0.16	0.10	0.22	0.675	1.820	0.904
1190	821.0	85.2	4.40	4.30	4.36	0.11	0.12	0.18	0.23	0.24	0.24	0.23	0.23	0.24	0.25	0.26	0.26	0.25	0.18	0.21	0.20	0.17	0.09	0.20	0.675	1.267	0.747
1191	675.0	85.6	3.07	3.00	3.04	0.13	0.13	0.20	0.24	0.25	0.25	0.24	0.25	0.25	0.26	0.27	0.28	0.26	0.19	0.22	0.21	0.18	0.09	0.18	0.678	0.684	0.614
1192	505.0	84.9	1.79	1.75	1.76	0.14	0.14	0.20	0.23	0.24	0.24	0.23	0.24	0.23	0.24	0.25	0.26	0.24	0.18	0.20	0.20	0.17	0.09	0.14	0.672	0.515	0.460
1194	382.0	85.5	1.13	1.11	1.11	0.16	0.16	0.21	0.24	0.25	0.25	0.24	0.25	0.25	0.26	0.26	0.26	0.24	0.17	0.20	0.20	0.16	0.09	0.12	0.677	0.325	0.348
1195	1057.0	95.9	7.30	7.16	7.28	0.18	0.20	0.37	0.49	0.49	0.49	0.49	0.51	0.52	0.53	0.55	0.56	0.54	0.11	0.44	0.42	0.33	0.21	0.36	0.759	2.113	0.962
1196	979.0	95.7	6.44	6.33	6.43	0.19	0.21	0.39	0.49	0.51	0.51	0.51	0.52	0.54	0.56	0.57	0.58	0.56	0.11	0.45	0.43	0.34	0.20	0.34	0.758	1.867	0.891
1197	921.0	95.8	5.79	5.66	5.75	0.21	0.22	0.41	0.50	0.53	0.53	0.52	0.54	0.55	0.56	0.59	0.60	0.58	0.11	0.46	0.44	0.35	0.18	0.32	0.759	1.671	0.838
1198	749.0	99.5	4.19	4.10	4.15	0.29	0.30	0.55	0.68	0.70	0.70	0.69	0.71	0.73	0.75	0.76	0.77	0.74	0.11	0.57	0.55	0.44	0.22	0.30	0.788	1.208	0.682
1199	970.0	113.5	7.30	7.17	7.28	0.42	0.47	1.08	2.67	2.50	2.35	2.20	2.01	1.84	1.69	1.61	1.60	1.51	1.00	1.00	0.55	0.71	0.40	0.48	0.899	2.116	0.883
1200	905.0	113.5	6.59	6.47	6.57	0.48	0.51	2.54	2.56	2.40	2.26	2.12	1.96	1.81	1.68	1.62	1.59	1.51	1.00	1.01	0.96	0.71	0.36	0.45	0.859	1.909	0.823
1201	677.0	113.9	4.56	4.48	4.54	0.98	1.02	2.58	2.19	2.11	2.02	1.93	1.85	1.76	1.68	1.64	1.59	1.50	1.04	1.04	0.95	0.67	0.26	0.35	0.902	1.320	0.616
1202	967.0	111.7	7.49	7.38	7.47	0.38	0.44	0.98	1.27	1.60	1.98	2.08	1.89	1.72	1.56	1.47	1.46	1.40	0.96	0.91	0.88	0.67	0.37	0.47	0.884	2.173	0.880
1203	976.0	111.3	7.56	7.41	7.51	0.37	0.43	0.95	1.24	1.26	1.29	1.60	1.78	1.68	1.53	1.44	1.44	1.38	0.94	0.89	0.87	0.67	0.37	0.48	0.881	2.183	0.888
1204	992.0	112.1	7.85	7.71	7.82	0.38	0.45	0.99	1.30	1.31	1.51	1.93	1.92	1.76	1.60	1.51	1.51	1.44	0.98	0.92	0.90	0.69	0.36	0.49	0.888	2.272	0.903
1205	924.0	112.1	6.97	6.83	6.93	0.41	0.47	1.02	2.42	2.31	2.19	2.07	1.87	1.72	1.59	1.51	1.49	1.42	0.98	0.93	0.89	0.67	0.32	0.46	0.888	2.013	0.841
1206	997.0	110.2	7.74	7.59	7.69	0.35	0.40	0.90	1.16	1.18	1.20	1.23	1.26	1.31	1.38	1.36	1.38	1.33	0.87	0.93	0.91	0.69	0.37	0.48	0.873	2.236	0.907
1207	937.0	110.6	7.00	6.86	6.95	0.38	0.43	0.95	1.22	1.41	2.01	1.96	1.78	1.62	1.48	1.41	1.40	1.33	0.74	0.87	0.84	0.64	0.35	0.45	0.876	2.020	0.853
1208	863.0	110.6	6.11	5.99	6.06	0.42	0.46	0.98	2.25	2.11	2.00	1.89	1.72	1.59	1.47	1.42	1.39	1.32	0.17	0.87	0.84	0.64	0.32	0.42	0.876	1.764	0.785
1209	965.0	109.2	7.21	7.07	7.16	0.35	0.40	0.86	1.12	1.13	1.15	1.18	1.20	1.25	1.31	1.29	1.30	1.25	0.11	0.89	0.86	0.66	0.35	0.45	0.865	2.082	0.878
1210	936.0	109.1	6.86	6.71	6.80	0.36	0.41	0.87	1.13	1.15	1.17	1.22	1.33	1.45	1.37	1.31	1.30	1.23	0.11	0.82	0.81	0.63	0.33	0.44	0.864	1.976	0.852
1211	843.0	108.7	5.72	5.60	5.67	0.40	0.43	0.89	1.88	1.92	1.83	1.72	1.56	1.44	1.33	1.28	1.27	1.20	0.11	0.80	0.77	0.59	0.29	0.40	0.861	1.650	0.767
1212	676.0	107.9	4.02	3.95	4.00	0.55	0.55	2.02	1.74	1.64	1.57	1.49	1.40	1.31	1.25	1.22	1.19	1.12	0.11	0.78	0.74	0.56	0.23	0.32	0.854	1.162	0.615
1213	457.0	110.1	2.69	2.66	2.68	1.03	1.11	1.78	1.60	1.56	1.52	1.47	1.43	1.39	1.35	1.30	1.24	1.16	0.11	0.84	0.75	0.49	0.15	0.23	0.872	0.781	0.416
1214	1037.0	104.9	7.75	7.59	7.68	0.27	0.31	0.66	0.85	0.87	0.89	0.90	0.92	0.95	0.97	0.99	1.02	1.00	0.10	0.75	0.72	0.55	0.32	0.45	0.831	2.235	0.944
1215	951.0	104.6	6.71	6.57	6.65	0.30	0.32	0.68	0.86	0.86	0.89	0.90	0.93	0.96	0.98	1.00	1.02	1.00	0.10	0.74	0.71	0.55	0.30	0.41	0.828	1.934	0.865
1216	791.0	104.1	4.89	4.78	4.84	0.34	0.36	0.71	0.89	0.91	0.92	0.98	1.17	1.12	1.04	1.00	0.99	0.93	0.10	0.64	0.63	0.50	0.27	0.34	0.824	1.407	0.720
1217	1068.0	96.4	7.52	7.37	7.45	0.20	0.22	0.44	0.56	0.58	0.58	0.56	0.60	0.62	0.64	0.66	0.66	0.65	0.10	0.51	0.50	0.39	0.25	0.39	0.779	2.168	0.972
1218	963.0	98.6	6.27	6.13	6.20	0.23	0.24	0.48	0.59	0.62	0.62	0.61	0.63	0.65	0.67	0.69	0.70	0.68	0.10	0.53	0.52	0.41	0.24	0.36	0.781	1.804	0.876
1219	785.0	99.1	4.47	4.37	4.42	0.27	0.28	0.53	0.65	0.67	0.67	0.66	0.69	0.70	0.71	0.74	0.75	0.72	0.10	0.54	0.54	0.42	0.22	0.30	0.785	1.287	0.714
1220	661.0	99.6	3.37	3.30	3.33	0.32	0.32	0.57	0.69	0.71	0.82	0.94	0.91	0.83	0.77	0.77	0.75	0.70	0.10	0.49	0.49	0.39	0.21	0.26	0.789	0.971	0.601
1221	494.0	99.3	2.10	2.07	2.07	0.39	0.38	0.98	0.95	0.92	0.89	0.82	0.80	0.75	0.71	0.72	0.69	0.64	0.11	0.46	0.45	0.36	0.17	0.20	0.786	0.606	0.489
1222	402.0	99.7	1.67	1.65	1.64	0.51	0.51	1.01	0.89	0.87	0.85	0.80	0.79	0.75	0.72	0.73	0.69	0.63	0.11	0.47	0.45	0.34	0.15	0.17	0.789	0.482	0.366
1223	1049.0	94.8	7.52	7.36	7.44	0.17	0.19	0.34	0.44	0.44	0.45	0.46	0.46	0.48	0.50	0.50	0.51	0.51	0.41	0.40	0.40	0.32	0.19	0.36	0.751	2.166	0.955
1224	926.0	95.0	6.01	5.88	5.94	0.19	0.21	0.38	0.47	0.48	0.48	0.49	0.49	0.51	0.53	0.54	0.53	0.54	0.43	0.42	0.42	0.33	0.18	0.32	0.752	1.729	0.843
1225	739.0	94.9	3.96	3.87	3.91	0.22	0.24	0.40	0.49	0.50	0.50	0.51	0.51	0.53	0.54	0.55	0.56	0.54	0.43	0.42	0.42	0.33	0.16	0.26	0.751	1.138	0.672
1226	618.0	95.2	2.90	2.84	2.86	0.25	0.26	0.42	0.51	0.53	0.52	0.53	0.53	0.54	0.56	0.57	0.57	0.54	0.42	0.41	0.42	0.33	0.15	0.22	0.754	0.835	0.562
1227	483.0	94.5	1.90	1.65	1.87	0.28	0.28	0.42	0.51	0.70	0.68	0.64	0.60	0.55	0.53	0.53	0.51	0.48	0.35	0.35	0.34	0.28	0.13	0.18	0.748	0.515	0.439
1228	369.0	94.8	1.38	1.36	1.36	0.32	0.32	0.53	0.67	0.65	0.62	0.59	0.57	0.53	0.52	0.52	0.50	0.46	0.36	0.35	0.33	0.27	0.12	0.15	0.751	0.399	0.354
1229	1048.0	91.0	7.31	7.19	7.26	0.13	0.15	0.25	0.33	0.33	0.34	0.33	0.34	0.35	0.36	0.38	0.38	0.37	0.31	0.30	0.31	0.24	0.17	0.32	0.721	2.114	0.954
1230	948.0	91.4	6.09	5.95	6.02	0.15	0.16	0.28	0.35	0.36	0.36	0.36	0.37	0.38	0.39	0.41	0.41	0.40	0.33	0.32	0.33	0.26	0.16	0.29	0.724	1.750	0.863
1231	811.0	91.6	4.55	4.44	4.49	0.17	0.18	0.31	0.37	0.39	0.39	0.38	0.39	0.40	0.41	0.44	0.44	0.42	0.34	0.33	0.34	0.27	0.16	0.26	0.725	1.308	0.738
1232	657.0	92.0	3.12	3.06	3.08	0.20	0.20	0.34	0.40	0.42	0.41	0.40	0.42	0.43	0.43	0.46	0.46	0.43	0.35	0.34	0.35	0.28	0.15	0.22	0.728	0.898	0.598
1233	506.0	91.4	1.96	1.92	1.93	0.22	0.22	0.33	0.39	0.41	0.40	0.38	0.40	0.42	0.42	0.43	0.42	0.39	0.31	0.31	0.32	0.26	0.13	0.17	0.724	0.563	0.460
1234	414.0	91.5	1.43	1.41	1.41	0.24	0.24	0.34	0.41	0.55	0.53	0.48	0.46	0.42	0.41	0.42	0.40	0.37	0.28	0.28	0.28	0.22	0.12	0.15	0.724	0.413	0.377
1235	362.0	91.7	1.17	1.15	1.15	0.26	0.26	0.34	0.53	0.52	0.50	0.46	0.45	0.42	0.40	0.42	0.40	0.36	0.28	0.28	0.27	0.22	0.12	0.14	0.726	0.338	0.329

