Representative Equations for the Viscosity of Water Substance

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The International Association for the Properties of Steam adopted in 1982 a new formulation for the thermodynamic properties of water substance for scientific and general use. In this paper, we present an assessment of currently available methods for calculating the viscosity of water substance when used in conjunction with the new formulation for the equilibrium properties.

Key words: IAPS; kinematic viscosity; steam; viscosity; water; water vapor.

Contents

1. Introduction	186	5. Viscosity and kinematic viscosity of liquid water	
2. International Equation for the Viscosity of Wa-		and of water vapor at saturation as calculated	
ter Substance	186	from the international equation	190
3. Alternative Equation for the Viscosity of Water		6. Coefficients a_{ij} for $\mu'_1(\bar{\rho}, \overline{T})$	192
Substance	192	7. Difference between the viscosity, calculated	
4. Viscosity near the Critical Point	196	from the equation of Watson et al. with densities	
5. Acknowledgments	197	from the IAPS 82 formulation, and the viscosity	
6. References	197	calculated from the same equation with densities	
Appendix I. Release on Dynamic Viscosity of Water		from the IFC 68 formulation	193
Substance Issued by IAPS in 1975 and Amended		8. Viscosity of water substance calculated from the	170
in 1982	198	equation of Watson et al.	194
Appendix II. Tables of Densities Calculated from the	170	9. Comparison between the calculated viscosity	174
Provisional IAPS Formulation 1982 for the		values and the Skeleton Table values for viscos-	
Thermodynamic Properties of Ordinary Water		_	194
Substance for Scientific and General Use	204	ity	194
Substance for Scientific and General Ose	204	10. Kinematic viscosity of water substance calculat-	105
		ed from the equation of Watson <i>et al.</i>	195
		11. Viscosity and kinematic viscosity of liquid water	
		and of water vapor at saturation as calculated	400
List of Tables		from the equation of Watson et al.	196
		Appendix B. Table of critically evaluated experimen-	
1. Coefficients a_k for $\mu_0(\overline{T})$	186	tal data	199
2. Coefficients b_y for $\mu_1(\bar{\rho}, T)$	187	Appendix D. Dynamic viscosity of water and steam,	
3. Difference between the viscosity, calculated		calculated with density values from the Provi-	
from the international equation with densities		sional IAPS Formulation 1982 for the Thermo-	
from the IAPS 82 formulation, and the viscosity		dynamic Properties of Ordinary Water Sub-	
calculated from the same equation with densities		stance for Scientific and General Use	203
from the IFC 68 formulation	188	IIA. Densities calculated from the Provisional IAPS	
4. Kinematic viscosity of water substance calculat-	100	Formulation 1982 for the Thermodynamic	
ed from the international equation	189	Properties of Ordinary Water Substance for	
ou from the international equation	10)	Scientific and General Use at a uniform grid of	
		pressures and temperatures	204
		IIB. Densities calculated from the Provisional IAPS	
0.10041 - 4.77.0 6	_	Formulation 1982 for the Thermodynamic	
© 1984 by the U.S. Secretary of Commerce on behalf of the United This copyright is assigned to the American Institute of Physics a	States.	Properties of Ordinary Water Substance for	
American Chemical Society.	uid tiit	Scientific and General Use for liquid water and	
Reprints available from ACS; see Reprint List at back of issue.		•	205
Reprints available from AC5; see Reprint List at back of issue.		for water vapor at saturation	205

1. Introduction

Stimulated by the International Association for the Properties of Steam (IAPS), sustained efforts have been made during the past decade with the goal of obtaining more accurate formulations for the properties of water and steam (water substance). One result of these efforts has been the adoption of a new international formulation for the viscosity of water substance in 1975 prepared by a Special Committee of IAPS. ^{1,2} This international formulation is based on an equation developed by Aleksandrov, Ivanov, and Matveev. ³ A detailed discussion of the considerations that led to the adoption of this formulation has been presented by Nagashima in this journal. ^{4,5} Subsequently Watson, Basu, and Sengers published a modified version of the international equation. ⁶

The international equation, as well as the equation of Watson *et al.*, yield the viscosity of water substance as a function of temperature and density. To calculate the viscosity as a function of temperature and pressure, the equations need to be supplemented with a suitable equation of state. For this purpose, the international equation, and also the equation of Watson *et al.*, were to be used in conjunction with the 1968 IFC Formulation for General and Scientific Use (IFC 68). The reason is that the IFC 68 formulation, apart from the 1967 IFC Formulation for Industrial Use, was the only internationally agreed upon formulation available for the thermodynamic surface of water substance.

The prescription that the equations for viscosity are to be used in conjunction with the IFC 68 formulation has a number of disadvantages. First, although the IFC 68 formulation has been used extensively in some countries, most notably in the USSR,9 it never received wide acceptance in some other countries such as the USA. Secondly, the IFC 68 formulation, as well as the IFC 67 formulation, are complicated by the fact that they are composites of separate formulations in a number of subregions, which leads to a lack of smoothness of the derivatives of the surface at the boundaries of the subregions. 10 Finally, and most importantly, since the adoption of the IFC 68 formulation a significant body of new accurate experimental thermodynamic property data has become available for water substance allowing a more accurate characterization of the thermodynamic surface. For this reason, IAPS adopted in 1982 a new formulation for the thermodynamic surface of water substance replacing the IFC 68 formulation. This formulation was developed by a research group consisting of Haar and Gallagher of the National Bureau of Standards in Washington and Kell of the National Research Council in Ottawa. 11,12 This new formulation has been designated as the Provisional IAPS Formulation 1982 for the Thermodynamic Properties of Ordinary Water Substance for Scientific and General Use. 13,14 For the sake of brevity, we shall refer to this formulation as the IAPS 82 formulation.

It is the purpose of the present paper to evaluate the accuracy of the equations for the viscosity of water substance when used in conjunction with the new IAPS 82 formulation. A preliminary assessment was presented at the meetings of the working groups and the executive committee of IAPS in Ottawa in 1982. ¹⁵ After reviewing the situation,

IAPS decided to amend the release on Dynamic Viscosity of Water Substance, originally issued in 1975, so as to make the international formulation for the viscosity of water substance fully consistent with the new IAPS 82 formulation for the thermodynamic surface. A verbatim copy of the amended release is presented in Appendix I of this paper.

2. International Equation for the Viscosity of Water Substance

In order to be consistent with the convention adopted in the releases on the transport properties of water substance as issued by IAPS, we introduce dimensionless variables for the temperature T, the density ρ , and the pressure P by defining

$$\overline{T} = \frac{T}{T^*}, \quad \overline{\rho} = \frac{\rho}{\rho^*}, \quad \overline{P} = \frac{P}{P^*},$$
 (2.1)

with

$$T^* = 647.27 \text{ K}, \quad \rho^* = 317.763 \text{ kg/m}^3,$$

 $P^* = 22.115 \times 10^6 \text{ Pa}.$ (2.2)

All temperatures in this paper are expressed in terms of the international practical temperature scale of 1968 (IPTS 68). ¹⁶ The reference constants T^*, ρ^*, P^* are close to, but are not identical with, the critical parameters of steam. ^{14,17}

The international equation for the viscosity μ has the form¹⁻⁵:

$$\mu = \mu_0(\overline{T}) \times \mu_1(\overline{\rho}, \overline{T}). \tag{2.3}$$

The function $\mu_0(\overline{T})$ represents the viscosity in the dilute gas limit as a function of temperature and is defined by

$$\mu_0(\overline{T}) = \frac{\mu^* \sqrt{\overline{T}}}{\sum\limits_{k=0}^{3} a_k \overline{T}^{-k}},$$
(2.4)

with

$$\mu^* = 1 \times 10^{-6} \, \text{Pa·s}, \tag{2.5}$$

and with coefficients a_k given in Table 1. The function $\mu_1(\bar{\rho}, \overline{T})$ is defined by

$$\mu_1(\bar{\rho}, \overline{T}) = \exp\left[\bar{\rho} \sum_{i=0}^{5} \sum_{j=0}^{4} b_{ij} \left(\frac{1}{\overline{T}} - 1\right)^i (\bar{\rho} - 1)^j\right], (2.6)$$

with coefficients b_{ij} given in Table 2. The equation is valid in a range of temperatures and pressures bounded by

0 °C
$$\leq$$
 $T \leq$ 800 °C,
0 MPa \leq $P \leq$ 100 MPa. (2.7)

Equation (2.3) for the viscosity was originally formulated by Aleksandrov, Ivanov, and Matveev in the USSR.³ It is based on a set of experimental viscosity data selected by the Special Committee of IAPS from the literature prior to 1974.^{4,18}

TABLE 1. Coefficients a_k for $\mu_0(\overline{T})$

 $a_0 = 0.018 158 3$ $a_1 = 0.017 762 4$ $a_2 = 0.010 528 7$ $a_3 = -0.003 674 4$

TABLE 2. Coefficients b_{ii} for $\mu_1(\bar{\rho}, \bar{T})$

i =	0	1	2	3	4	5
i = 0	0.501 938	0.162 888	- 0.130 356	0.907 919	- 0.551 119	0.146 543
1	0.235 622	0.789 393	0.673 665	1.207 552	0.067 066 5	- 0.084 337 0
2	- 0.274 637	- 0.743 539	0.959 456	- 0.687 343	- 0.497 089	0.195 286
3	0.145 831	0.263 129	0.347 247	0.213 486	0.100 754	-0.032932
4	- 0.027 044 8	- 0.025 309 3	- 0.026 775 8	- 0.082 290 4	0.060 225 3	0.020 259 5