TABLE IV. - DATA FOR FLUID NITROGEN FLOWING THROUGH A 73 L/D TUBE WITH A BORDA TYPE INLET

All pressures in MPa

Run NO.	$\dot{w}$, g/s	T_0, K	P_0, MPa	P_{0_1}	P_{0_2}	P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8	P_9	P_{10}	P_{11}	P_{12}	P_{13}	P_{14}	P_{15}	P_{16}	P_{17}	P_{18}	P_{BACK}, MPa	T_R	P_R	G_R	T_{IN}	T_{OUT}
1436	1182.0	86.4	8.91	8.75	8.84	0.09	0.11	0.17	0.23	0.24	0.24	0.23	0.24	0.24	0.25	0.26	0.26	0.26	0.21	0.20	0.20	0.17	0.13	0.42	0.684	2.573	1.08	86.4	87.5
1437	1025.0	86.2	6.78	6.64	6.71	0.10	0.12	0.18	0.23	0.24	0.24	0.25	0.25	0.26	0.26	0.26	0.27	0.27	0.21	0.21	0.21	0.18	0.13	0.33	0.683	1.953	0.933	86.1	86.0
1438	826.0	86.3	4.49	4.40	4.43	0.11	0.12	0.19	0.25	0.26	0.26	0.26	0.26	0.27	0.28	0.28	0.29	0.28	0.22	0.22	0.22	0.19	0.13	0.30	0.683	1.291	0.752	86.1	86.3
1439	558.0	85.7	2.16	2.13	2.12	0.13	0.13	0.20	0.24	0.25	0.25	0.25	0.25	0.27	0.28	0.26	0.27	0.26	0.20	0.20	0.20	0.18	0.14	0.25	0.679	0.621	0.508	85.6	85.4
1440	1094.0	85.1	7.54	7.39	7.48	0.09	0.10	0.16	0.21	0.22	0.22	0.22	0.22	0.23	0.23	0.24	0.24	0.24	0.19	0.19	0.19	0.16	0.12	0.41	0.674	2.176	0.995	85.1	87.3
1441	907.0	85.0	5.27	5.16	5.20	0.10	0.11	0.17	0.21	0.23	0.22	0.22	0.23	0.24	0.24	0.24	0.25	0.25	0.20	0.20	0.20	0.17	0.12	0.31	0.673	1.516	0.825	84.9	86.1
1442	706.0	85.1	3.31	3.23	3.24	0.11	0.12	0.18	0.22	0.23	0.23	0.23	0.23	0.25	0.25	0.25	0.26	0.26	0.20	0.20	0.20	0.17	0.12	0.27	0.674	0.947	0.642	85.0	85.3
1443	706.0	86.0	3.31	3.25	3.25	0.12	0.12	0.19	0.24	0.25	0.25	0.25	0.25	0.26	0.27	0.27	0.28	0.28	0.22	0.22	0.24	0.68	0.88	0.93	0.681	0.951	0.642	85.9	86.6
1444	458.0	85.4	1.52	1.49	1.48	0.14	0.14	0.20	0.24	0.29	0.38	0.36	0.32	0.29	0.26	0.24	0.24	0.24	0.19	0.20	0.24	0.37	0.44	0.49	0.676	0.435	0.417	85.8	85.7
1445	395.0	85.9	1.20	1.18	1.16	0.15	0.15	0.21	0.41	0.39	0.36	0.34	0.31	0.29	0.26	0.25	0.25	0.24	0.19	0.19	0.19	0.18	0.18	0.23	0.680	0.343	0.359	85.9	84.6
1446	1019.0	103.9	7.57	7.42	7.50	0.27	0.30	0.64	0.85	0.86	0.88	0.89	0.91	0.96	1.02	1.00	1.02	0.99	0.72	0.70	0.69	0.55	0.33	0.66	0.823	2.183	0.927	103.9	98.2
1447	922.0	104.7	6.41	6.28	6.34	0.31	0.34	0.70	1.93	1.85	1.74	1.62	1.43	1.29	1.13	1.05	1.05	1.01	0.71	0.67	0.66	0.52	0.34	0.59	0.829	1.847	0.639	104.6	97.1
1448	716.0	104.3	4.15	4.07	4.10	0.41	0.42	1.87	1.58	1.48	1.40	1.33	1.22	1.13	1.04	1.00	0.99	0.95	0.68	0.66	0.64	0.50	0.34	0.48	0.826	1.196	0.652	104.3	94.4
1449	519.0	103.6	2.61	2.59	2.59	0.63	0.63	1.51	1.25	1.20	1.15	1.11	1.06	1.01	0.97	0.93	0.90	0.85	0.64	0.62	0.58	0.44	0.30	0.38	0.820	0.758	0.472	103.6	91.4
1450	1054.0	97.2	7.68	7.53	7.61	0.19	0.22	0.41	0.55	0.56	0.56	0.57	0.58	0.61	0.62	0.63	0.64	0.64	0.51	0.50	0.48	0.39	0.25	0.57	0.770	2.216	0.959	97.3	95.5
1451	928.0	97.9	6.13	6.01	6.06	0.22	0.24	0.46	0.60	0.61	0.62	0.63	0.64	0.66	0.68	0.67	0.70	0.69	0.53	0.52	0.51	0.41	0.26	0.50	0.775	1.767	0.844	97.9	94.3
1452	699.0	97.8	3.66	3.62	3.63	0.27	0.28	0.50	1.18	1.11	1.05	0.98	0.87	0.80	0.72	0.68	0.67	0.65	0.46	0.46	0.45	0.36	0.28	0.40	0.774	1.060	0.636	97.8	91.9
1453	496.0	97.1	2.09	2.06	2.09	0.35	0.34	0.93	0.89	0.84	0.80	0.76	0.71	0.68	0.64	0.61	0.60	0.56	0.43	0.42	0.41	0.33	0.26	0.32	0.769	0.607	0.451	97.2	89.2
1454	626.0	83.8	2.63	2.57	2.58	0.11	0.11	0.16	0.20	0.21	0.21	0.21	0.21	0.22	0.22	0.22	0.23	0.23	0.18	0.18	0.18	0.15	0.13	0.29	0.663	0.753	0.570	83.5	84.3
1455	506.0	83.5	1.79	1.75	1.75	0.11	0.11	0.16	0.20	0.20	0.20	0.20	0.20	0.23	0.23	0.21	0.21	0.21	0.16	0.16	0.17	0.15	0.13	0.24	0.661	0.512	0.460	83.4	63.9
1456	400.0	83.5	1.22	1.19	1.18	0.12	0.12	0.17	0.21	0.30	0.32	0.30	0.26	0.25	0.22	0.20	0.20	0.20	0.16	0.16	0.16	0.16	0.15	0.23	0.661	0.346	0.364	83.6	83.9
1457	1092.0	104.0	8.57	8.44	8.58	0.25	0.30	0.62	0.84	0.85	0.87	0.88	0.89	0.93	0.95	0.96	1.00	0.99	0.75	0.74	0.70	0.54	0.33	0.69	0.823	2.485	0.994	104.0	98.9
1458	1020.0	104.5	7.63	7.49	7.57	0.27	0.31	0.66	0.89	0.89	0.91	0.93	0.94	0.98	1.04	1.02	1.04	1.02	0.75	0.73	0.71	0.56	0.33	0.64	0.827	2.204	0.928	104.4	98.0
1459	954.0	104.6	6.78	6.66	6.73	0.29	0.33	0.65	0.91	0.91	1.09	1.52	1.43	1.29	1.13	1.04	1.04	1.00	0.70	0.67	0.66	0.52	0.34	0.60	0.828	1.958	0.868	104.5	97.4
1460	859.0	104.3	5.64	5.53	5.59	0.32	0.35	0.71	1.82	1.69	1.60	1.49	1.33	1.21	1.09	1.02	1.02	0.98	0.68	0.66	0.65	0.51	0.33	0.56	0.826	1.627	0.782	104.3	96.3
1461	712.0	104.0	4.05	4.02	4.04	0.37	0.38	0.73	1.55	1.44	1.38	1.30	1.19	1.11	1.02	0.98	0.96	0.92	0.66	0.65	0.62	0.49	0.33	0.48	0.823	1.179	0.648	103.9	94.4
1462	474.0	102.8	2.30	2.26	2.26	0.62	0.62	1.36	1.15	1.10	1.07	1.03	0.96	0.95	0.91	0.88	0.84	0.80	0.60	0.58	0.54	0.42	0.29	0.35	0.814	0.661	0.431	102.8	90.5
1463	1085.0	93.1	7.88	7.73	7.81	0.15	0.17	0.30	0.40	0.41	0.42	0.42	0.42	0.44	0.45	0.45	0.46	0.46	0.37	0.37	0.36	0.29	0.19	0.51	0.737	2.274	0.987	93.1	92.8
1464	1010.0	93.4	6.89	6.76	6.84	0.16	0.18	0.32	0.42	0.43	0.44	0.44	0.44	0.46	0.47	0.47	0.48	0.48	0.39	0.38	0.37	0.30	0.20	0.45	0.740	1.990	0.919	93.4	92.2
1465	913.0	93.5	5.75	5.64	5.69	0.17	0.19	0.34	0.44	0.45	0.45	0.45	0.46	0.48	0.49	0.49	0.50	0.50	0.39	0.39	0.38	0.31	0.21	0.42	0.740	1.658	0.631	93.5	91.9
1466	791.0	93.6	4.41	4.33	4.36	0.19	0.20	0.36	0.46	0.46	0.47	0.47	0.48	0.50	0.51	0.50	0.51	0.51	0.39	0.39	0.39	0.32	0.21	0.38	0.741	1.271	0.720	93.6	91.0
1467	698.0	93.9	3.53	3.46	3.49	0.21	0.22	0.38	0.48	0.48	0.49	0.49	0.59	0.61	0.56	0.51	0.51	0.50	0.37	0.36	0.37	0.30	0.23	0.36	0.743	1.016	0.635	93.9	90.4
1468	597.0	93.7	2.69	2.63	2.64	0.23	0.23	0.38	0.73	0.80	0.76	0.71	0.64	0.58	0.53	0.49	0.49	0.48	0.35	0.35	0.34	0.28	0.24	0.32	0.742	0.772	0.543	93.7	89.3
1469	498.0	93.8	2.00	1.96	1.96	0.26	0.25	0.39	0.76	0.71	0.67	0.64	0.58	0.54	0.51	0.49	0.48	0.46	0.34	0.34	0.33	0.27	0.24	0.29	0.743	0.574	0.453	93.8	88.2
1470	110.0	272.0	3.14	3.13	3.15	1.74	2.18	2.38	2.04	1.95	1.88	1.81	1.70	1.59	1.43	1.31	1.24	1.17	0.61	0.43	0.30	0.14	0.12	0.29	2.154	0.919	0.100	272.1	265.2
1471	165.0	274.0	4.70	4.65	4.72	2.59	3.23	3.56	3.04	2.92	2.82	2.71	2.55	2.38	2.14	1.96	1.87	1.75	0.91	0.65	0.44	0.20	0.15	0.40	2.169	1.377	0.150	274.5	264.2
1472	211.0	274.0	6.10	6.10	6.15	3.33	4.17	4.62	3.95	3.80	3.65	3.52	3.31	3.09	2.78	2.55	2.42	2.28	1.19	0.85	0.57	0.26	0.18	0.50	2.169	1.792	0.192	273.5	260.1
1473	253.0	276.0	7.38	7.38	7.45	4.00	5.02	5.58	4.77	4.58	4.41	4.25	4.00	3.73	3.35	3.07	2.93	2.75	1.44	1.02	0.69	0.32	0.20	0.59	2.185	2.170	0.230	275.7	260.2
1474	76.0	259.0	2.16	2.13	2.15	1.20	1.50	1.63	1.40	1.34	1.29	1.24	1.17	1.09	0.98	0.90	0.85	0.80	0.42	0.30	0.20	0.10	0.11	0.22	2.051	0.627	0.692E-01	256.8	251.6
1475	57.0	265.0	1.70	1.70	1.69	0.95	1.18	1.29	1.10	1.05	1.01	0.98	0.91	0.84	0.77	0.70	0.67	0.63	0.32	0.23	0.16	0.08	0.10	0.20	2.098	0.495	0.519E-01	265.3	259.7

TABLE V. - DATA FOR FLUID NITROGEN FLOWING THROUGH A 105 L/D TUBE WITH A BORDA TYPE INLET

Run NO.	ω, g/s	T_0, K	P_0, MPa	P_{0_1}	P_{0_2}	P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8	P_9	P_{10}	P_{11}	P_{12}	P_{13}	P_{14}	P_{15}	P_{16}	P_{17}	P_{18}	P_{BACK}, MPa	T_R	P_R	G_R
				All pressures in MPa																							
1511	100.0	272.0	3.11	3.09	3.11	1.87	2.25	2.43	1.93	1.85	1.79	1.72	1.62	1.51	1.35	1.24	1.19	1.11	0.58	0.41	0.28	0.13	0.12	0.28	2.154	0.907	0.910E-01
1512	153.0	272.0	4.66	4.64	4.69	2.78	3.35	3.65	2.89	2.78	2.68	2.58	2.42	2.26	2.04	1.87	1.78	1.67	0.87	0.62	0.42	0.20	0.14	0.38	2.154	1.363	0.139
1513	196.0	272.0	5.98	5.95	6.02	3.54	4.29	4.68	3.71	3.55	3.43	3.31	3.11	2.90	2.62	2.40	2.29	2.14	1.12	0.80	0.54	0.25	0.16	0.47	2.154	1.751	0.178
1514	83.0	264.0	2.51	2.50	2.50	1.51	1.82	1.96	1.55	1.49	1.44	1.39	1.30	1.21	1.09	1.00	0.95	0.90	0.46	0.33	0.23	0.11	0.11	0.24	2.090	0.731	0.755E-01
1515	61.0	262.0	1.88	1.87	1.87	1.13	1.36	1.47	1.16	1.11	1.07	1.03	0.97	0.90	0.82	0.75	0.71	0.67	0.34	0.25	0.17	0.08	0.10	0.20	2.074	0.547	0.555E-01
1516	46.0	264.0	1.42	1.42	1.40	0.86	1.03	1.11	0.87	0.84	0.80	0.78	0.73	0.68	0.61	0.56	0.53	0.50	0.26	0.18	0.13	0.06	0.10	0.18	2.090	0.413	0.419E-01
1518	1109.0	85.0	7.73	7.55	7.70	0.08	0.10	0.16	0.24	0.22	0.23	0.24	0.23	0.24	0.25	0.25	0.26	0.26	0.20	0.20	0.20	0.17	0.12	0.38	0.673	2.238	1.01
1519	1026.0	85.3	6.73	6.59	6.68	0.09	0.10	0.16	0.24	0.24	0.24	0.24	0.24	0.25	0.26	0.26	0.27	0.28	0.21	0.21	0.21	0.18	0.13	0.33	0.675	1.942	0.934
1520	967.0	85.6	6.04	5.52	5.99	0.10	0.11	0.17	0.25	0.25	0.25	0.25	0.25	0.27	0.29	0.28	0.29	0.29	0.22	0.22	0.22	0.19	0.13	0.31	0.678	1.742	0.880
1521	904.0	86.0	5.26	5.16	5.22	0.10	0.11	0.18	0.26	0.27	0.27	0.27	0.27	0.32	0.34	0.31	0.32	0.31	0.22	0.22	0.22	0.19	0.13	0.30	0.681	1.519	0.823
1522	847.0	86.8	4.69	4.60	4.64	0.12	0.12	0.20	1.04	0.91	0.82	0.73	0.59	0.50	0.40	0.34	0.34	0.32	0.23	0.22	0.23	0.20	0.14	0.31	0.687	1.352	0.771
1523	1100.0	91.9	7.90	7.76	7.86	0.13	0.15	0.26	0.39	0.40	0.41	0.41	0.42	0.44	0.47	0.46	0.49	0.49	0.36	0.35	0.35	0.29	0.19	0.49	0.728	2.285	1.00
1524	1044.0	92.4	7.23	7.09	7.19	0.14	0.16	0.28	0.41	0.43	0.48	0.56	0.61	0.66	0.60	0.52	0.54	0.52	0.35	0.35	0.35	0.30	0.20	0.45	0.732	2.089	0.950
1525	988.0	92.8	6.59	6.46	6.55	0.15	0.17	0.30	1.52	1.33	1.21	1.09	0.91	0.77	0.62	0.53	0.54	0.52	0.36	0.35	0.36	0.30	0.20	0.43	0.735	1.905	0.899
1526	838.0	92.6	4.87	4.77	4.84	0.21	0.20	1.55	1.21	1.08	0.99	0.90	0.76	0.66	0.56	0.50	0.50	0.49	0.34	0.33	0.34	0.29	0.20	0.38	0.733	1.406	0.763
1527	602.0	92.7	2.74	2.69	2.70	0.32	0.31	1.37	0.83	0.76	0.71	0.66	0.59	0.54	0.48	0.45	0.45	0.44	0.32	0.32	0.32	0.27	0.22	0.32	0.734	0.788	0.548
1528	1129.0	95.4	8.47	8.34	8.46	0.16	0.18	0.34	1.95	1.71	1.55	1.40	1.15	0.97	0.78	0.66	0.68	0.65	0.43	0.42	0.42	0.36	0.24	0.54	0.755	2.458	1.03
1529	1024.0	95.5	7.15	7.02	7.11	0.23	0.22	2.55	1.71	1.51	1.38	1.25	1.05	0.89	0.73	0.64	0.65	0.63	0.43	0.41	0.42	0.35	0.23	0.49	0.756	2.067	0.932
1530	870.0	95.2	5.36	5.25	5.31	0.30	0.28	2.40	1.37	1.23	1.13	1.04	0.89	0.77	0.66	0.60	0.60	0.58	0.40	0.40	0.40	0.33	0.23	0.43	0.754	1.546	0.792
1531	604.0	94.6	2.87	2.81	2.83	0.39	0.38	1.49	0.91	0.84	0.79	0.74	0.67	0.61	0.56	0.53	0.53	0.51	0.37	0.37	0.37	0.30	0.24	0.33	0.749	0.825	0.550
1532	434.0	94.2	1.73	1.69	1.69	0.43	0.44	1.00	0.69	0.65	0.63	0.60	0.56	0.53	0.50	0.48	0.48	0.46	0.34	0.34	0.33	0.27	0.24	0.27	0.746	0.495	0.395

TABLE VI. - DATA FOR FLUID NITROGEN FLOWING THROUGH A 14 L/D TUBE WITH A BORDA TYPE INLET

Run NO.	w, g/s	T_0, K	P_0, MPa	P_{0_1}	P_{0_2}	P_1	P_2	P_3	P_4	P_5	P_{BACK}, MPa	T_R	P_R	G_R
						All pressures in MPa								
1744	111.0	290.7	2.95	2.93	2.93	1.07	1.75	1.91	0.93	0.78	0.28	2.302	0.858	0.101
1745	172.0	299.2	4.60	4.57	4.60	1.66	2.73	3.00	1.45	1.20	0.41	2.329	1.341	0.157
1746	220.0	298.4	5.93	5.88	5.92	2.11	3.50	3.86	1.87	1.51	0.52	2.363	1.726	0.200
1747	274.0	295.6	7.32	7.27	7.32	2.58	4.31	4.76	2.30	1.84	0.63	2.342	2.135	0.249
1748	115.0	298.4	8.45	8.39	9.45	2.95	4.95	5.48	2.64	2.10	0.73	2.363	2.464	0.105
1749	67.5	279.0	1.74	1.71	1.71	0.63	1.02	1.11	0.54	0.45	0.19	2.209	0.501	0.614E-01
1750	1135.0	85.4	7.71	7.56	7.62	0.07	0.09	0.14	0.21	0.17	0.39	0.676	2.221	1.03
1751	946.0	85.1	5.43	5.31	5.35	0.08	0.09	0.15	0.20	0.17	0.29	0.674	1.560	0.861
1752	687.0	85.1	2.97	2.90	2.91	0.10	0.10	0.16	0.20	0.17	0.24	0.674	0.849	0.625
1753	495.0	84.2	1.62	1.58	1.57	0.11	0.11	0.16	0.19	0.16	0.21	0.667	0.460	0.450
1754	411.0	84.3	1.18	1.14	1.13	0.12	0.12	0.17	0.19	0.17	0.20	0.667	0.333	0.374
1755	101.0	112.1	7.72	7.57	7.63	0.38	0.44	0.99	1.15	0.97	0.72	0.688	2.225	0.919E-01
1756	836.0	111.2	5.51	5.40	5.44	0.45	0.48	1.02	1.16	1.03	0.60	0.880	1.585	0.761
1757	562.0	109.6	2.95	2.89	2.90	0.61	0.61	1.12	1.26	1.04	0.42	0.868	0.847	0.511
1758	342.0	112.1	2.10	2.07	2.07	1.18	1.27	1.54	1.31	1.05	0.31	0.888	0.606	0.311
1759	967.0	118.6	7.74	7.62	7.67	0.49	0.58	1.33	1.55	1.38	0.77	0.939	2.237	0.860
1760	715.0	121.3	5.31	5.21	5.24	1.00	1.18	1.80	2.04	1.70	0.64	0.960	1.529	0.651
1761	557.0	120.1	3.82	3.77	3.76	1.18	1.32	2.08	2.11	1.67	0.51	0.951	1.105	0.507
1762	351.0	188.8	2.73	2.72	2.72	1.67	1.82	2.07	1.67	1.27	0.35	1.495	0.796	0.319
1763	229.0	116.5	2.05	2.03	2.03	1.40	1.49	1.44	1.08	0.80	0.26	0.922	0.594	0.208
1765	83.2	99.7	7.59	7.45	7.50	0.21	0.25	0.47	0.59	0.49	0.54	0.789	2.187	0.757E-01
1766	854.0	98.9	5.03	4.93	4.96	0.24	0.26	0.50	0.56	0.49	0.44	0.783	1.448	0.777
1767	653.0	98.3	3.11	3.22	3.05	0.28	0.29	0.51	0.57	0.50	0.35	0.778	0.918	0.594
1768	473.0	97.2	1.82	1.78	1.78	0.32	0.33	0.50	0.56	0.49	0.28	0.770	0.521	0.430
1769	848.0	127.3	7.63	7.50	7.56	1.27	1.79	2.12	2.22	1.91	0.80	1.008	2.204	0.772
1776	628.0	127.9	5.47	5.40	5.44	1.66	2.17	2.26	2.41	1.96	0.62	1.013	1.586	0.571
1771	527.0	126.0	4.64	4.61	4.64	1.84	2.26	2.26	2.44	1.91	0.54	0.998	1.353	0.480
1772	298.0	125.6	3.26	3.22	3.22	1.74	2.04	2.27	1.62	1.20	0.36	0.994	0.942	0.271
1773	298.0	126.1	3.30	3.29	3.30	1.78	2.09	2.33	1.66	1.22	0.36	0.998	0.963	0.271
1774	169.0	126.0	2.85	2.80	2.80	1.19	1.84	1.93	1.26	0.92	0.31	0.998	0.819	0.172
1776	40.0	125.6	0.74	0.75	0.73	0.27	0.44	0.48	0.23	0.19	0.15	0.994	0.217	0.364E-01
1777	929.0	122.0	7.76	7.55	0.85	0.73	0.92	1.57	1.83	1.62	0.84	0.966	1.230	0.845
1778	754.0	120.9	5.59	5.48	5.52	0.89	1.04	1.71	1.98	1.67	0.67	0.957	1.610	0.686
1779	456.0	116.2	3.05	3.07	3.08	1.36	1.49	2.10	1.87	1.48	0.42	0.936	0.900	0.815
1780	707.0	144.7	8.39	0.92	8.35	1.95	2.91	2.87	3.26	2.73	0.83	1.146	1.357	0.643
1781	465.0	142.2	5.99	5.94	5.97	2.06	3.90	4.02	2.80	2.20	0.60	1.126	1.743	0.423
1782	243.0	143.1	3.92	3.88	3.89	1.42	2.32	2.35	1.48	1.19	0.38	1.133	1.137	0.221
1783	81.4	143.5	1.52	1.50	1.49	0.56	0.90	0.98	0.48	0.40	0.19	1.136	0.438	0.741E-01
1784	1127.0	111.8	7.39	7.22	7.27	2.53	0.74	0.99	1.15	1.00	0.82	0.885	2.120	1.03
1785	447.0	112.5	2.33	2.30	2.30	1.45	1.41	1.58	1.41	1.15	0.39	0.891	0.673	0.407
1786	443.0	112.7	2.34	2.31	2.31	1.48	1.45	1.60	1.42	1.17	0.39	0.892	0.675	0.403
1787	223.0	111.3	1.59	1.58	1.57	1.32	1.31	1.16	0.93	0.72	0.25	0.881	0.460	0.203
1788	178.0	109.3	1.39	1.38	1.37	1.14	1.10	0.93	0.76	0.58	0.23	0.865	0.402	0.162
1789	1090.0	114.3	7.19	7.02	7.07	2.53	0.82	1.16	1.35	1.14	0.84	0.905	2.062	0.992
1790	876.0	113.8	5.05	4.92	4.96	1.94	0.94	1.30	1.47	1.23	0.67	0.901	1.446	0.797
1791	611.0	112.7	3.02	2.98	2.99	1.45	1.09	1.49	1.51	1.23	0.49	0.892	0.873	0.556
1792	491.0	112.3	2.47	2.42	2.43	1.42	1.30	1.55	1.43	1.17	0.42	0.889	0.710	0.447
1793	357.0	112.4	2.03	2.02	2.02	1.46	1.48	1.50	1.29	1.06	0.33	0.890	0.590	0.325
1794	240.0	113.0	1.70	1.69	1.69	1.41	1.41	1.31	1.05	0.81	0.26	0.895	0.493	0.218

TABLE VII. - DATA FOR FLUID HYDROGEN FLOWING THROUGH A 53 L/D TUBE WITH A BORDA TYPE INLET.