In order to calculate the viscosity as a function of pressure and temperature, the international equation [Eq. (2.3)], as originally adopted in 1975, is to be used in conjunction with the IFC 68 formulation as mentioned in the introduction. Most of the original experimental data for the viscosity were obtained as a function of pressure and temperature. We also note that the IFC 68 formulation uses the international practical temperature scale of 1948 (IPTS 48), while the new IAPS 82 formulation for the equation of state is based on IPTS 68. One could envision a procedure to redetermine the constants in the viscosity equation which would involve the following steps: a change of the temperature scale of the original experimental data to IPTS 68, a recalculation of the densities corresponding to the experimental pressures and temperatures with the aid of the new IAPS 82 formulation. and a redetermination of the constants in the viscosity equation from a new fit to the experimental data. Fortunately such an elaborate procedure is not necessary. If one adopts the international equation [Eq. (2.3)] with temperatures in terms of IPTS 68 and with the coefficients given in Tables 1 and 2 and uses it in conjunction with the IAPS 82 formulation, one reproduces the viscosity of water substance within the accuracy with which the viscosity is known.

To substantiate this claim, we note that the release on the viscosity of water substance issued by IAPS contains two tables for the viscosity of water substance. First, the release contains a table of critically evaluated viscosity data reduced to a uniform grid of pressures and temperatures by a local averaging procedure. 19 This table is reproduced as Appendix B in Appendix I and we shall refer to these values as the Skeleton Table values $\mu_{S,T}$ for viscosity. This table is identical to Table 3 in Ref. 4, except that we have used this opportunity to make some necessary corrections as pointed out by Nagashima. 5 Secondly, the release contains a table of viscosity values calculated from the international equation. Both tables contain equally valid representations of the viscosity surface of water substance. However, the Skeleton Tables give, in addition, tolerances $\delta\mu$ which constitute estimates of the accuracy with which the viscosity is known as agreed upon by the Special Committee of IAPS. Hence, as a simple criterion whether any viscosity equation yields a satisfactory representation of the experimental viscosity data we check whether it reproduces the same viscosity values within the given tolerances $\delta\mu$.

In Table 3, we compare the values μ_{82} , calculated forthe viscosity from the international equation [Eq. (2.3)] using densities from the IAPS 82 formulation, with the values μ_{68} calculated from the same equation but using densities from the IFC 68 formulation in accordance with the release on viscosity issued by IAPS in 1975. Specifically, we list the relative difference $(\mu_{82} - \mu_{68})/\delta\mu$. It is seen that this difference is much smaller than unity at all pressures and temperatures. We thus conclude that the two procedures lead to the same values of the viscosity of water substance that are well within the accuracy agreed upon by IAPS. Accordingly IAPS issued in 1982 an amended release in which the formulation for the viscosity of water substance was made consistent with the IAPS 82 formulation for the thermodynamic properties of water substance. This amended release on the viscosity of water substance is reproduced in Appendix I.

Appendix D of this release gives the values for μ calculated from the international equation on a uniform grid of pressures and temperatures. It can be readily verified that the Skeleton Table values $\mu_{S.T.}$ in Appendix B and the calculated viscosity values in Appendix D agree within the assigned tolerances. 15 In Table 4, we present the values calculated for the kinematic viscosity $v = \mu/\rho$. In Table 5, we present the values for the viscosities μ_1 and μ_2 and kinematic viscosities v_1 and v_a calculated from the international equation for liquid water and water vapor at saturation. To obtain a unified set of equations for the thermodynamic properties and transport properties of water substance, we found it convenient to express the IAPS 82 formulation in terms of the dimensionless variables defined in Eq. (2.1). The resulting form and constants for the IAPS 82 formulation are presented elsewhere in this journal.¹⁷ For the convenience of the user, we reproduce in Appendix II the densities calculated from the IAPS 82 formulation for the pressures and temperatures quoted in the viscosity tables.

The behavior of the viscosity μ along isobars as a function of temperature is shown in Fig. 1. The kinematic viscosity $\nu = \mu/\rho$ along isobars as a function of temperature is shown in Fig. 2. In Fig. 3, we present a picture of a three-dimensional model for the viscosity of water substance constructed by Stephan and Laesecke of the University of Stuttgart on the basis of the international equation.²⁰

Table 3. Difference between the viscosity μ_{82} , calculated from the international equation with densities from the IAPS 82 formulation and the viscosity μ_{68} , calculated from the same equation with densities from the IFC 68 formulation, relative to the tolerance $\delta\mu$. Quantity listed: $(\mu_{82}$ - $\mu_{68})/\delta\mu$

\						ТЕМРЕ	RATHRE, '	°C				
		0	25	50	75	100	150	200	250	300	350	375
	•1	00	.01	00	,02	00	00	00	•00	.00	.00	.00
	.5 1.0	00	.01 .01	00	.02 .02	.05 .05	.07 .07	00 00	00 00	00	.00	.00
	2.5	01	.00	00	.02	.05	•06	.01	00	00	00	.00
	5.0	01	•00	00	.01	•04	.05	.00	02	00	00	.00
	7.5 10.0	01	.00	00 00	.01 .01	.04 .03	.03	00 01	03 04	.00 .02	.00	.00
	12.5	01	.00	00	.01	.03	.03	02	04	.02	.00	.00
	15.0	02	•00	00	.00	.02	.02	02	04	.01	.01	.00
g B	17.5 20.0	02	.00	00	00	.02	.01	03	05	.01 .00	.01	.0:
₩ B	22.5	01	.00	00	00	.01 .01	00	04 04	05 05	.00	.03 .04	.0.
	25.0	01	.00	01	00	.00	01	05	06	00	.05	08
器	27.5	01	.00	01	00	00	02	05	06	01	.06	0:
PRESSURE	30.0 35.0	01	.00	01 01	01 01	00 01	02 04	05 04	06	01 02	.06	.01
ĕ	40.0	.00	•00	01	01	02	05	07	06	02	.05	.01
Ρŀ	45.0	.01	.00	00	01	02	06	07	06	~.02	.04	• 01
	50.0	.01	00	00	02	03	07	08	05	02	.03	+04
	55.0 60.0	.02	00	00	02 02	-,04	08	08	05	02	02	•04
	65.0	.02	00	00	02	04 05	09 10	09 09	05 04	02 02	.02 .01	.0
	70.0	.03	00.	00	02	05	11	-,09	04	01	.01	.0
	75.0	.03	00	00	02	06	11	10	03	01	.00	• 0
	80.0	.03	00	00	02	06	12	10	02	01	00	.0:
	85.0 90.0	.03	00 01	00 00	03 03	07 07	13 14	11 11	02 01	00 00	01 01	.0:
	95.0	.02	ŏî	01	03	08	15	11	00	.00	02	.00
	100.0	.02	01	01	03	Q8_	<u>16</u>	.=.11	00	01_	02	00
/						TEMPE	RATURE, '	°c				
\						TEMPE	RATURE, '	°c		·		
		400	425	450	475	TEMPE:	RATURE, '	°C 600	650	700	750	800
	.1	.00	.00	•00	.00	500	550	.00	•00	•00	•00	•00
	.5	.00	.00	.00	.00	500 -00 -00	.00 00	.00 00	.00	.00	.00	.00 00
	1.0	.00 .00	.00	.00	.00	500	550	.00	.00 00 00	.00 00 00	.00 00 00	.00 00 00
	.5	.00 .00 .00 .00	.00 .00 .00 .00	.00 .00 .00 00	.00 .00 .00 00	.00 00 00 00	.00 00 00 00	.00 00 00 00	.00 00 00 00	.00 00 00 00	.00 00 00 00	.00 00 00 00
	.5 1.0 2.5 5.0 7.5	.00 .00 .00 .00 00	.00 .00 .00 .00 00	.00 .00 .00 00 00	.00 .00 .00 00 00	.00 00 00 00 00	.00 00 00 00 00	.00 00 00 00 00	.00 00 00 00 00	.00 00 00 00 00	.00 00 00 00 00	00 00 00 00 00
	.5 1.0 2.5 5.0 7.5 10.0	.00 .00 .00 .00 00 00	.00 .00 .00 .00 00 00	.00 .00 .00 00 00	.00 .00 .00 00 00	.00 00 00 00 00 00	.00 00 00 00 00 00	.00 00 00 00 00 00	.00 00 00 00	.00 00 00 00	.00 00 00 00	.00 00 00 00
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a	.5 1.0 2.5 5.0 7.5 10.0 12.5 15.0 17.5	.00 .00 .00 .00 00 00 00	.00 .00 .00 .00 00 00 00	.00 .00 .00 00 00 00 00	.00 .00 .00 00 00 00 00	.00 00 00 00 00 00 00 00	.00 00 00 00 00 00 00 00	.00 00 00 00 00 00 00 00	.00 00 00 00 00 00 00	.00 00 00 00 00 00 00 00	.00 00 00 00 00 00 00 00	.00 00 00 00 00 00 00
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ΜP	.5 1.0 2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5 25.0	.00 .00 .00 .00 .00 00 00 .00	.00 .00 .00 .00 00 00 00	.00 .00 .00 00 00 00 00	.00 .00 .00 00 00 00 00 00	.00 00 00 00 00 00 00 00	.00 00 00 00 00 00 00 00	.00 00 00 00 00 00 00 00	.00 00 00 00 00 00 00 00	.00 00 00 00 00 00 00 00	.00 00 00 00 00 00 00 00	.00 00 00 00 00 00 00 00
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ESSURE, MP	.5 1.0 2.5 5.0 7.5 10.0 12.5 17.5 20.0 22.5 25.0 27.5 30.0 35.0 40.0 45.0 50.0 50.0	.00 .00 .00 .00 .00 -00 -00 .00 .00 .00	.00 .00 .00 .00 .00 00 00 00 .00	.00 .00 .00 00 00 00 00 00 	.00 .00 .00 -00 -00 -00 -00 -00 -00 .00	500 -00 -00 -00 -00 -00 -00 -00 -00 -00	.00 00 00 00 00 00 00 00	.000000000000000000000000000000001011011011011011	.00 00 00 00 00 00 00 00	.00 00 00 00 00 00 00 00	.00 00 00 00 00 00 00 00	.00 00 00 00 00 00 00 00
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ESSURE, MP	.5 1.0 2.5 5.0 7.5 10.0 12.5 20.0 22.5 25.0 22.5 25.0 35.0 40.0 45.0 55.0 65.0 70.0 80.0	.00 .00 .00 .00 .00 00 00 .00 .00 .0	.00 .00 .00 .00 .00 00 00 00 .00	.00 .00 .00 .00 00 00 00 00 0	.00 .00 .00 .00 .00 .00 .00 .00 .00 .00	500 -000 -000 -000 -000 -000 -000 -000	.00 00 00 00 00 00 00 00	.00 00 00 00 00 00 00 00	.00 00 00 00 00 00 00 00	.00 00 00 00 00 00 00 00	.00 00 00 00 00 00 00 00	.00 00 00 00 00 00 00 00