All pressures in MPa

Run NO.	$\dot{w}$, g/s	T_0, K	P_0, MPa	P_{01}	P_{02}	P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8	P_9	P_{10}	P_{11}	P_{12}	P_{13}	P_{14}	P_{15}	P_{16}	P_{17}	P_{18}	P_{BACK}, MPa	T_R	P_R	G_R
1333	16.6	287.3	2.00	1.99	1.98	1.01	1.31	1.45	1.35	1.29	1.24	1.19	1.11	1.04	0.94	0.86	0.82	0.76	0.38	0.27	0.19	0.08	0.08	0.22	8.706	1.533	0.827E-01
1334	24.7	287.3	2.55	2.93	2.94	1.47	1.93	2.14	2.00	1.91	1.84	1.76	1.65	1.53	1.40	1.28	1.21	1.13	0.57	0.40	0.28	0.12	0.06	0.28	8.706	2.272	0.123
1335	38.4	288.4	4.56	4.54	4.57	2.25	2.97	3.31	3.09	2.96	2.84	2.73	2.56	2.39	2.15	1.98	1.88	1.76	0.85	0.63	0.43	0.18	0.09	0.40	8.739	3.522	0.191
1336	50.3	286.9	5.95	5.92	5.97	2.91	3.84	4.31	4.02	3.86	3.71	3.56	3.35	3.11	2.80	2.58	2.44	2.29	1.17	0.82	0.55	0.24	0.12	0.50	8.694	4.596	0.250
1337	63.2	287.2	7.50	7.45	7.53	3.63	4.82	5.43	5.06	4.86	4.66	4.49	4.21	3.91	3.52	3.24	3.08	2.89	1.47	1.04	[illegible]	0.30	0.15	0.62	8.703	5.791	0.315
1338	332.0	29.1	8.12	7.97	8.06	0.06	0.09	0.23	0.31	0.36	0.36	0.37	0.40	0.42	0.46	0.48	0.48	0.47	0.35	0.33	0.30	0.19	0.15	0.69	0.882	6.199	1.65
1339	272.0	27.6	5.66	5.55	5.60	0.10	0.09	0.25	0.33	0.36	0.37	0.38	0.41	0.43	0.46	0.48	0.49	0.48	0.36	0.34	0.31	0.19	0.15	0.57	0.836	4.309	1.35
1340	265.0	25.6	5.32	5.22	5.26	0.06	0.07	0.20	0.26	0.29	0.30	0.29	0.32	0.33	0.36	0.38	0.38	0.37	0.27	0.26	0.24	0.15	0.14	0.52	0.776	4.050	1.32
1341	206.0	24.4	3.26	3.20	3.20	0.09	0.08	0.22	0.27	0.30	0.30	0.30	0.32	0.34	0.36	0.38	0.38	0.37	0.26	0.25	0.24	0.16	0.16	0.42	0.739	2.474	1.03
1342	165.0	23.3	2.71	2.65	2.66	0.18	0.07	0.20	0.24	0.27	0.27	0.26	0.29	0.30	0.32	0.34	0.34	0.32	0.23	0.22	0.21	0.14	0.17	0.39	0.706	2.053	0.921
1343	161.0	22.8	2.02	1.98	1.97	0.16	0.08	0.20	0.24	0.27	0.27	0.27	0.29	0.30	0.31	0.33	0.34	0.32	0.22	0.21	0.21	0.14	0.18	0.34	0.691	1.528	0.802
1344	141.0	22.8	1.57	1.54	1.52	0.15	0.08	0.21	0.25	0.28	0.28	0.28	0.30	0.31	0.32	0.34	0.34	0.32	0.22	0.21	0.21	0.14	0.19	0.31	0.691	1.184	0.702
1345	115.0	23.2	1.18	1.16	1.14	0.15	0.10	0.23	0.37	0.43	0.45	0.42	0.40	0.37	0.36	0.36	0.34	0.31	0.20	0.20	0.19	0.13	0.20	0.29	0.703	0.891	0.573
1346	334.0	27.5	8.09	7.95	8.02	0.13	0.08	0.19	0.27	0.31	0.31	0.30	0.33	0.35	0.38	0.40	0.40	0.39	0.29	0.27	0.25	0.16	0.14	0.62	0.833	6.175	1.66
1347	264.0	44.1	8.12	8.02	8.10	1.46	2.60	4.42	3.91	3.64	3.42	3.20	2.87	2.53	2.12	1.86	1.75	1.62	1.01	1.01	0.72	0.39	0.15	0.75	1.336	6.236	1.31
1348	210.0	42.9	6.02	5.93	5.99	1.28	2.06	3.38	3.02	2.84	2.69	2.52	2.30	2.06	1.78	1.60	1.53	1.45	0.98	0.94	0.67	0.34	0.13	0.61	1.300	4.610	1.05
1349	284.0	42.4	8.34	8.22	8.30	1.22	1.95	4.35	3.82	3.55	3.32	3.09	2.75	2.40	1.99	1.73	1.64	1.53	1.01	1.00	0.72	0.39	0.15	0.73	1.285	6.388	1.41
1350	233.0	55.1	8.69	8.60	8.69	2.71	4.14	5.37	4.86	4.61	4.37	4.15	3.82	3.44	2.97	2.65	2.50	2.31	1.06	0.98	0.68	0.35	0.23	0.79	1.670	6.687	1.16
1351	323.0	31.9	7.92	7.77	7.85	0.07	0.12	0.37	0.48	0.55	0.57	0.58	0.63	0.67	0.73	0.77	0.78	0.77	0.28	0.54	0.47	0.28	0.13	0.64	0.967	6.042	1.61
1352	316.0	36.1	8.05	7.91	7.99	0.20	0.36	1.36	2.33	2.81	2.65	2.44	2.12	1.82	1.49	1.32	1.31	1.22	0.46	0.78	0.66	0.37	0.15	0.68	1.094	6.151	1.57
1353	169.0	32.7	7.83	7.71	7.79	0.08	0.13	0.40	0.53	0.60	0.62	0.63	0.69	0.74	0.80	0.84	0.86	0.85	0.62	0.59	0.51	0.31	0.13	0.67	0.991	5.994	0.842
1354	263.0	32.6	5.76	5.64	5.68	0.11	0.16	0.50	0.63	0.69	0.72	0.73	0.84	0.98	1.01	1.00	1.02	0.97	0.62	0.60	0.54	0.32	0.14	0.56	0.988	4.378	1.31
1355	103.0	43.9	3.36	3.28	3.30	0.91	1.33	2.00	1.82	1.75	1.67	1.58	1.50	1.38	1.26	1.20	1.15	1.13	0.66	0.53	0.39	0.19	0.16	0.39	1.330	2.544	0.513
1361	344.0	30.7	7.61	7.69	7.79	0.06	0.14	0.33	0.44	0.48	0.50	0.51	0.55	0.58	0.63	0.65	0.66	0.65	0.46	0.47	0.40	0.25	0.12	0.65	0.930	5.986	1.71
1362	301.0	30.3	6.63	6.52	6.60	0.16	0.16	0.35	0.45	0.49	0.52	0.52	0.56	0.60	0.64	0.67	0.68	0.66	0.48	0.47	0.40	0.25	0.12	0.58	0.918	5.074	1.50
1363	257.0	29.4	5.03	4.94	5.00	0.08	0.13	0.38	0.47	0.50	0.53	0.54	0.58	0.60	0.64	0.67	0.68	0.65	0.48	0.45	0.39	0.24	0.13	0.50	0.891	3.845	1.28
1364	206.0	33.8	4.10	4.03	4.07	0.33	0.13	2.02	1.78	1.67	1.58	1.49	1.37	1.25	1.14	1.09	1.07	1.02	0.73	0.68	0.55	0.29	0.19	0.48	1.024	3.133	1.03
1365	155.0	33.0	2.80	2.76	2.78	0.54	0.13	1.56	1.44	1.38	1.33	1.27	1.20	1.13	1.09	1.06	1.02	0.97	0.71	0.60	0.47	0.23	0.20	0.40	1.000	2.141	0.772
1366	259.0	32.3	5.28	5.18	5.25	0.11	0.16	0.50	0.64	0.69	0.72	0.81	1.10	1.11	1.04	1.00	0.98	0.91	0.59	0.56	0.50	0.31	0.15	0.52	0.979	4.034	1.28
1367	177.0	34.2	3.44	3.40	3.42	0.49	0.16	1.64	1.66	1.58	1.51	1.43	1.34	1.24	1.17	1.13	1.11	1.07	0.78	0.67	0.53	0.27	0.20	0.43	1.036	2.634	0.881
1368	119.0	33.3	2.23	2.21	2.21	0.80	0.16	1.46	1.36	1.33	1.30	1.24	1.22	1.17	1.13	1.11	1.08	1.04	0.62	0.49	0.38	0.18	0.19	0.35	1.009	1.709	0.593
1369	74.0	32.0	1.47	1.47	1.46	0.82	0.16	1.12	1.05	1.03	0.99	0.94	0.91	0.84	0.76	0.72	0.67	0.62	0.36	0.28	0.22	0.10	0.16	0.28	0.970	1.130	0.369
1370	226.0	35.3	8.43	8.30	8.42	0.11	0.16	0.54	0.69	1.23	1.47	1.64	1.53	1.55	1.37	1.27	1.25	1.14	0.78	0.74	0.62	0.37	0.15	0.69	1.070	6.465	1.13
1371	283.0	34.7	6.22	6.12	6.19	0.21	0.16	1.17	1.79	2.20	2.09	1.94	1.71	1.50	1.29	1.18	1.16	1.08	0.75	0.72	0.60	0.34	0.15	0.58	1.052	4.762	1.41
1372	152.0	36.6	3.16	3.12	3.13	0.60	0.16	1.76	1.60	1.53	1.47	1.40	1.33	1.24	1.18	1.15	1.13	1.09	0.76	0.62	0.49	0.23	0.18	0.40	1.048	2.416	0.757
1373	234.0	39.1	9.50	9.37	9.49	0.80	0.16	4.55	3.96	3.61	3.34	3.08	2.68	2.28	1.83	1.57	1.50	1.35	0.93	0.90	0.71	0.40	0.16	0.73	1.185	7.295	1.17
1374	274.0	40.4	7.24	7.11	7.19	0.95	0.16	3.67	3.23	2.98	2.79	2.60	2.32	2.03	1.71	1.53	1.47	1.39	0.95	0.95	0.68	0.37	0.14	0.63	1.224	5.530	1.36
1375	93.7	51.9	8.46	8.39	8.49	2.42	3.87	5.11	4.62	4.35	4.12	3.90	3.57	3.21	2.75	2.45	2.29	2.06	1.10	0.96	0.72	0.39	0.24	0.77	1.573	6.527	0.467
1376	219.0	51.2	6.91	6.84	6.93	2.16	3.34	4.29	3.89	3.67	3.49	3.31	3.05	2.75	2.39	2.15	2.01	1.82	1.03	0.87	0.64	0.33	0.20	0.65	1.552	5.327	1.09
1377	132.0	53.0	5.00	4.96	5.01	1.92	2.73	3.29	3.01	2.87	2.74	2.61	2.44	2.22	1.95	1.78	1.67	1.53	0.79	0.63	0.46	0.24	0.26	0.50	1.606	3.855	0.657
1380	157.0	21.9	1.66	1.64	1.84	0.07	0.07	0.17	0.21	0.22	0.23	0.23	0.24	0.25	0.26	0.26	0.27	0.27	0.19	0.16	0.18	0.12	0.23	0.36	0.664	1.424	0.782
1385	224.0	23.7	3.70	3.62	3.64	0.06	0.07	0.16	0.23	0.25	0.26	0.26	0.28	0.30	0.30	0.31	0.32	0.31	0.23	0.22	0.21	0.13	0.15	0.40	0.718	2.810	1.12
1386	328.0	26.8	7.74	7.61	7.68	0.08	0.07	0.19	0.26	0.28	0.29	0.29	0.31	0.33	0.35	0.36	0.36	0.36	0.27	0.26	0.23	0.15	0.14	0.60	0.812	5.914	1.63
1387	289.0	26.0	6.14	6.05	6.11	0.05	0.07	0.20	0.26	0.29	0.30	0.29	0.31	0.33	0.35	0.36	0.37	0.36	0.27	0.26	0.23	0.15	0.13	0.51	0.788	4.700	1.44
1388	334.0	27.4	8.08	7.95	8.03	0.04	0.07	0.20	0.27	0.29	0.31	0.30	0.33	0.34	0.36	0.37	0.38	0.38	0.29	0.27	0.24	0.15	0.13	0.61	0.830	6.178	1.66
1393	214.0	22.8	3.36	3.30	3.31	0.05	0.06	0.16	0.20	0.22	0.24	0.22	0.25	0.25	0.26	0.27	0.28	0.27	0.21	0.20	0.18	0.24	0.44	0.69	0.691	2.557	1.07
1394	212.0	23.3	3.36	3.30	3.31	0.06	0.06	0.17	0.22	0.24	0.25	0.24	0.26	0.27	0.28	0.29	0.30	0.29	0.22	0.21	0.20	0.30	0.58	0.76	0.706	2.557	1.06
1395	213.0	23.2	3.38	3.32	3.33	0.06	0.06	0.18	0.22	0.24	0.25	0.24	0.26	0.27	0.28	0.30	0.30	0.30	0.22	0.21	0.21	0.45	0.92	0.98	0.703	2.573	1.06
1396	212.0	23.7	3.38	3.32	3.33	0.06	0.07	0.19	0.24	0.26	0.27	0.26	0.28	0.30	0.31	0.32	0.33	0.32	0.24	0.24	0.57	1.03	1.27	1.31	0.718	2.573	1.06
1397	219.0	23.1	3.56	3.50	3.52	0.11	0.09	1.54	1.48	1.36	1.31	1.22	1.13	1.04	0.95	0.91	0.91	0.89	1.11	1.31	1.51	1.71	1.83	1.87	0.700	2.714	1.09
1399	260.0	44.5	8.19	8.09	8.18	1.58	2.90	4.51	4.03	3.75	3.53	3.31	2.98	2.65	2.22	1.93	1.82	1.67	1.13	1.00	0.76	0.40	0.16	0.69	1.361	6.292	1.29
1400	302.0	36.5	7.98	7.85	7.93	0.40	0.49	2.86	3.17	2.91	2.70	2.49	2.15	1.86	1.52	1.33	1.32	1.24	0.84	0.81	0.65	0.37	0.16	0.64	1.106	6.103	1.50
1401	286.0	40.2	8.07	7.97	8.05	0.89	1.25	4.02	3.54	3.25	3.04	2.82	2.49	2.17	1.78	1.54	1.49	1.40	0.97	0.94	0.69	0.39	0.16	0.69	1.218	6.194	1.42
1402	308.0	34.9	7.87	7.75	7.82	0.11	0.21	0.53	0.68	0.74	1.06	1.22	1.46	1.52	1.38	1.23	1.22	1.12	0.74	0.72	0.60	0.36	0.16	0.64	1.058	6.020	1.53
1403	271.0	42.2	8.08	7.96	8.04	1.14	1.82	4.18	3.72	3.43	3.22	3.00	2.67	2.35	1.94	1.69	1.61	1.51	1.00	0.98	0.71	0.38	0.16	0.67	1.279	6.168	1.35
1419	233.0	24.3	3.93	3.85	3.89	0.07	0.07	0.19	0.24	0.26	0.27	0.27	0.29	0.30	0.31	0.33	0.34	0.33	0.25	0.23	0.22	0.14	0.20	0.47	0.736	2.991	1.16
1420	167.0	22.9	2.07	[illegible]	2.07	0.10	0.10	0.37	0.25	0.26	0.31	0.27	0.29	0.30	0.32	0.32	0.33	0.32	0.23	0.21	0.20	0.14	0.22	0.37	0.694	1.602	0.832
1421	170.0	22.1	2.14	2.09	2.09	0.14	0.12	0.23	0.21	0.00	0.21	0.23	0.25	0.26	0.26	0.27	0.28	0.26	0.20	0.19	0.18	0.12	0.20	0.36	0.670	1.618	0.647
1422	146.0	21.8	1.67	1.64	1.64	0.13	0.15	0.27	0.21	0.00	0.21	0.23	0.25	0.26	0.26	0.27	0.28	0.26	0.20	0.19	0.18	0.12	0.20	0.32	0.661	1.266	0.727
1423	131.0	21.7	1.36	1.33	1.33	0.13	0.12	0.29	0.22	0.00	0.22	0.24	0.25	0.26	0.27	0.27	0.28	0.26	0.19	0.18	0.17	0.12	0.19	0.28	0.658	1.026	0.652
1424	119.0	21.9	1.15	1.96	2.00	0.12	0.11	0.33	0.23	0.13	0.23	0.25	0.27	0.28	0.29	0.28	0.28	0.26	0.19	0.18	0.18	0.12	0.19	0.26	0.664	1.533	0.593
1425	328.0	30.0	7.67	7.73	7.63	0.06	0.10	0.28	0.39	0.42	0.44	0.45	0.48	0.51	0.55	0.57	0.58	0.58	0.45	0.42	0.36	0.23	0.16	0.66	0.909	6.018	1.63

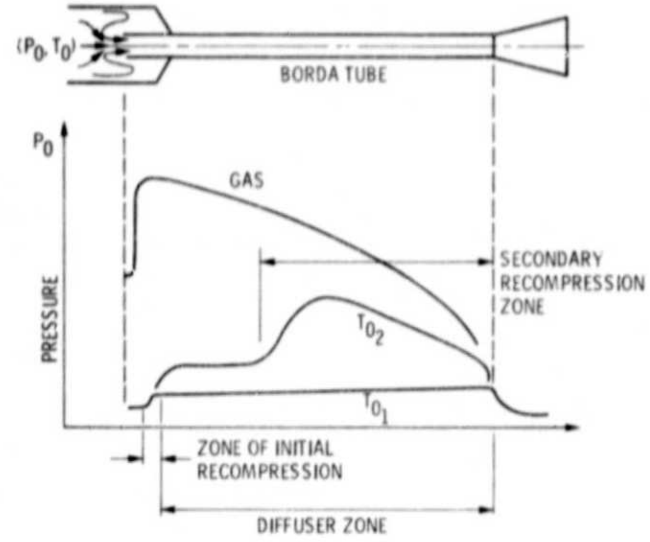


Figure 1. - Sketch of pressure profiles which characterize the Borda tube data of reference 3.

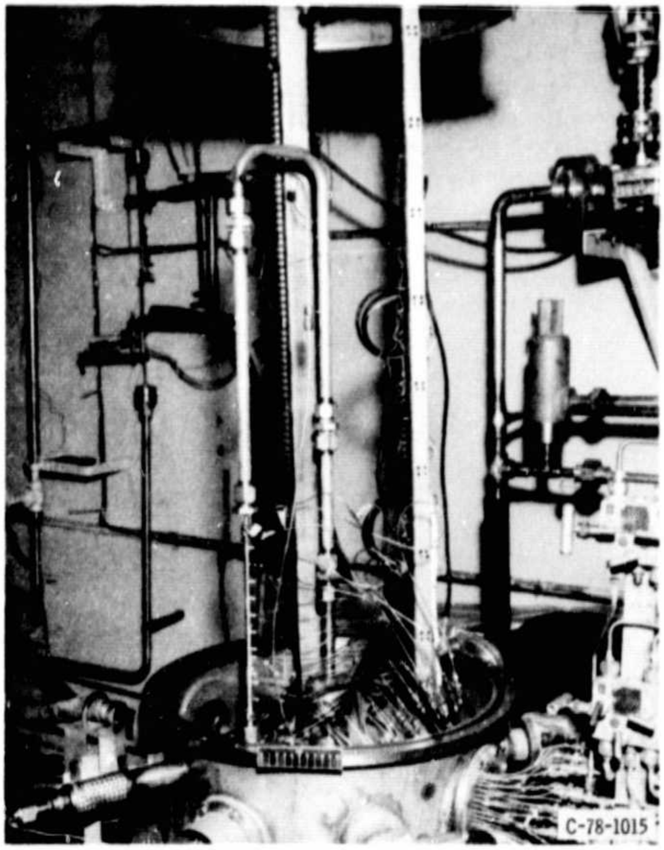


Figure 2. - Apparatus.

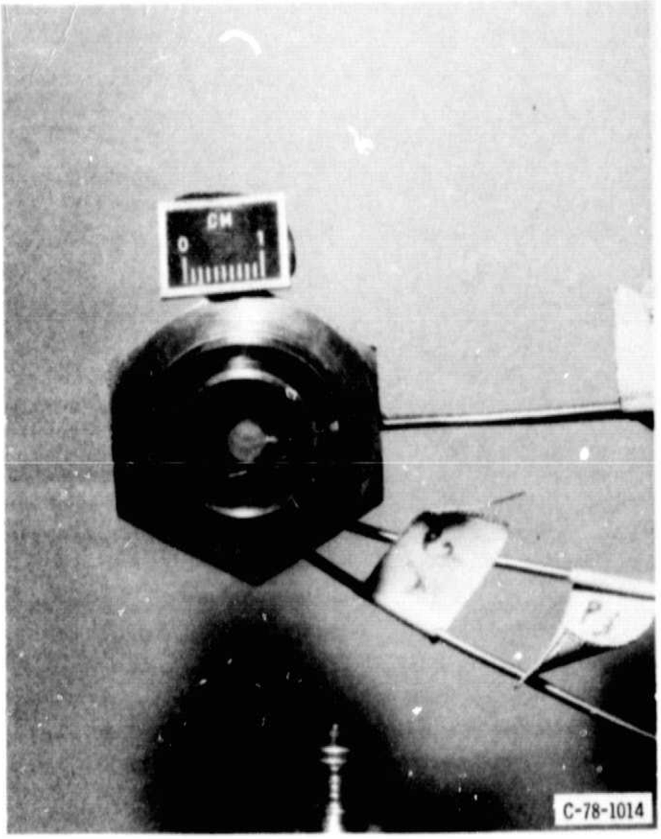


Figure 3. - Borda inlet.

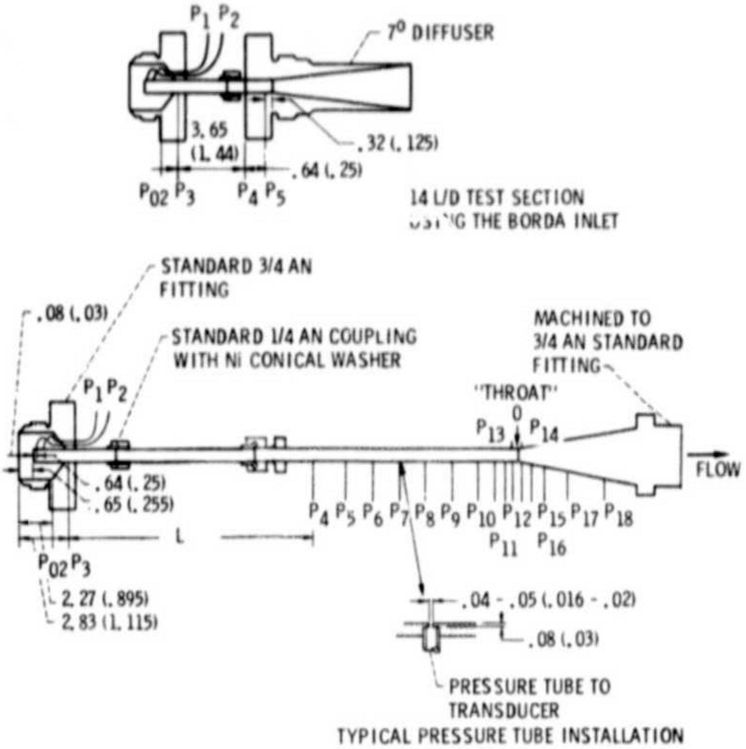
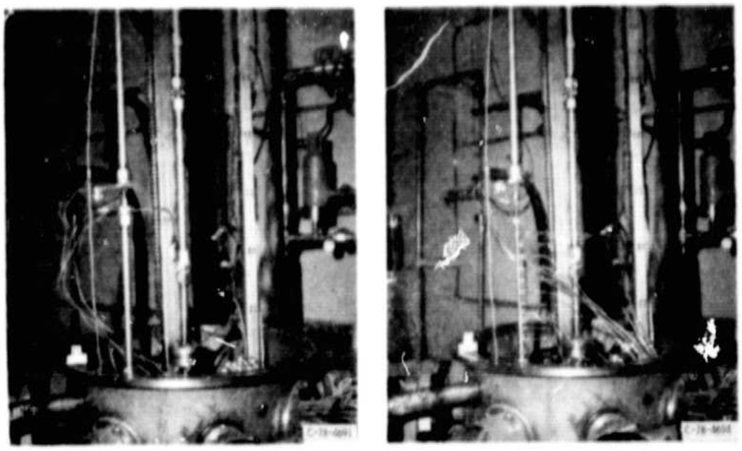
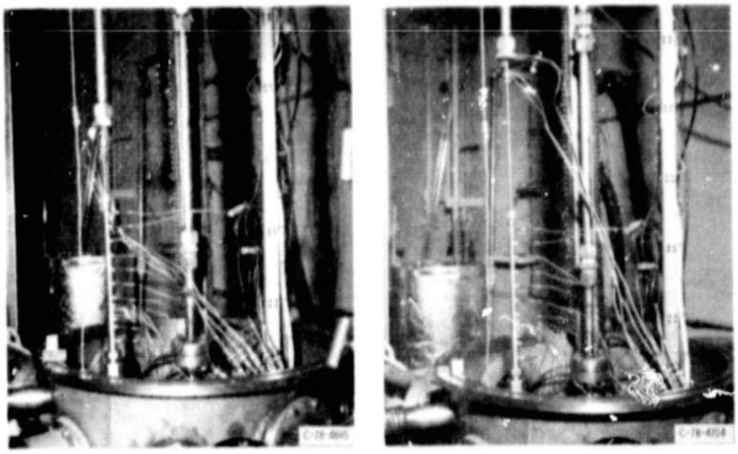


Figure 4. - Schematic of Borda tube test sections. See table I for pressure tap locations, and dimension L.



(a) BORDA + 7° NOZZLE.

(b) BORDA + 5.1 cm (2 INCH) EXTENSION NOZZLE.



(c) BORDA + 10.2 cm (4 INCH) EXTENSION NOZZLE.

(d) BORDA + 25.4 cm (10 INCH) EXTENSION NOZZLE.

Figure 5. Test sections.

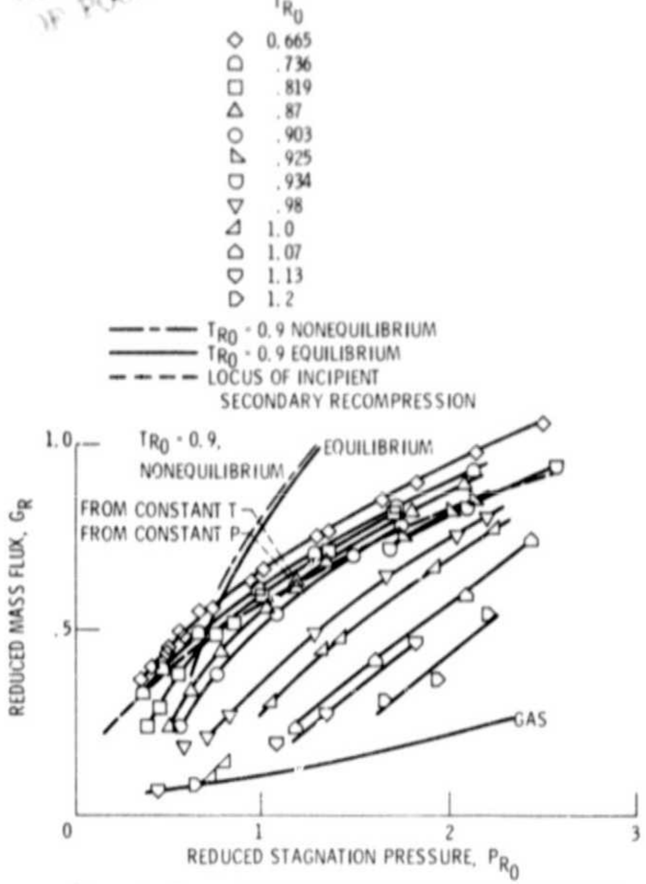


Figure 6. - Reduced critical mass flux for Borda tubes as a function of reduced inlet stagnation pressure for selected isotherms fluid nitrogen. L/D = 53.