Table 4. Kinematic viscosity ν of water substance calculated from the international equation (ν in $10^{-6}~\text{m}^2/\text{s})$

						TEM	PERATURE	e, °C				
`												
		, 0	25	50	75	100	150	200	250	300	350	375
	•1	1.792	.8934	•5537	3882	20.82	27.47	35.15	43.84	53.54	64.22	69.92
	.5 1.0	1.791	•8932	•5537	.3882 .3882	•2946 •2947	.1985 .1986	6.828	8.611 4.204	10.58 5.210	12.74 6.304	13.89 6.885
	2.5	1.789	+8929 +8920	•5536 •5535	3884	2949	1788		1.550	1.983	2.441	2.681
	5.0	1.776	•8905	•5533	.3885	•2952	.1992	.1550	.1326		1.151	1.279
	7.5 10.0	1.768	.8890 .8876	.5531 .5529	.3887 .3889	.2956 .2959	.1996 .2000		.1330 .1334			
	12.5	1.753	.8862	•5528	.3891	.2962	.2003	.1562	.1338	.1212	.3609	• 4291
	15.0	1.746	.8849	.5526	3894	.2966	•2007	.1566	.1341	•1217	.2628	
ದ	17.5 20.0	1.739	.8835 .8823	•5525 •5524	•3876 •3898	•2767 • 297 2	.2011 .2015		.1345 .1349		.1146	
₩ W	22.5	1.725	.8810	5522	.3900	•2976	.2019	.1577	. 1353	•1229	.1157	.1161
•	25.0	1.719	•8798	•5522 •5521	.3902	•2979	.2023	1580	.1356	. 1233	•1162	.1150
띮	27.5 30.0	1.712	•8786 •8775	.5520 .5519	.3905 .3907	•2983 •2986	.2026 .2030		.1360 .1363	.1237 .1241 .1248	·1167 ·1171	
PRESSURE	35.0	1.694	•8753	.5518	.3912	.2993	.2038	.1595	.1370	.1248	.1179	.1162
ES	40.0	1.682	₽8733	•5517	•3917	.3000	-2046		.1377	1255	.1186	.1168
PR	45.0 50.0	1.671	.8713 .8695	.5516 .5516	.3922 .3927	.3007 .3014	.2053 .2061		•1384 •1391	.1262 .1269	.1193 .1200	
	55.0	1.650	.8678	.5516	.3932	.3021	.2068	.1623	•1398	.1275	.1206	.118
	60.0	1.641	.8663	.5516	.3932 .3938	.3029	•2076		•1404	.1282		
	65.0 70.0	1.632	.8648 .8634	.5517 .5519	.3943 .3949	.3036 .3043	.2084 .2091				•1218 •1224	.1197
	75.0	1.615	.8622	.5520	·3955	.3050	12099			.1300	.1230	.1208
	80.0	1.608	.8610	+5522	.3961	.3058	.2106					
	85.0 90.0	1.600	.8600 .8590	.5524 .5527	.3967 .3973	.3065 .3073	.2114 .2121		.1436	.1312 .1318	.1241 .1247	
	95.0	1.587	.8582		.3980	.3080	.2129			.1324	.1252	1228
	100.0											
\		1.581		.5533				.1685	i <u>-1454</u>	.1329	.1257	.1233
		1.361	.8574					.1685	i <u>1145</u> 4	1329	.1257	,1233
		400	425	450				600	650	700	750	800
	.1	400	425 82.02	450	TEM 475 95.04	DERATURE	, °C 550	600	650 147.3	700	750 181.7	800
	.1	400 75.86 15.09	425 82.02 16.33	450 88.42 17.61	475 95.04 18.94	500 101.9 20.32	, °C 550 116.2 23.19	600 131.4 26.23	650 147.3 29.44	700 164.1 32.80	750 181.7 36.31	800 199.9 39.98
	.1 .5 1.0 2.5	400 75.86 15.09 7.488 2.730	425 82.02 16.33 8.114 3.186	450	TEM 475 95.04	500 101.9 20.32 10.12	, °C 550	600	650 147.3	700 164.1 32.80 16.39	750 181.7 36.31 18.15	800
	.1 .5 1.0 2.5 5.0	75.86 15.09 7.488 2.930 1.409	425 82.02 16.33 8.114 3.186 1.543	450 88.42 17.61 8.761 3.451 1.680	475 95.04 18.94 9.430 3.723 1.821	500 101.9 20.32 10.12 4.004 1.966	550 116.2 23.19 11.57 4.391 2.266	600 131.4 26.23 13.09 3.209 2.581	650 147.3 29.44 14.70 5.858 2.911	700 164.1 32.80 16.39 6.538 3.256	750 181.7 36.31 18.15 7.247 3.615	800 199.9 39.98 19.98 7.986 3.988
	.1 .5 1.0 2.5 5.0 7.5	75.86 15.09 7.488 2.930 1.409	425 82.02 16.33 8.114 3.186 1.543 .9950	450 88.42 17.61 8.761 3.451 1.680 1.090	475 95.04 18.94 9.430 3.723 1.821 1.187	500 101.9 20.32 10.12 4.004 1.966 1.287	550 116.2 23.19 11.57 4.391 2.266 1.492	600 131.4 26.23 13.09 5.207 2.581 1.706	650 147.3 29.44 14.70 5.858 2.911 1.930	700 164.1 32.80 16.39 6.538 3.256 2.163	750 181.7 36.31 18.15 7.247 3.415 2.405	800 199.9 39.98 19.98 7.986 3.988 2.656
	.1 .5 1.0 2.5 5.0 7.5 10.0 12.5	75.86 15.09 7.488 2.930 1.409 .9014 .6467 .4931	425 82.02 16.33 8.114 3.184 1.543 .9950 .7206 .5557	450 88.42 17.61 8.761 3.451 1.680 1.090 .7951 .6180	475 95.04 18.94 9.430 3.723 1.821	500 101.9 20.32 10.12 4.004 1.966	550 116.2 23.19 11.57 4.391 2.266	600 131.4 26.23 13.09 5.209 2.581 1.706 1.269 1.007	650 147.3 29.44 14.70 5.858 2.911	700 164.1 32.80 16.39 6.538 3.256 2.163 1.617	750 181.7 36.31 18.15 7.247 3.615 2.405 1.801	800 199.9 39.98 19.98 7.986 3.988 2.656 1.991
sa.	.1 .5 1.0 2.5 5.0 7.5 10.0 12.5 15.0	75.86 15.09 7.488 2.730 1.409 .9014 .6467 .4731 .3899	425 82.02 16.33 8.114 3.186 1.543 .9750 .7206 .5557 .4456	450 88.42 17.61 8.761 3.451 1.680 1.090 .7951 .6180 .5000	75.04 18.94 9.430 3.723 1.821 1.187 .8706 .6807	500 101.9 20.32 10.12 4.004 1.986 1.287 .9473 .7440 .6087	550 550 116.2 23.19 11.57 4.391 2.266 1.492 1.105 .8735 .7194	600 131.4 26.23 13.09 5.209 2.581 1.706 1.269 1.007	450 147.3 29.44 14.70 5.858 2.911 1.930 1.440 1.144	700 164.1 32.80 16.39 6.538 3.256 2.163 1.617 1.290 1.072	750 181.7 36.31 18.15 7.247 3.615 2.405 1.801 1.438 1.197	800 199.9 39.98 19.98 7.786 3.988 1.991 1.592
МРа	.1 .5 1.0 2.5 5.0 7.5 10.0 12.5 15.0 17.5	75.86 15.09 7.488 2.730 1.409 .9014 .6467 .4931 .3899 .3153	425 82.02 16.33 8.114 3.186 1.543 .9950 .7206 .5557 .4456	450 88.42 17.61 8.761 3.451 1.680 1.090 .7951 .6180 .5000	75 95.04 18.94 9.430 3.723 1.821 1.187 .8706 .6807 .5543	500 101.9 20.32 10.12 4.004 1.966 1.287 .9473 .7440 .6087 .5124	550 550 116.2 23.19 11.57 4.591 2.266 1.492 1.105 .8735 .7194 .6097	600 131.4 26.23 13.09 5.209 2.581 1.706 1.269 1.007 .8332 .7091	650 147.3 29.44 14.70 5.858 2.911 1.930 1.440 1.146 .9506 8114	700 164.1 32.80 16.39 6.538 3.256 2.163 1.617 1.290 1.072 .9167	750 181.7 36.31 18.15 7.247 3.615 2.405 1.801 1.438 1.197 1.025	800 199.9 39.98 19.98 7.986 3.988 2.656 1.991 1.592 1.327 1.137
Æ,	.1 .5 1.0 2.5 5.0 12.5 10.0 12.5 20.0 22.5	75.86 15.09 7.488 2.730 1.409 .9014 .6467 .4731 .3899 .3153 .2582 .2125	425 82.02 16.33 8.114 3.186 1.543 .9950 .7206 .5557 .4456 .3666 .3072 .2609	450 88.42 17.61 8.761 3.451 1.680 1.090 .7951 .6180 .5000 .4158 .3527 .3038	75.04 18.94 95.04 18.94 1.821 1.187 .8706 .6807 .5543 .4642 .3968	500 101.9 20.32 10.12 4.004 1.966 1.287 .9473 .7440 .6087 .5124 .4404 .3847	550 550 116.2 23.19 11.57 4.391 2.266 1.492 1.105 .8735 .7194	600 131.4 26.23 13.09 5.207 2.581 1.706 1.269 1.007 .8332 .7091	650 147.3 29.44 14.70 5.858 2.911 1.930 1.440 1.146 .9506	700 164.1 32.80 16.39 6.538 3.256 2.163 1.617 1.290 1.072 .9167 .8006	750 181.7 36.31 18.15 7.247 3.615 2.405 1.438 1.197 1.025 .8967	800 199.9 39.98 19.98 7.986 2.656 1.991 1.592 1.327 1.137 1.9955
Ψ.	.1 .5 1.0 2.5 5.0 7.5 10.0 12.5 15.0 22.5 20.0 22.5	75.86 15.09 7.488 2.930 1.409 .9014 .6467 .4931 .3899 .3153 .2582 .2125 .1740	425 82.02 16.33 8.114 3.186 1.543 .9950 .7206 .5557 .4456 .3072 .2236	450 88.42 17.61 8.761 3.451 1.680 1.090 .7951 .6180 .5000 .4158 .3527 .3038 .2649	75 95.04 18.94 9.430 3.723 1.821 1.187 .8706 .6807 .5543 .4642 .3968 .3447 .3033	500 101.9 20.32 10.12 4.004 1.966 1.287 .7440 .6087 .5124 .404 .3405	550 116.2 23.19 11.57 4.391 2.266 1.492 1.105 .8735 .7194 .6097 .5277 .4642 .4138	600 131.4 26.23 13.09 5.207 2.581 1.706 1.269 1.007 .8332 .7091 .6164 .54874	650 147.3 29.44 14.70 5.858 2.911 1.930 1.440 1.146 .9506 .8114 .7072 .6265 .5622	700 164.1 32.80 16.39 6.538 3.256 2.163 1.617 1.290 1.072 .9167 .8006 .7106 .6387	750 181.7 36.31 18.15 7.247 3.615 2.405 1.801 1.438 1.197 1.025 .8967 .7968 .7171	800 199.9 39.98 19.98 7.986 3.988 2.656 1.991 1.592 1.327 1.137 .9955 .8854
Ψ.	.1 .5 1.0 2.5 5.0 12.5 15.0 17.5 22.5 25.0 27.5	75.86 15.09 7.488 2.930 1.409 .9014 .6467 .4931 .3899 .3153 .2582 .2125 .1740	82.02 14.33 8.114 3.186 1.543 .9950 .7206 .5557 .4456 .3664 .3072 .2609 .2236	450 88.42 17.61 8.761 3.451 1.680 1.090 .7951 .6180 .5000 .4158 .3527 .3038 .2649 .2333	75 95.04 18.94 9.430 3.723 1.821 1.187 .8706 .6807 .5543 .4642 .3968 .3447 .3033 .2697	500 101.9 20.32 10.12 4.004 1.966 1.287 .9473 .7440 .6087 .5124 .404 .3847 .3405 .3046	550 550 116.2 23.19 11.57 4.391 2.266 1.492 1.105 .8735 .7194 .6097 .5277 .4642 .4138 .3728	600 131.4 26.23 13.09 3.207 2.581 1.706 1.269 1.007 .8332 .7091 .6164 .5445 .4874 .4409	650 147.3 29.44 14.70 5.858 2.911 1.930 1.440 1.146 .9506 .8114 .7072 .6265 .5622 .5098	700 164.1 32.80 16.39 6.538 3.256 2.163 1.617 1.290 1.072 .9167 .8006 .7106 .6387 .5802	750 181.7 36.31 18.15 7.247 3.615 2.405 1.801 1.438 1.197 1.025 .8967 .7968 .7171	800 199.9 39.98 19.98 7.786 3.988 2.656 1.991 1.592 1.327 1.137 .9955 .8854 .7259
ESSURE, MP	.1 .5 1.0 2.5 5.0 7.5 10.0 12.5 15.0 22.5 25.0 27.5 30.0 35.0	75.86 15.09 7.488 2.930 1.409 .9014 .6467 .4931 .3899 .3153 .2582 .2125 .1740	425 82.02 16.33 8.114 3.186 1.543 .9950 .7206 .5557 .4456 .3072 .2236	450 88.42 17.61 8.761 3.451 1.680 1.090 .7951 .6180 .5000 .4158 .3527 .3038 .2649	75 95.04 18.94 9.430 3.723 1.821 1.187 .8706 .6807 .5543 .4642 .3968 .3447 .3033	500 101.9 20.32 10.12 4.004 1.966 1.287 .7440 .6087 .5124 .404 .3405	550 116.2 23.19 11.57 4.391 2.266 1.492 1.105 .8735 .7194 .6097 .5277 .4642 .4138	600 131.4 26.23 13.09 5.207 2.581 1.706 1.269 1.007 .8332 .7091 .6164 .54874	650 147.3 29.44 14.70 5.858 2.911 1.930 1.440 1.146 .9506 .8114 .7072 .6265 .5622	700 164.1 32.80 16.39 6.538 3.256 2.163 1.617 1.290 1.072 .9167 .8006 .7106 .6387	750 181.7 36.31 18.15 7.247 3.615 2.405 1.801 1.438 1.197 1.025 .8967 .7968 .7171	800 199.9 39.98 19.98 7.986 3.988 2.656 1.991 1.592 1.327 1.137 .9955 .8854
Ψ.	.1 .5 1.0 2.5 5.0 10.0 12.5 15.0 17.5 20.0 22.5 25.0 35.0 40.0	75.86 15.09 7.488 2.930 1.409 .9014 .6467 .4931 .3899 .3153 .2582 .2125 .1740 .1410 .1224 .1175	425 82.02 14.33 8.114 3.186 1.543 .7206 .5557 .4456 .3666 .3072 .2609 .2236 .1682 .1348 .1234	450 88.42 17.61 8.761 3.451 1.680 1.090 .7951 .6180 .5000 .4158 .3527 .3038 .2649 .2649 .2073 .1442	75.04 18.94 9.430 3.723 1.821 1.187 .8706 .6807 .5543 .4642 .3968 .3447 .3033 .2421 .2001 .1711	500 101.9 20.32 10.12 4.004 1.966 1.287 .9473 .7440 .4087 .5124 .4040 .3847 .3046 .2751 .2298 .1976	550 550 116.2 23.19 11.57 4.571 2.266 1.492 1.105 .8735 .7194 .6097 .5277 .4642 .4138 .3728 .3728 .3728 .3728 .3728 .3728 .3728	600 131.4 26.23 13.09 3.209 2.581 1.706 1.269 1.007 .8332 .7091 .6164 .5445 .4874 .4409 .4024 .3426 .2987	450 147.3 29.44 14.70 5.858 2.911 1.930 1.440 .9506 .8114 .7072 .6265 .5622 .5098 .4664 .3988 .3488	700 164.1 32.80 16.39 6.538 3.256 2.163 1.617 1.290 1.072 .9167 .8006 .7106 .6387 .5802 .5316 .4558	750 181.7 36.31 18.15 7.247 3.615 2.405 1.801 1.438 1.197 1.025 .8967 .7768 .7171 .6522 .5982 .5582	800 199.9 39.98 19.98 7.786 3.988 2.656 1.991 1.592 1.132 1.132 1.137 .9955 .8854 .7976 .7259 .6663 .5730 .5036
ESSURE, MP	.1 .5 1.0 2.5 5.0 7.5 10.0 12.5 15.0 22.5 22.5 22.0 27.5 30.0 40.0 45.0	400 75.86 15.09 7.488 2.930 1.409 .9014 .6467 .4931 .3899 .3153 .2582 .2125 .1740 .1410 .1224 .1175 .1170	#25 #2.02 16.33 #8.114 3.186 1.543 .9750 .7206 .5557 .4456 .3666 .3072 .2609 .2236 .1732 .1348 .1234	450 88.42 17.61 8.761 3.451 1.680 1.090 .7951 .6180 .5000 .4158 .3527 .3038 .2649 .2333 .1685 .1442 .1317	75 95.04 18.94 9.430 3.723 1.821 1.187 .8706 .6807 .5543 .4642 .3968 .3447 .3033 .2697 .2001 .1711 .1518	500 101.9 20.32 10.12 4.004 1.966 1.287 .9473 .7440 .6087 .5124 .4404 .3847 .3405 .3046 .2298 .1976 .1745	550 116.2 23.19 11.57 4.591 2.266 1.492 1.105 .8735 .7194 .6097 .5277 .4642 .4138 .3390 .2867 .2486 .2202	6000 131.4 26.23 13.09 5.207 2.581 1.706 1.269 1.007 .8332 .7091 .6164 .5445 .4874 .4409 .4024 .3426 .2987	650 147.3 29.44 14.70 5.858 2.911 1.930 1.440 1.146 .9506 .8114 .7072 .6265 .5622 .5098 .4664 .3988 .3188	700 164.1 32.80 16.39 6.538 3.256 2.163 1.617 1.290 1.072 .9167 .8006 .7106 .6387 .5802 .5316 .4558 .3995	750 181.7 36.31 18.15 7.247 3.615 2.405 1.801 1.438 1.197 1.025 .8967 .7968 .7171 .6522 .5782 .5138 .4511	800 199.9 39.98 19.98 7.986 3.988 2.656 1.991 1.592 1.327 1.137 .9955 .8854 .7976 .7259 .6663 .5730 .5030 .4500
ESSURE, MP	.1 .5 1.0 2.5 5.0 10.0 12.5 15.0 17.5 20.0 22.5 25.0 35.0 40.0	400 75.86 15.09 7.488 2.930 1.409 .9014 .6467 .4931 .3899 .3153 .2582 .2125 .1740 .1174 .1175 .1170 .1172 .1175	82.02 146.33 8.114 3.186 1.543 .9950 .7206 .5557 .4456 .3666 .2609 .2236 .1682 .1682 .1348 .1234 .1193	450 88.42 17.61 8.761 3.451 1.680 1.090 .7951 .6180 .5000 .4158 .3527 .3038 .2649 .2333 .2073 .1685 .1442 .1317 .1261	75 95.04 18.94 9.430 3.723 1.821 1.187 .8768 .6807 .5543 .4642 .3968 .3447 .3033 .2697 .2421 .1711 .1518	500 101.9 20.32 10.12 4.004 1.966 1.287 .7440 .6087 .5124 .404 .3847 .3046 .2751 .2298 .1776 .1785	550 116.2 23.19 11.57 4.591 2.266 1.492 1.105 .8735 .7194 .6097 .5277 .4642 .4138 .3370 .2867 .2486 .2202 .1987	600 131.4 26.23 13.09 5.207 2.581 1.706 1.269 1.007 .8332 .7091 .6164 .5445 .4874 .4409 .4024 .3426 .2987 .2654 .2376	450 147.3 29.44 14.70 5.858 2.911 1.930 1.440 1.146 .9506 8114 .7072 .6265 .5622 .5098 .4664 .3798 .3488 .3106 .2808	700 164.1 32.80 16.39 6.538 3.256 2.163 1.617 1.290 1.072 .9167 .8006 .7106 .6387 .5802 .5316 .4558 .3995 .3564	750 181.7 36.31 18.15 7.247 3.615 2.405 1.801 1.438 1.197 1.025 .8967 .7768 .7171 .6522 .5782 .5138 .4511 .4028	800 199.9 39.98 19.98 7.986 3.988 2.656 1.991 1.592 1.327 1.137 .9955 .8854 .7976 .7259 .6663 .5730 .5036 .4500
ESSURE, MP	.1 .5 1.0 2.5 5.0 7.5 5.0 12.5 15.0 22.5 25.0 27.5 30.0 40.0 45.0 50.0 50.0	75.86 15.09 7.488 2.930 1.409 .9014 .6467 .4931 .3899 .3153 .2582 .2125 .1740 .1140 .1224 .1175 .1172 .1175 .1178	82.02 16.33 8.114 3.186 1.543 .9950 .7206 .5557 .4456 .3072 .2236 .1932 .1682 .1348 .1234 .1204 .1193 .1189	450 88.42 17.61 8.761 3.451 1.680 1.090 .7951 .6180 .5000 .4158 .3527 .3038 .2649 .2333 .2073 .1685 .1442 .1317 .1261 .1234 .1219	75 95.04 18.94 9.430 3.723 1.821 1.187 .8706 .6807 .5543 .4642 .3968 .3447 .3033 .2697 .2421 .2001 .1711 .1518 .1399 .1329	500 101.9 20.32 10.12 4.004 1.966 1.287 .7440 .6087 .5124 .4004 .3046 .2751 .2298 .1775 .1745 .1745 .1400	550 116.2 23.19 11.57 4.371 2.266 1.492 1.105 .8735 .7194 .6097 .5277 .4642 .4138 .3728 .3728 .3728 .3729 .2867 .2486 .2202 .1987 .1824	600 131.4 26.23 13.09 5.209 2.581 1.706 1.269 1.007 .8332 .7091 .6164 .5445 .4874 .4409 .4024 .3426 .2987 .2654 .2396 .2194	450 147.3 29.44 14.70 5.858 2.911 1.930 1.140 1.146 .956 .5622 .5622 .5622 .5628 .3488 .3488 .3488 .3106 .2808 .2808	700 164.1 32.80 16.39 6.538 3.256 2.163 1.617 1.290 1.072 .9167 .8006 .7106 .6387 .5802 .5316 .4558 .3795 .3564 .3224 .2950	750 181.7 36.31 18.15 7.247 3.615 2.405 1.801 1.438 1.197 1.025 .8967 .7968 .7171 .6522 .5598 .5138 .4551 .4028 .3645 .3337 .3093	800 199.9 39.98 19.98 7.986 3.988 2.656 1.991 1.592 1.137 .9955 .8854 .7976 .7259 .6663 .5730 .5036 .4500 .4074 .3729 .3445