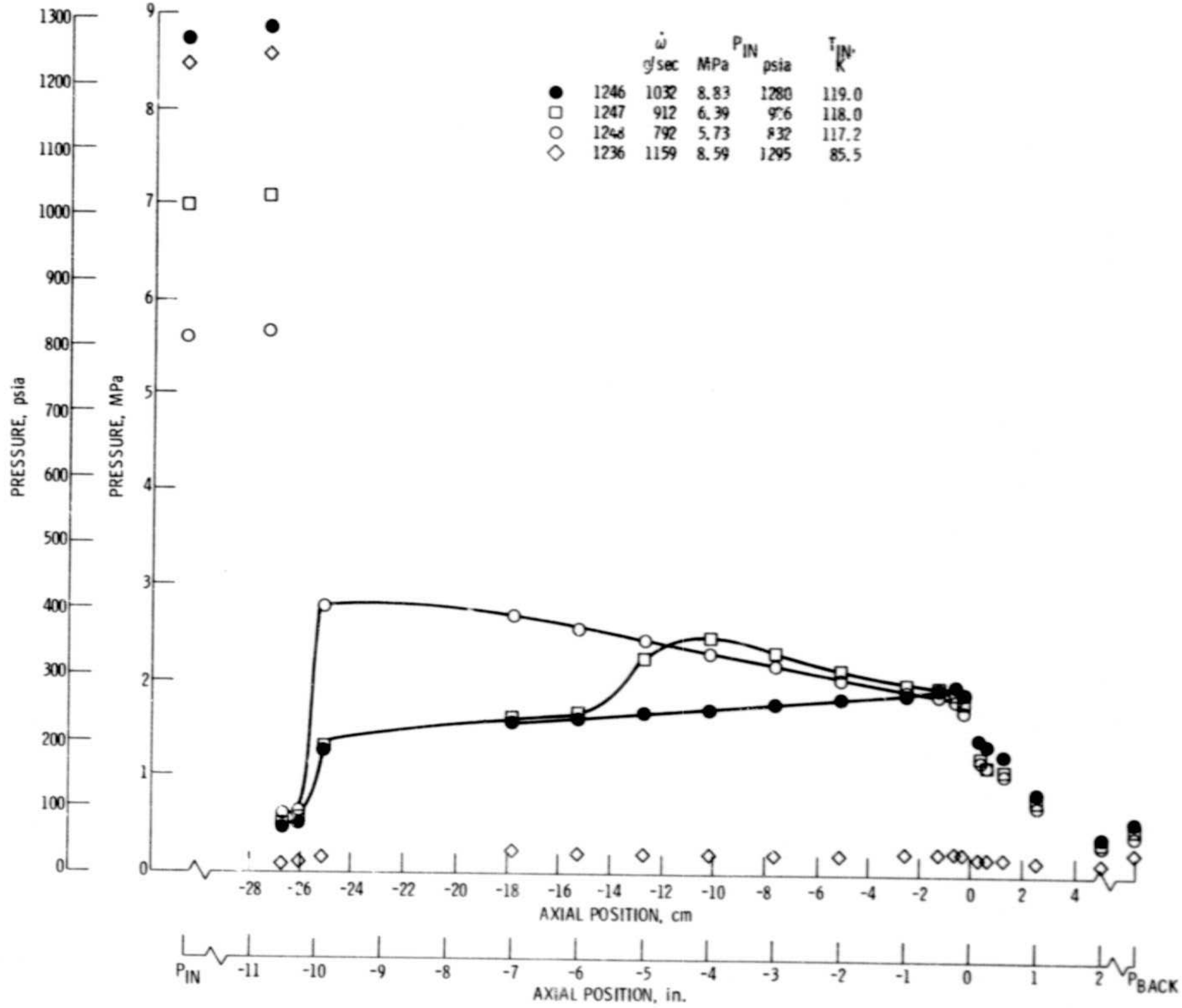


Figure 7. - Axial pressure profiles for Borda tubes illustrating incipient secondary recompression fluid nitrogen. L/D = 53.

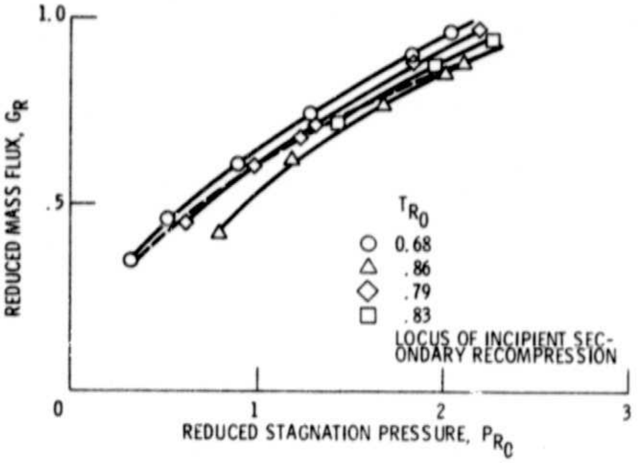


Figure 8. - Reduced critical mass flux for Borda tubes as a function of reduced inlet stagnation pressure for selected isotherms fluid nitrogen. L/D = 64.

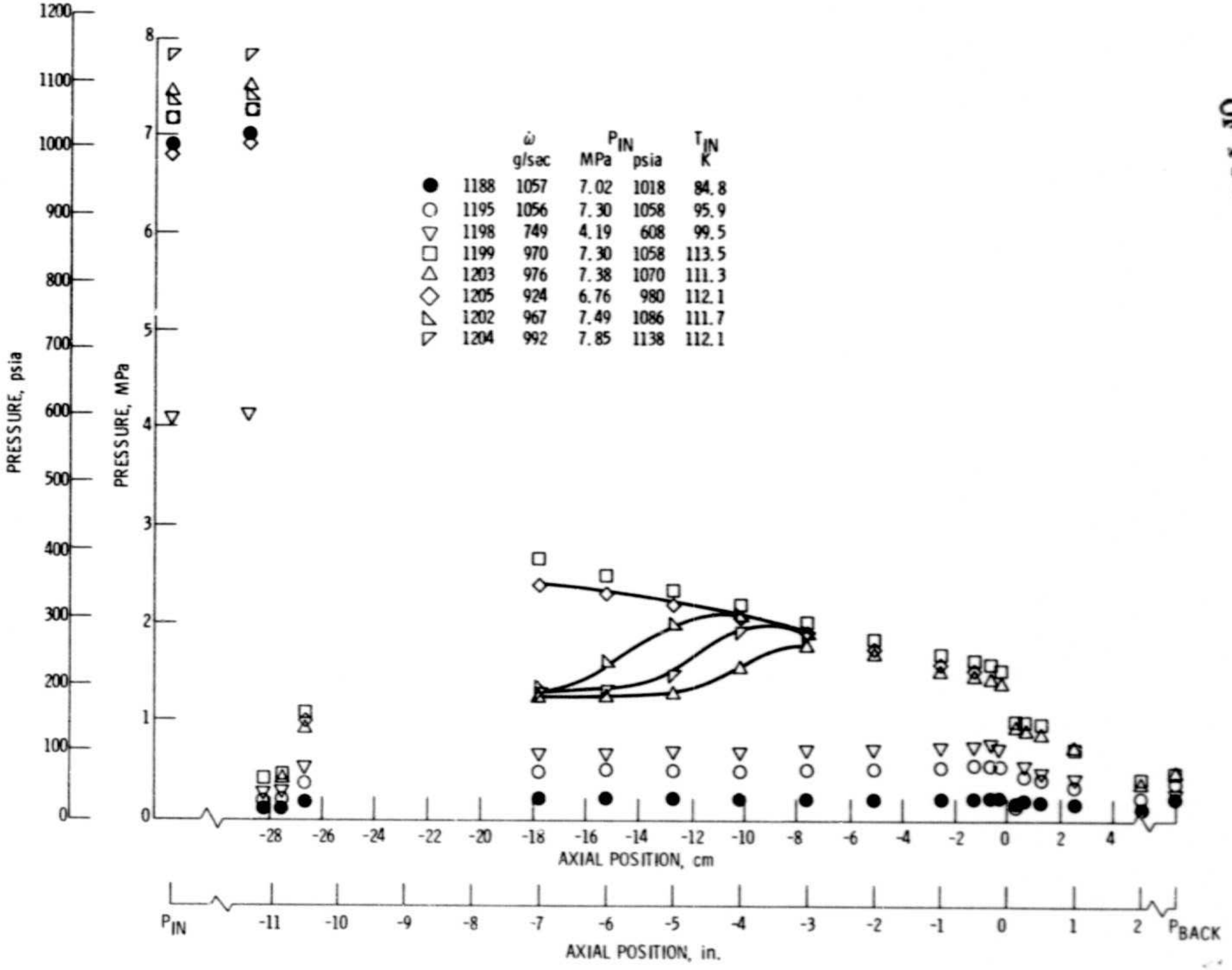


Figure 9. - Axial pressure profiles for Borda tubes illustrating incipient secondary recompression fluid nitrogen. L/D - 64.

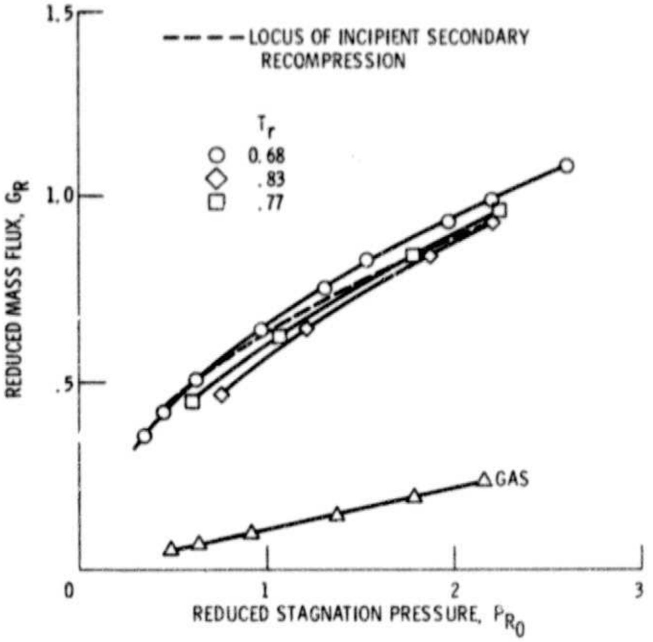
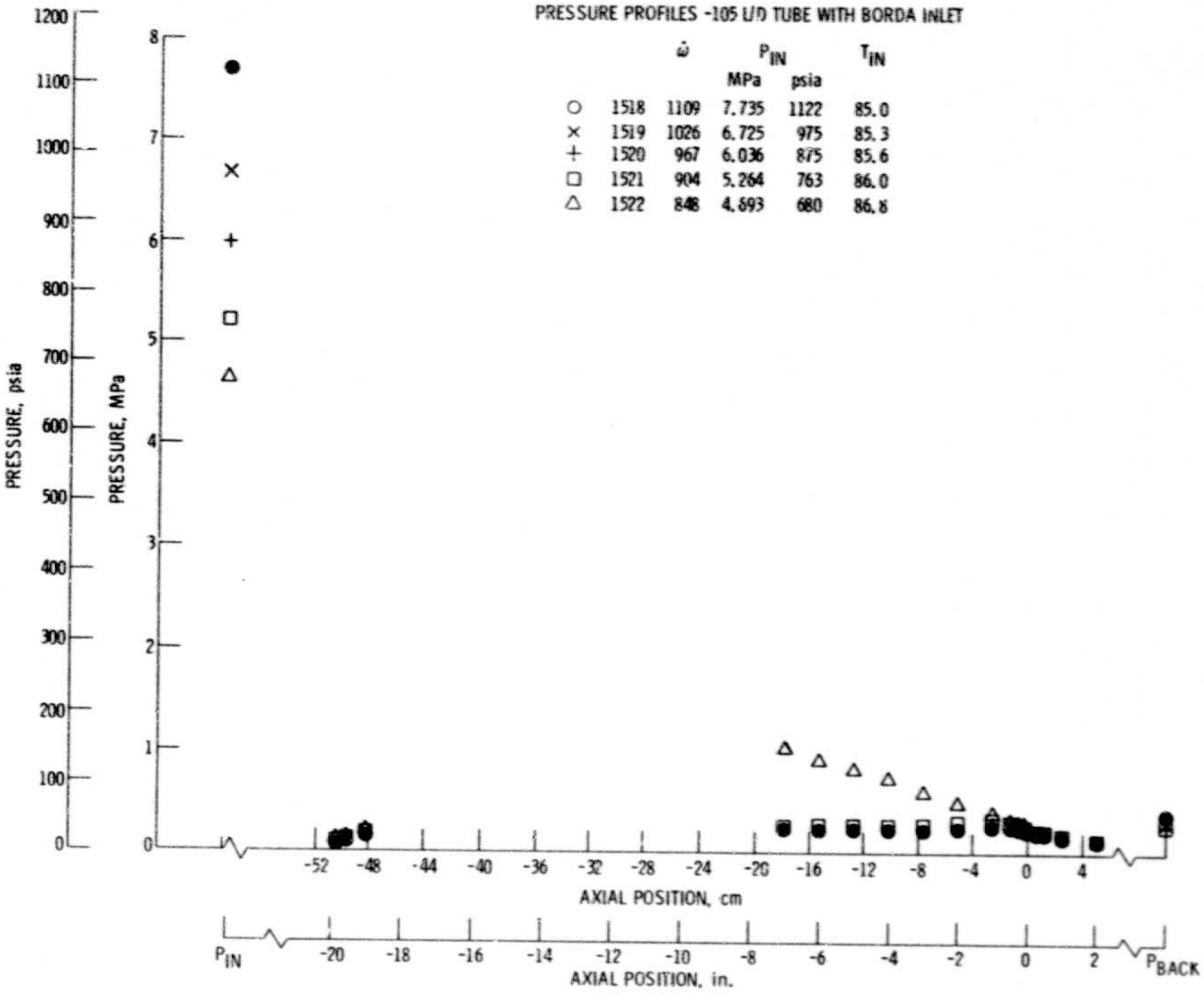
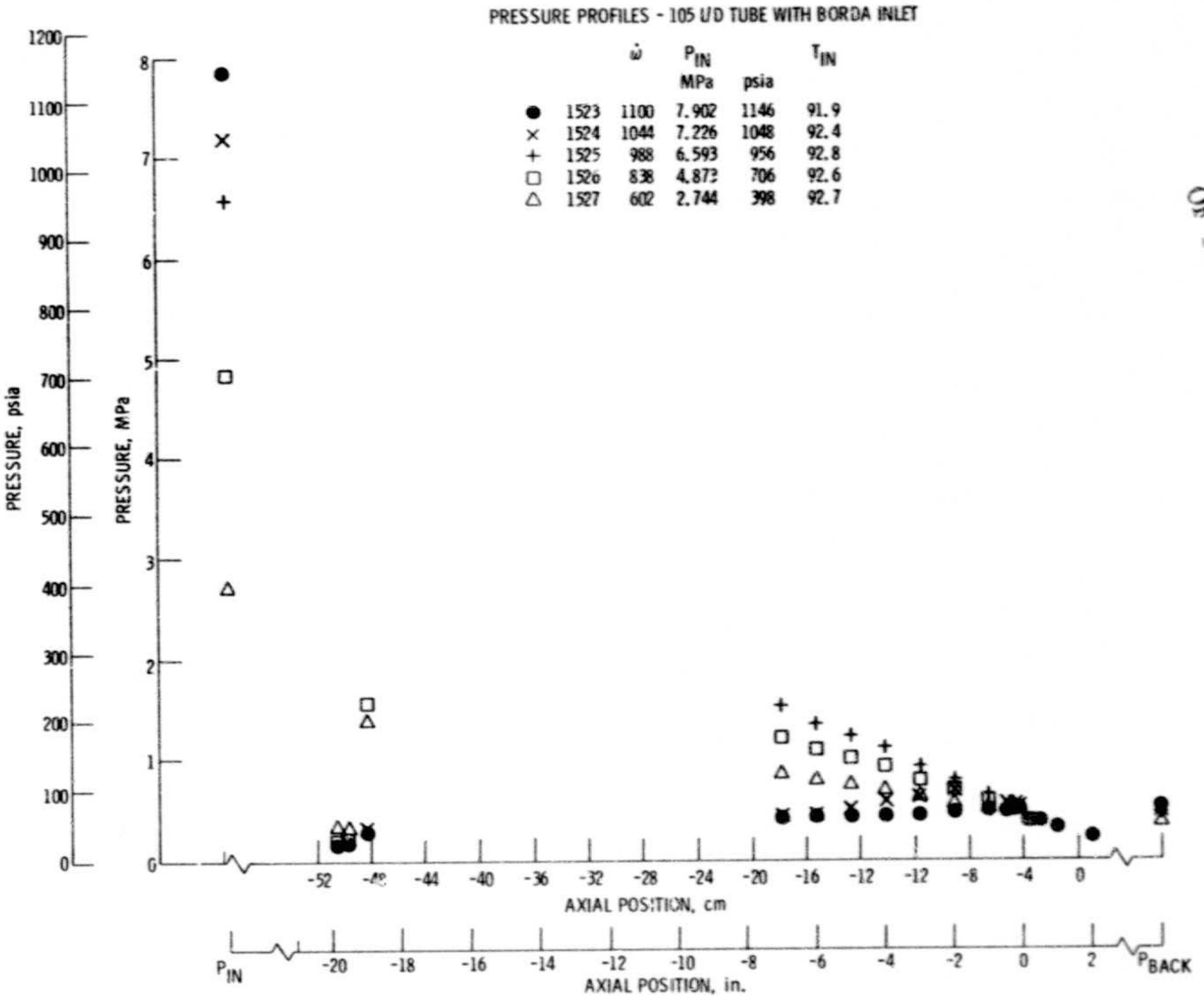