ESSURE, MP	.1 .5 1.0 2.5 5.0 12.5 15.0 17.5 22.0 27.5 30.0 35.0 45.0 45.0 65.0	75.86 15.09 7.488 2.930 1.409 .9014 .6467 .4931 .3899 .3153 .2582 .2125 .1740 .1224 .1175 .1172 .1172 .1175 .1178 .1182	#25 #2.02 16.33 #8.114 3.186 1.543 .7206 .5557 .4456 .3666 .3072 .2609 .2236 .1682 .1348 .1234 .1204 .1193 .1189 .1189	450 88.42 17.61 8.761 3.451 1.680 1.090 .7951 .6180 .5000 .4158 .3527 .3038 .2649 .2073 .1442 .1317 .1261 .1234 .1211	75.04 18.94 9.430 3.723 1.821 1.187 8706 6807 .5543 .4642 .3968 .3447 .3033 .2421 .2001 .1711 .1518 .1399 .1298 .1263	500 101.9 20.32 10.12 4.004 1.966 1.287 .9473 .7440 .404 .3847 .33046 .2751 .2298 .1776 .1745 .1584 .1474 .1400 .1350	550 116.2 23.19 11.57 4.371 2.266 1.492 1.105 .8735 .7194 .6097 .5277 .4642 .4138 .372	600 131.4 26.23 13.09 3.209 2.581 1.706 1.269 1.007 .8332 .7091 .6164 .5445 .4409 .4024 .3426 .2787 .2654 .2396 .2194 .2033 .1903	450 147.3 29.44 14.70 5.858 2.911 1.930 1.440 .9506 .8114 .7072 .6265 .5622 .5098 .4664 .3788 .3106 .2808 .2808 .2569 .2377 .2219	700 164.1 32.80 16.39 6.538 3.256 2.163 1.617 1.290 1.072 .9167 .8006 .7106 .6387 .5802 .5316 .4558 .3795 .3564 .3224 .2950 .2227 .2542	750 181.7 36.31 18.15 7.247 3.615 2.405 1.801 1.438 1.197 1.025 .8962 .7171 .6522 .5982 .55138 .4511 .4028 .3645 .3337 .3063	800 199.9 39.98 19.98 7.986 3.988 2.656 1.991 1.527 1.1327 1.1327 1.1327 1.6663 .7976 .7259 .6663 .5730 .4500 .4500 .4500 .4500 .4500 .4074 .3729 .3445 .3207
ESSURE, MP	.1 .5 1.0 2.5 5.0 7.5 5.0 12.5 15.0 22.5 25.0 27.5 30.0 40.0 45.0 50.0 50.0	400 75.86 15.09 7.488 2.930 1.409 .9014 .6467 .4931 .3899 .3153 .2582 .2125 .1740 .1175 .1176 .1175 .1178 .1186 .1190 .1195	82.02 146.33 8.114 3.186 1.543 .9950 .7206 .5557 .4456 .3666 .3672 .2609 .2236 .11932 .1682 .11934 .1193 .1189 .1189 .1189 .1190	450 88.42 17.61 8.761 8.761 3.451 1.680 1.090 .791 .6180 .5000 .4158 .2649 .2333 .2073 .1685 .1442 .1317 .1261 .1234 .1211 .1204	75 95.04 18.94 9.430 3.723 1.821 1.187 .8706 .6807 .5543 .4642 .3968 .3447 .3033 .2697 .2421 .2001 .1711 .1518 .1399 .1329	500 101.9 20.32 10.12 4.004 1.966 1.287 .7440 .6087 .5124 .4004 .3046 .2751 .2298 .1775 .1745 .1745 .1400	550 116.2 23.19 11.57 4.371 2.266 1.492 1.105 .8735 .7194 .6097 .5277 .4642 .4138 .3728 .3728 .3728 .3729 .2867 .2486 .2202 .1987 .1824	600 131.4 26.23 13.09 5.209 2.581 1.706 1.269 1.007 .8332 .7091 .6164 .5445 .4874 .4409 .4024 .3426 .2987 .2654 .2396 .2194	650 147.3 29.44 14.70 5.858 2.911 1.930 1.440 1.146 .9506 .8114 .7072 .6265 .5622 .5622 .5088 .3488 .3106 .2808 .2177 .2219	700 164.1 32.80 16.39 6.538 3.256 2.163 1.617 1.290 1.072 .9167 .8006 .7106 .6387 .5802 .5316 .4558 .3995 .3354 .3224 .2950 .2727 .2542 .2587	750 181.7 36.31 18.15 7.247 3.615 2.405 1.801 1.438 1.197 1.025 .8967 .7968 .7171 .6522 .5582 .5138 .4511 .4028 .3645 .3337 .3003 .2872 .2673	800 199.9 39.98 19.98 7.986 3.988 2.656 1.991 1.592 1.327 1.137 .9955 .8854 .7976 .7259 .6663 .5730 .5036 .4500 .4074 .3729 .3445
ESSURE, MP	.1 .5 1.0 2.5 5.0 12.5 15.0 17.5 20.0 27.5 30.0 35.0 45.0 55.0 40.0 65.0 75.0 80.0	75.86 15.09 7.488 2.930 1.409 .9014 .6467 .4931 .3899 .3153 .2582 .2125 .1740 .1175 .1172 .1175 .1178 .1182 .1186 .1190 .1195	82.02 16.33 8.114 3.186 1.543 .9750 .7206 .5557 .4456 .3666 .3072 .2609 .2236 .1348 .1234 .1234 .1193 .1189 .1189 .1189 .1189 .1190 .1192	450 88.42 17.61 8.761 8.761 3.451 1.680 1.090 .791 .6180 .5000 .4158 .2649 .2333 .2073 .1685 .1442 .1317 .1261 .1234 .1211 .1204	75.04 18.94 9.430 3.723 1.821 1.187 .8706 .6807 .5543 .4642 .3968 .3447 .3033 .2697 .2421 .2001 .1711 .1518 .1329 .1263 .1247 .1236	500 101.9 20.32 10.12 4.004 1.966 1.287 .9473 .7440 4.0087 .5124 .4404 .3847 .3405 .2751 .2298 .1775 .1584 .1775 .1584 .1474 .1400 .1350 .1316 .1291	550 116.2 23.19 11.57 4.591 2.266 1.492 1.105 .8735 .7194 .6097 .5277 .4642 .4138 .3728 .3390 .2867 .2486 .2202 .1987 .1824 .1603 .1603 .1530 .1473 .1429	6000 131.4 26.23 13.09 5.207 2.581 1.706 1.269 1.007 .8332 .7091 .6164 .5445 .4874 .4409 .4024 .33426 .2987 .2654 .2396 .2194 .2033 .1993 .1799 .1713	650 147.3 29.44 14.70 5.858 2.911 1.930 1.440 .9506 .8114 .7072 .6265 .5622 .9464 .3798 .3488 .3106 .2808 .3106 .2808 .2569 .2219 .2219 .2088 .1979	700 164.1 32.80 16.39 6.538 3.256 2.163 1.617 1.290 1.072 .9167 .8006 .7106 .6387 .5802 .5316 .4558 .3975 .3564 .3224 .2250 .2227 .2542 .2387 .22542	750 181.7 36.31 18.15 7.247 3.615 2.405 1.801 1.438 1.197 1.025 .8967 7.171 .6552 .5782 .5138 .4511 .4028 .3445 .3337 .3003 .2072 .2673 .2673	800 199.9 39.98 19.98 7.986 3.988 2.656 1.991 1.592 1.327 1.137 .9955 .8854 .7976 .7259 .6663 .5730 .4500 .4074 .4700 .4074 .4700 .4074 .4700 .4074 .407
ESSURE, MP	.1 .5 1.0 2.5 5.0 7.5 10.0 12.5 15.0 22.5 22.5 22.5 27.5 30.0 40.0 45.0 50.0 50.0 70.0 75.0 80.0 85.0	75.86 15.09 7.488 2.930 1.409 .9014 .6467 .4931 .3899 .3153 .2582 .2125 .1740 .1175 .1175 .1175 .1176 .1186 .1190 .1195 .1199	82.02 16.33 8.114 3.186 1.543 .9950 .7206 .5557 .4456 .3666 .3072 .2609 .2236 .1193 .1193 .1193 .1199 .1199 .1199 .1199 .1192 .1195	450 88.42 17.61 8.761 3.451 1.680 1.090 .7951 .6180 .5000 .4158 .3527 .3038 .2649 .2333 .1685 .1442 .1234 .1211 .1207 .1204 .1203	75 95.04 18.94 9.430 3.723 1.821 1.187 .8706 .6807 .5543 .4642 .3968 .3447 .3033 .2697 .2001 .1711 .1518 .1399 .1298 .1247 .1236 .1247 .1236 .1223	500 101.9 20.32 10.12 4.004 1.966 1.287 .7440 .6087 .5124 .4404 .3847 .3046 .2751 .2298 .1775 .1745 .1745 .1584 .1474 .1474 .1400 .1316 .1291 .1291 .1240	550 116.2 23.19 11.57 4.591 2.266 1.492 1.105 .8735 .7194 .6097 .5277 .4642 .4138 .3728 .	6000 131.4 26.23 13.09 5.207 2.581 1.706 1.269 1.007 .8332 .7091 .6164 .5445 .4874 .4409 .4024 .3426 .2987 .2654 .2396 .2194 .2033 .1903 .1799 .1713 .1643	650 147.3 29.44 1470 5.858 2.911 1.930 1.440 1.146 .9506 .8114 .7072 .6265 .5622 .5098 .3488 .3106 .2808 .2569 .2217 .2088 .1979 .1887	700 164.1 32.80 16.39 6.538 3.256 2.163 1.617 1.290 1.072 .9167 .8006 .7106 .6387 .5802 .5316 .4558 .3995 .3564 .3224 .2256 .22387 .2256 .2145	750 181.7 36.31 18.15 7.247 3.615 2.405 1.801 1.438 1.197 1.025 .8967 .7968 .7171 .6522 .5592 .5138 .4511 .4028 .3645 .3337 .2672 .2693 .2541 .2298	800 199.9 39.98 19.98 7.786 3.988 2.656 1.991 1.592 1.327 1.137 .9955 .8854 .7976 .7259 .6663 .5730 .5036 .4500 .4074 .3729 .3445 .3207 .3006 .2833 .2684 .2554
ESSURE, MP	.1 .5 1.0 2.5 5.0 12.5 15.0 17.5 20.0 27.5 30.0 35.0 45.0 55.0 40.0 65.0 75.0 80.0	75.86 15.09 7.488 2.930 1.409 .9014 .6467 .4931 .3899 .3153 .2582 .2125 .1740 .1175 .1172 .1175 .1178 .1182 .1186 .1190 .1195	82.02 16.33 8.114 3.186 1.543 .9750 .7206 .5557 .4456 .3666 .3072 .2609 .2236 .1348 .1234 .1234 .1193 .1189 .1189 .1189 .1189 .1190 .1192	450 88.42 17.61 8.761 8.761 3.451 1.680 1.090 .791 .6180 .5000 .4158 .2649 .2333 .2073 .1685 .1442 .1317 .1261 .1234 .1211 .1204	75.04 18.94 9.430 3.723 1.821 1.187 .8706 .6807 .5543 .4642 .3968 .3447 .3033 .2697 .2421 .2001 .1711 .1518 .1329 .1263 .1247 .1236	500 101.9 20.32 10.12 4.004 1.966 1.287 .9473 .7440 4.0087 .5124 .4404 .3847 .3405 .2751 .2298 .1775 .1584 .1775 .1584 .1474 .1400 .1350 .1316 .1291	550 116.2 23.19 11.57 4.591 2.266 1.492 1.105 .8735 .7194 .6097 .5277 .4642 .4138 .3728 .3390 .2867 .2486 .2202 .1987 .1824 .1603 .1603 .1530 .1473 .1429	6000 131.4 26.23 13.09 5.207 2.581 1.706 1.269 1.007 .8332 .7091 .6164 .5445 .4874 .4409 .4024 .33426 .2987 .2654 .2396 .2194 .2033 .1993 .1799 .1713	650 147.3 29.44 14.70 5.858 2.911 1.930 1.440 .9506 .8114 .7072 .6265 .5622 .9464 .3798 .3488 .3106 .2808 .3106 .2808 .2569 .2219 .2219 .2088 .1979	700 164.1 32.80 16.39 6.538 3.256 2.163 1.617 1.290 1.072 .9167 .8006 .7106 .6387 .5802 .5316 .4558 .3975 .3564 .3224 .2250 .2227 .2542 .2387 .22542	750 181.7 36.31 18.15 7.247 3.615 2.405 1.801 1.438 1.197 1.025 .8967 7.171 .6552 .5782 .5138 .4511 .4028 .3445 .3337 .3003 .2072 .2673 .2673	800 199.9 39.98 19.98 7.986 3.988 2.656 1.991 1.592 1.327 1.137 .9955 .8854 .7976 .7259 .6663 .5730 .5036 .4500 .4074 .4074 .3729 .3445 .3207 .3006 .2833 .2684

Table 5. Viscosity μ and kinematic viscosity ν of liquid water (&) and of water vapor (g) at saturation as calculated from the international equation

T °C	$\mu_{\ell} \times 10^6$	$\mu_{g} \times 10^{6}$	$v_{\ell_{-2}} \times 10^6$	$v_{g_{2}} \times 10^{6}$
	Pa.s	Pa.s	m~/s	m ⁻ /s
.00	1792.	9.216	1.792 1.792	1900. 1898.
.01	1791.	9.216	1.792	1006.
10.00	1308.	9.461		562.0
20.00	1003.	9.727	1.005 .8013	329.3
30.00	797+8	10.01	.6583	201.3
40.00	653 - 1	10.31	•5537	127.8
50.00	547 - 1	10.62	.4748	83.92
60.00	466.8	10.94	,4137	56.81
70.00	404+5	11.26	.3653	39.53
80.00	355.0	11.60	.3653	28.18
90.00	315.1	11.93	.2946	20.54
100.00	282+3	12.28	.2682	15.28
110.00	255.1	12.62	.2682 .2462	11.57
120.00	232.2	12.97 13.32	•2277	8.706
130.00	212.8	13.32	.2119	6.957
140.00	196.3	13.07	.1985	5.507
150.00	182.0		.1869	4.413
160.00	169.7	14.37	• 1867 • 1770	3.575
170.00	158.9	14.72		2.924
180.00	149.4	15.07	.1684 .1610	2.414
190.00	141.0	15.42		2.009
200.00	133.6	15.78	•1545 •1489	1.684
210.00	127.0	16.13	• 1489 • 1439	1.421
220.00	120.9	16.49	•1437 •1396	1.206
230.00	115.5	16.85		1.029
240.00	110.5	17.22	.1358	.8816
250.00	105.8	17.59	1324	•7586
260.00	101.5	17.98	.1294 .1268	.4550
270.00	97.35	18.38 18.80	•1245	.5671
280.00	93.41	19.25	.1245	.4921
290.00	89.59	19.25	.1205	.4276
300.00	85.85	20.28	.1189	.3719
310.00	82+12	20.28	.1174	.3233
320.00	78.35	20.89	.11/4	.2807
330.00	74 - 45	22.52	.1151	,2430
340.00	70.30	22.32 23.72	-1143-	
350.00-	-65+ 71 -	25.54	.1140	.1778
360.00	60.19	23.34 29.26	.1147	.1461
370.00	51.97		.1150	.1424
371.00	50.67	30.00 30.95	.1154	.1383
372.00	49.06			
373.00	46.73	32.38	.1161	.1334