Figure 10. - Reduced critical mass flux for Borda tubes as a function of reduced inlet stagnation pressure for selected isotherms fluid nitrogen. L/D = 73.



(a)

Figure 11. - Axial pressure profiles for Borda tubes illustrating incipient secondary recompression fluid nitrogen. L/D = 105.



(b)

Figure 11. - Concluded.

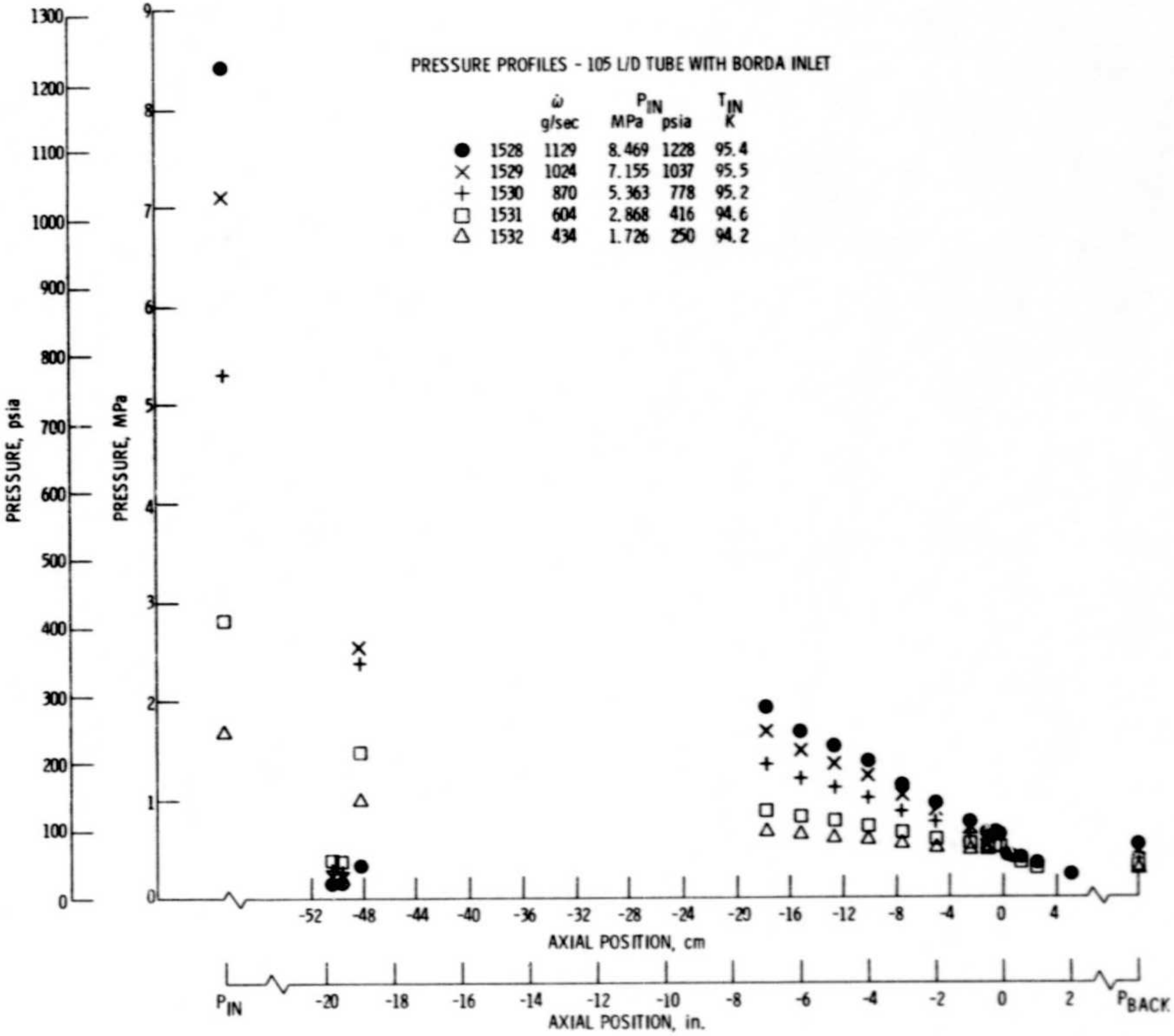


Figure 12. - Axial pressure profiles for Borda tubes illustrating incipient secondary recompression fluid nitrogen. L/D - 105.

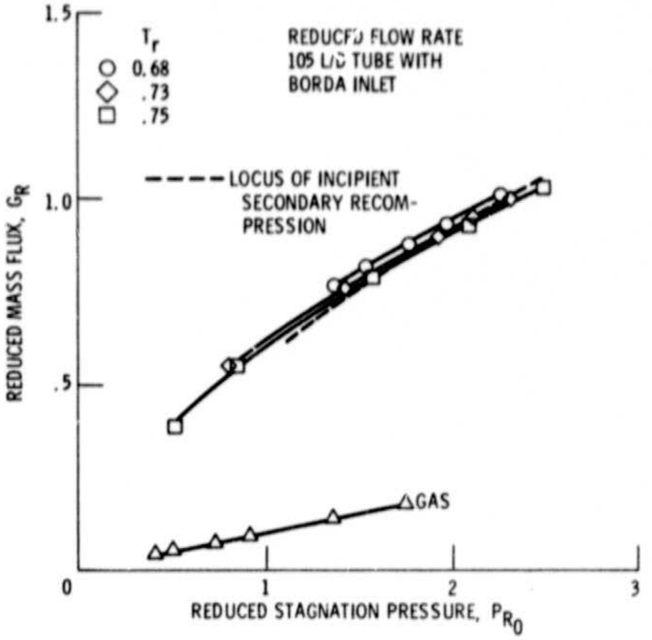


Figure 13. - Reduced critical mass flux for Borda tubes as a function of reduced inlet stagnation pressure for selected isotherms fluid nitrogen. L/D = 105.

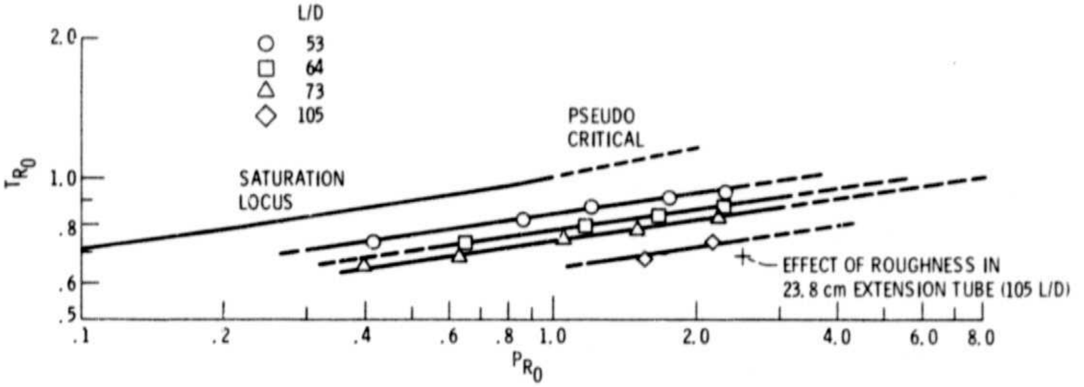


Figure 14. - Locii of incipient secondary recompression in tubes with Borda type inlets.

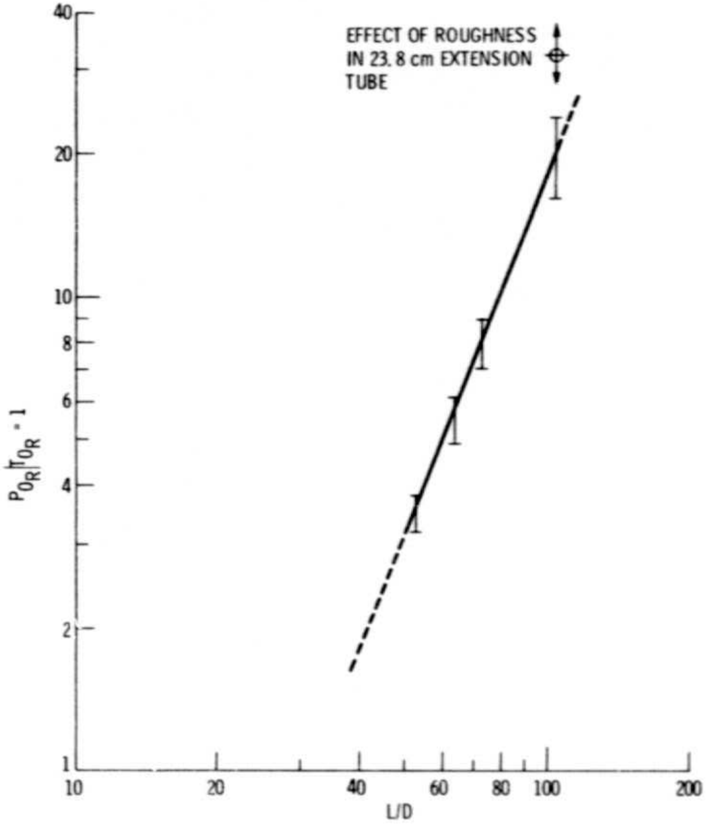


Figure 15. - Intercept values at $T_{0_R} = 1$ for incipient secondary compression in Borda tubes as a function of L/D.