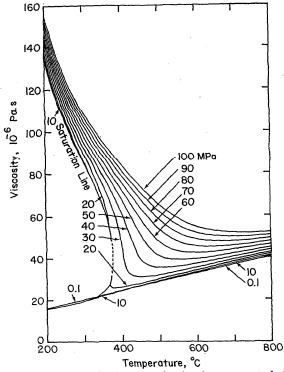


Fig. 1. Viscosity μ of water substance as a function of temperature at selected pressures.

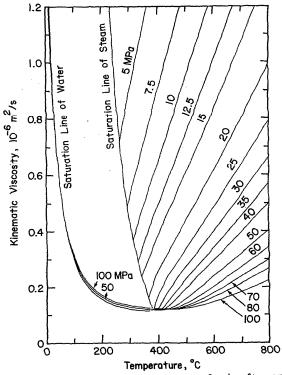


Fig. 2. Kinematic viscosity ν of water substance as a function of temperature at selected pressures.

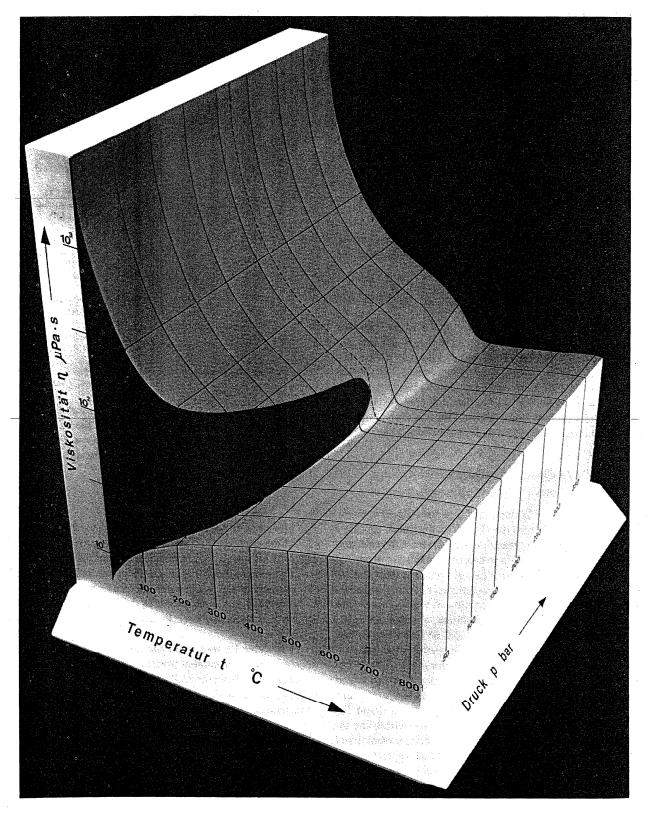


FIG. 3. Picture of a three-dimensional model for the viscosity of water substance as represented by the international equation (Courtesy of Stephan and Laesecke, University of Stuttgart¹⁸).

3. Alternative Equation for the Viscosity of Water Substance

Watson, Basu, and Sengers made a systematic study of the significance of the various coefficient b_{ij} in the international viscosity equation. They considered the set of primary experimental data adopted by the Special Committee of IAPS, but supplemented it with some additional sources of data that had become available after 1974. They proposed an alternative set of coefficients for the viscosity equation [Eq. (2.3)] in which the number of nonzero coefficients b_{ij} was reduced from 30 to 19. The equation of Watson, Basu, and Sengers is defined by

$$\mu = \mu_0(\overline{T}) \times \mu_1'(\overline{\rho}, \overline{T}). \tag{3.1}$$

The function $\mu_0(\overline{T})$ is identical to the function $\mu_0(\overline{T})$ in the international equation [Eq. (2.3)]. The function $\mu_1'(\overline{\rho}, \overline{T})$ is

$$\mu_1(\bar{\rho}, \overline{T}) = \exp\left[\bar{\rho} \sum_{i=0}^{5} \sum_{j=0}^{6} a_{ij} \left(\frac{1}{\overline{T}} - 1\right)^{i} (\bar{\rho} - 1)^{j}\right], (3.2)$$

with the coefficients a_{ij} given in Table 6. The difference between the international equation [Eq. (2.3)] and the equation of Watson *et al.* [Eq. (3.1)] is that the set of 30 nonzero coefficients b_{ij} in Eq. (2.6) has been replaced with the set of 19 nonzero coefficients a_{ij} in Eq. (3.2); furthermore, the equation of Watson *et al.* represents a better fit to the experimental data. As shown by Watson *et al.*, the equation is valid in a range of temperatures and pressures bounded by

0 °C
$$\leq$$
T \leq 150 °C, 0 MPa \leq P \leq 500 MPa,
150 °C \leq T \leq 600 °C, 0 MPa \leq P \leq 350 MPa,
600 °C \leq T \leq 900 °C, 0 MPa \leq P \leq 300 MPa.

The equation of Watson et al. was formulated with the densities calculated from the IFC 68 formulation. As in the case of the international equation, we can retain the equation of Watson et al. and use in it densities calculated from the IAPS 82 formulation without loss of accuracy. This is illustrated in Table 7 where we compare the values μ_{82} , calculated for the viscosity from the equation of Watson et al. with densities from the IAPS 82 formulation, and the values μ_{68} calculated with densities from the IFC 68 formulation. The quantity $(\mu_{82} - \mu_{68})/\delta\mu$ is still much smaller than unity.