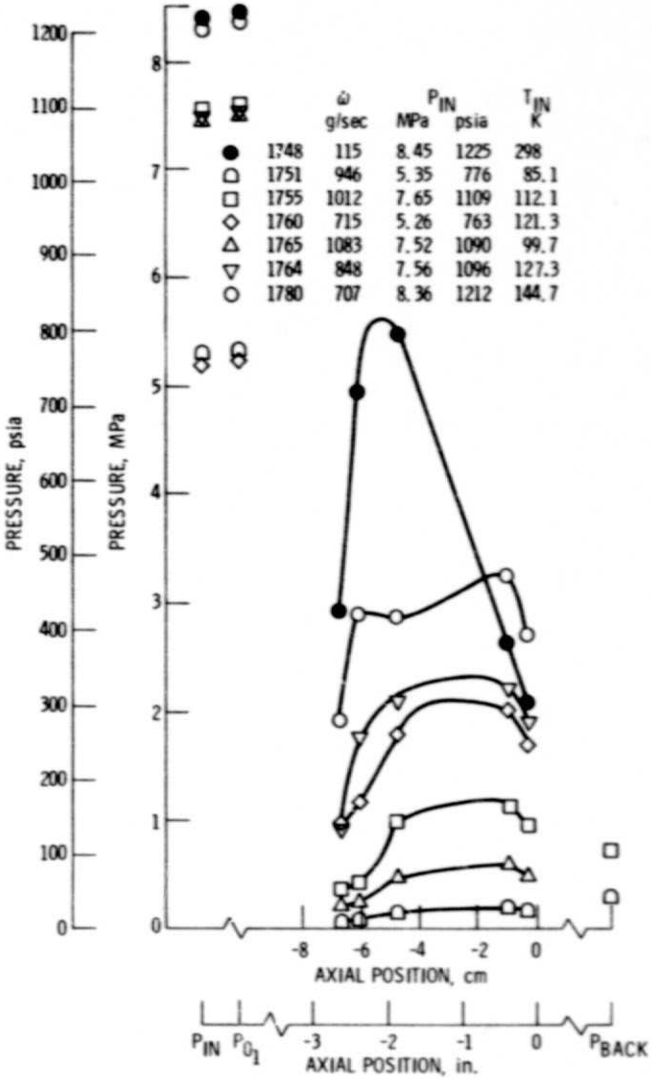


Figure 16. - Axial pressure profiles for a 14 L/D Borda tube, fluid nitrogen.

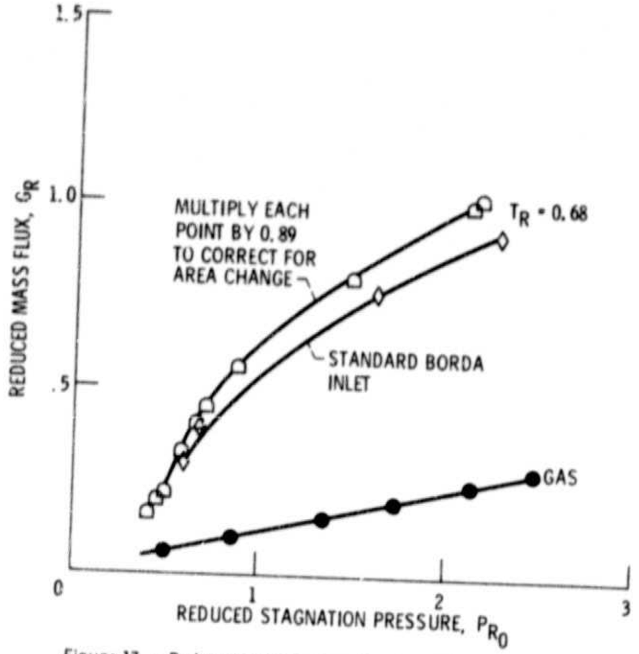


Figure 17. - Reduced critical mass flux for a 14 L/D Borda tube with and without a 6 percent enlarged conical inlet, fluid nitrogen.

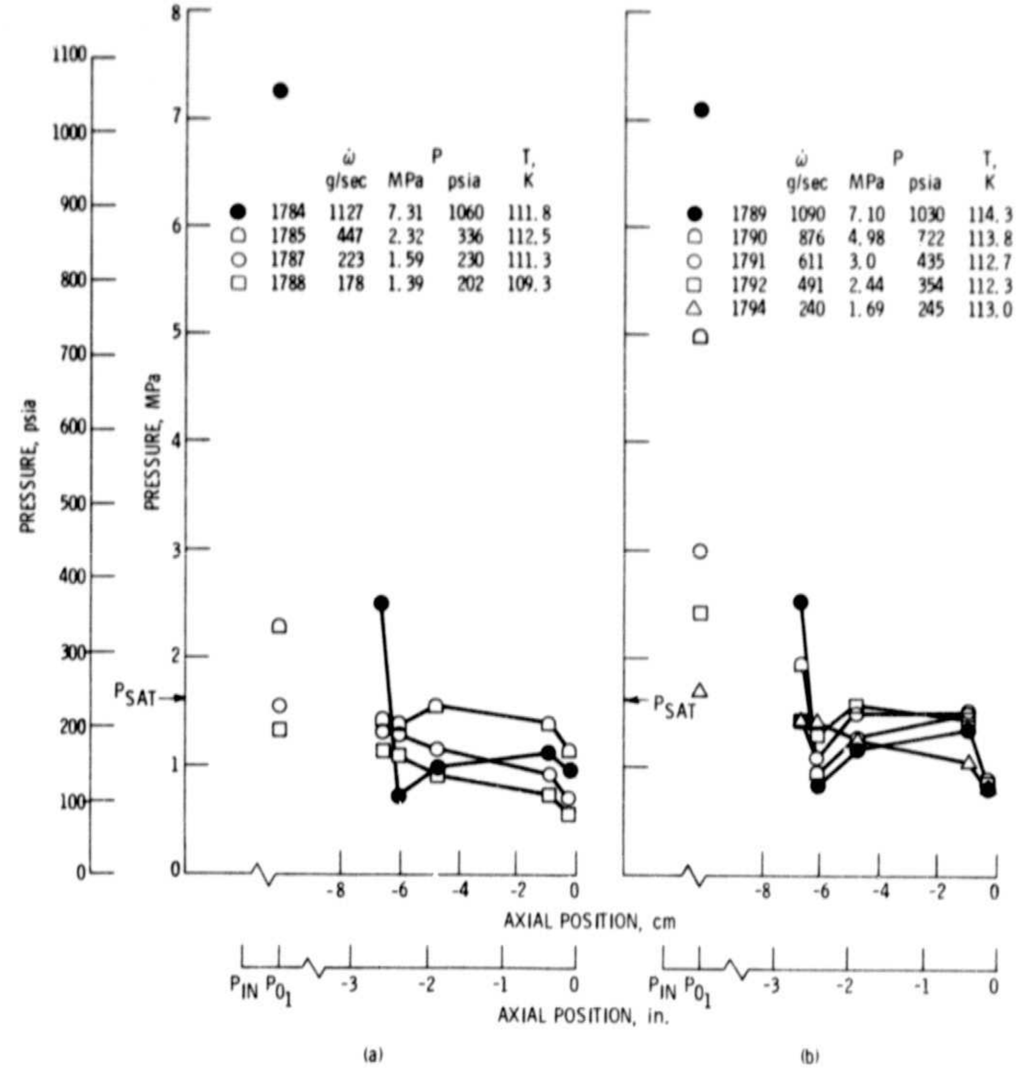


Figure 18. - Axial pressure profiles for a 14 L/D Borda tube with a 6 percent enlarged conical type inlet, fluid nitrogen.

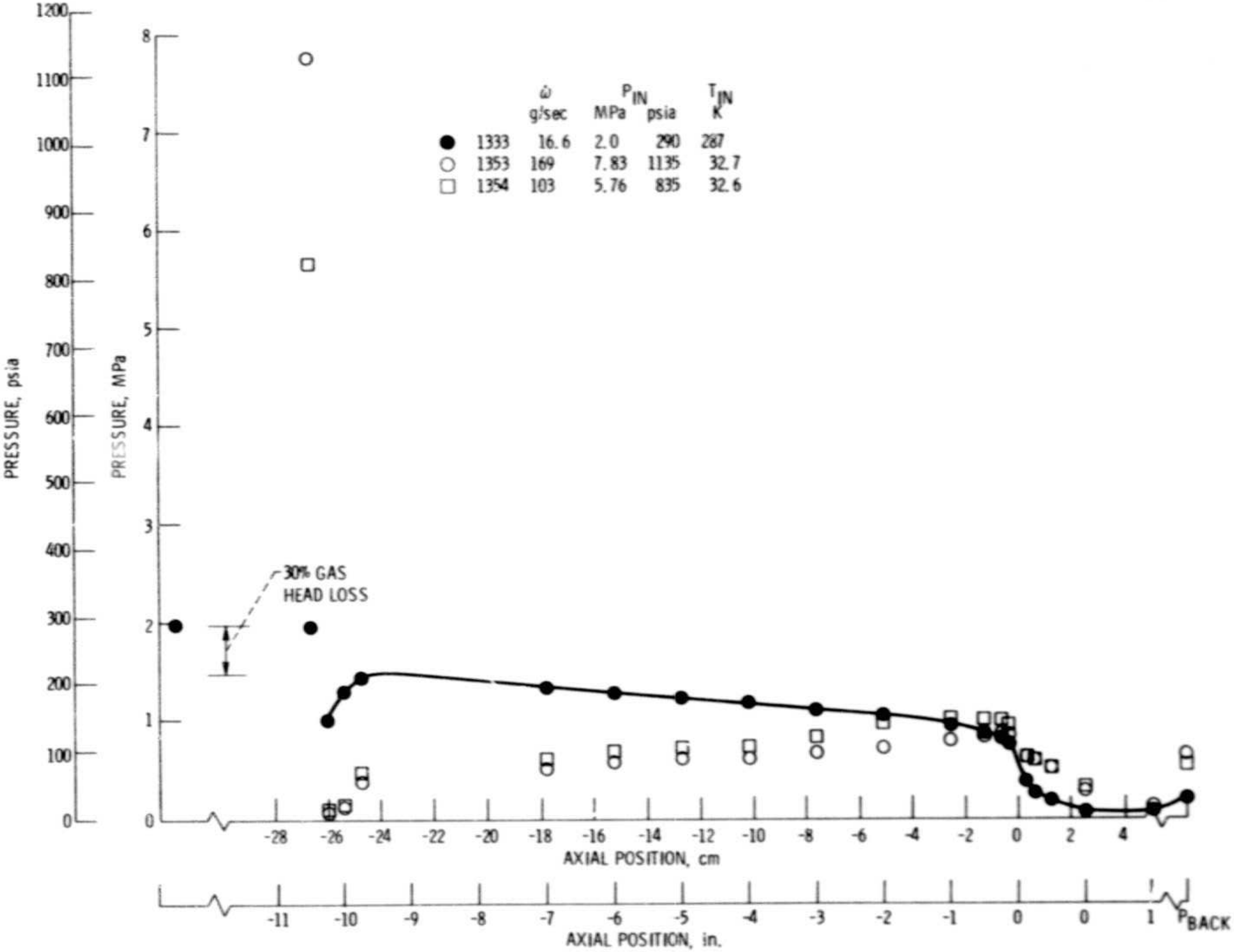


Figure 19. - Axial pressure profiles for fluid hydrogen in a 53 L/D Borda tube.

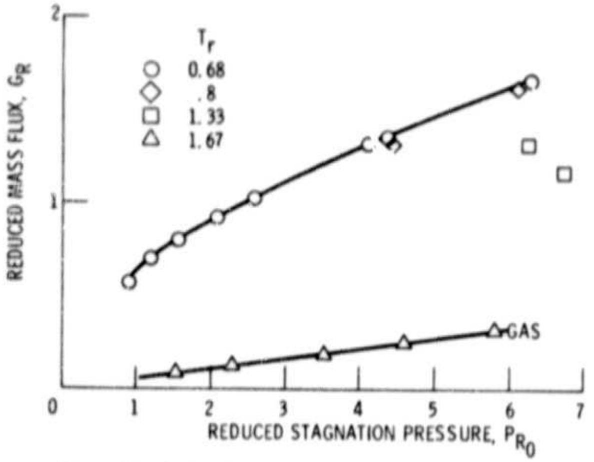


Figure 20. - Reduced critical mass flux for fluid hydrogen in a 53 L/D Borda tube as a function of reduced inlet stagnation pressure for selected isotherms.

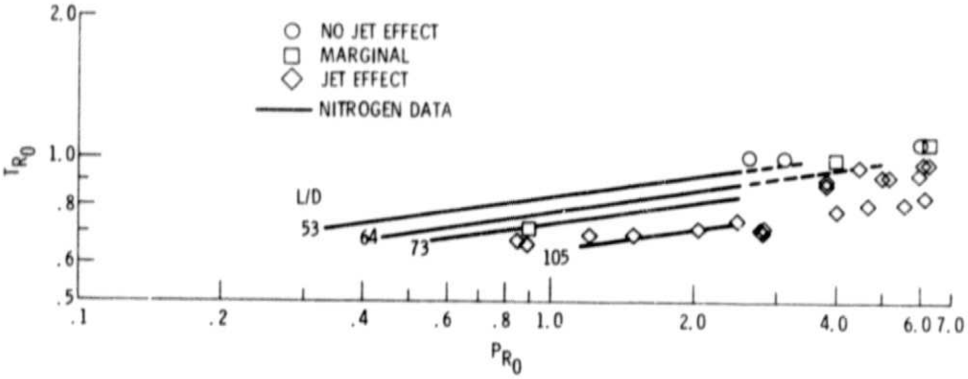


Figure 21. - Fluid jet effects for P-hydrogen in 53 L/D Borda tube.