In Table 8, we present the values for μ calculated from the equation of Watson et~al. with the densities calculated from the IAPS 82 formulation. Again, it can be readily verified that the values in this table agree with the Skeleton Tables $\mu_{\rm S.T.}$ in Appendix B of the IAPS release within the assigned tolerances. ¹⁵ We conclude that both the international equation and the equation of Watson et~al. reproduce the viscosity of water substance within the experimental accuracy as assessed by the Special Committee of IAPS.

A closer inspection reveals that the equation of Watson

TABLE 6. Coefficients a_{ij} for $\mu'_1(\bar{\rho}, \bar{T})$

i	j	a_{ij}
0	0	$a_{00} = 0.5132047$
1	0	$a_{10} = 0.3205656$
4	. 0	$a_{40} = -0.7782567$
5	0	$a_{50} = 0.1885447$
0	.1	$a_{01} = 0.215 177 8$
1	1	$a_{11} = 0.7317883$
2	1	$a_{21} = 1.241044$
3 .	1	$a_{31} = 1.476783$
0	_2_	$a_{02} = -0.2818107$
1 2	2 2	$a_{12} = -1.070786$
2	2	$a_{22} = -1.263 \ 184$
0	3	$a_{03} = 0.1778064$
1	3	$a_{12} = 0.4605040$
2	3	$a_{23} = 0.2340379$
3	3	$a_{33} = -0.4924179$
0	. 4	$a_{04} = -0.04176610$
3	4	$a_{34} = 0.1600435$
1	5	$a_{15} = -0.01578386$
3	6	$a_{36} = -0.003629481$
-		-30 01000 025 101

Note: Coefficients a_{ii} omitted from the table are all equal to zero identically.

et al. is in somewhat closer agreement with the Skeleton 1able values $\mu_{s.t.}$ than the international equation. This feature is demonstrated by the information presented in the Table 9. Defining the relative difference

$$\Delta = \frac{\mu_{\text{calc}} - \mu_{\text{S.T.}}}{\delta \mu},\tag{3.4}$$

we present in this table the average deviation $\langle \Delta \rangle$, the mean deviation $\langle |\Delta| \rangle$, and the root-mean-square deviation $\langle \Delta^2 \rangle^{1/2}$ with $\mu_{\rm calc}$ from both the international equation and the equation of Watson *et al.* The fact that the differences are smaller when the viscosity is calculated from the equation of Watson *et al.* is a consequence of the fact that this equation yields a somewhat closer fit to the original experimental data.

In Table 10, we present the values of the kinematic viscosity $v = \mu/\rho$ calculated from the equation of Watson *et al.* with densities from the IAPS 82 formulation. In Table II, we present the values for the viscosities μ_1 and μ_g and kinematic viscosities μ_1 and ν_g calculated from the equation of Watson *et al.* for the liquid and the vapor at the saturation boundary.

For industrial purposes, both the international equation and the equation of Watson, Basu, and Sengers can be used in conjunction with the 1967 IFC Formulation for Industrial Use. The accuracy obtained by that procedure is discussed in Appendix VI of Ref. 4.

Table 7. Difference between the viscosity μ_{82} , calculated from the equation of Watson et al. with densities from the IAPS 82 formulation, and the viscosity μ_{68} calculated from the same equation with densities from the IFC 68 formulation, relative to the tolerance $\delta\mu$. Quantity listed $(\mu_{82}\text{-}\mu_{68})/\delta\mu$

					TE	MPERATUR	E,°C				,	
		o	25	50	75	100	150	200	250	300	350	375
	.1	00	.01	00	.02	00	00	00	•00	•00	•00	•00
	.5 1.0	00 00	.01 .01	00 00	.02 .02	.05 .05	•07 •07	00 00	00 00	00 00	.00	•00
	2.5	01	.01	00	.02	.05	.06	.01	00	00	00	•00
	5.0 7.5	01 01	.00	00 00	.01 .01	•04 •04	.05 .04	.00 00	02 03	00	~.00	.00
	10.0	01	•00	00	.01	•03	•03	01	03	+00 +02	•00	.00
cg.	12.5 15.0	02 02	.00 .00	00 01	.01	.03 .02	.03 .02	02 02	04	.02	.00	.00
MP	17.5	02	.00	01	.00	.02	.01	03	04 05	.01 .01	.01 .01	.00 .01
щ	20.0	02	•00	01	00	.01	.00	04	05	•00	•03	.04
Ħ	22.5 25.0	01 01	.00	01 01	00 00	.01	00 01	04 05	05 06	00	.04 .05	-05. -08
PRESSURE,	27.5	01	.00	01	01	00	02	05	06	01	.06	03
E.	30.0 35.0	01 00	.00 .00	01 01	01 01	00 01	02 04	05 06	06 06	01 02	.06 .05	•00
	40.0	•00	.00	01	01	02	05	07	06	02	.05	.05 .08
	45.0 50.0	.01 .01	00	01 00	01 02	02 03	04	07	06	02	.04	.09
	55.0	.02	00	00	02	04	07 07	08 08	05 05	02 02	.03 .02	.06 .06
	60.0 65.0	.02 .02	00 00	00 00	02	04	-+08	~.08	04	02	.02	•05
	70.0	.02	00	00	02 02	05 05	09 10	09 09	04 03	02 01	.01 .01	.04 .03
	75.0	.03	00	00	02	06	11	09	03	01	.00	•03
	80.0 85.0	∙03 02-	00 - .01 -	00	03	06 07	12 1;	10 10	02 01	01 00	00 01	.02
	90.0	.02	01	00	03	07	14	11	01	00	01	.01
	95.0 100.0	.02 .01	01 01	01 01	03 04	08	14 15	10 11	00	.00 .01	02 02	.00 00
					TEMPE	RATURE, '	,c					
		400	425	450	475	500	550	600	650	700	750	800
	.1	.00	.00	•00	.00	•00	.00	•00	00	•00	•00	.00
	.5 1.0	.00	.00	.00	.00 00	.00 00	00	00	00 00	00	00	00
	2.5	.00	.00	00	00	00	00	00 00	00	00	00	00
	5.0 7.5	00	00 00	00	00	00	00 00	00	00	00	00	00
	10.0	00	00	00	00	00	00	00	00	00	00	00
	12.5 15.0	•00	00	00	00	00	00	00	00	00	00	00
	17.5	.00	.00	00	00	00 00	00 00	00 00	00 00	00 00	-,00 -,00	00
ಡ	20.0	.00	.00	. 00	-00	.00	.00	00	00	00	00	00
₩	22.5 25.0	.01	.00 00	.00	.00	.00	.00	-,00 .00	00	00 00	00 00	00
_	27.5	.16	01	00	.00	.00	.00	.00	00	00	00	00
2	30.0	-18	02	01	00	.00	.01	•00	.00	00	00	00
SS	35.0 40.0	.03	•11 •07	02 .03	01 02	00 01	.01 .01	.01 .01	.00	00	-,00 -,00	00
PRESSURE	45.0	.04	.05	.04	.00	01	.01	.01	.01	•00	•00	00
Ы	50.0 55.0	.04	.03	.02 .02	.00 01	00 01	.00 01	.01 .01	.01 .01	.01 .01	.00 .01	00
	60.0	.05	•03	.02	01	02	03	.01	.02	.02	.01	.00
	65.0 70.0	.05	•04 •04	.03 .03	.00 .01	02 02	03 04	.00 01	.02 .02	.02 .02	.01 .02	.01 .01
			.05	.03	.02	01	03	01	.02	.02	.02	.02
	75.0	.05										
	75.0 80.0	.04	• 05	•03	.02	00	02	02	.01	.03	.03	.02
	75.0											

Table 8. Viscosity μ of water substance calculated from the equation of Watson et al. with densities from the IAPS 82 formulation (μ in 10^{-6} Pa.s)

					Т	EMPERAT	URE, °C					
		o	25	50	75	100	150	200	250	300	350	375
	.1	1793.	890.5	547.0	377.9	12.27	14.18	16.18	18.22	20.29	22.37	23.41
	1.0	1792. 1791.	890.4 890.3	547.1 547.2	378.0 378.1	281.9 282.1	182.5 182.6	16.05 15.89	18.14 18.04	20.24 20.18	22.34 22.31	23.3
	2.5	1787.	889.9	547.5	378.5	282.5	183.0	134.6	17.76	20.02	22.23	23.3
	5.0 7.5	1781. 1775.	889.4 888.9	547.9 548.4	379.1 379.8	283.1 283.8	183.7 184.3	135.2 135.8	106.4 107.1	19.80 19.66	22.12 22.09	23.2
	10.0	1769	888.4 888.0	548.8	380.4	284.5	184.9	136.4	107.B	86.51	22.15	_233
	12.5 15.0	1763. 1758.	887.5	549.3 549.8	381.1 381.7	285.2 285.8	185.5 186.2	137.1 137.7	108.5 109.2	87.48 88.39	22.37 22.94	23.5
	17.5	1753.	887.2	550.3	382.4	286.5	186.8	138.3	109.8	89.27	67.00	24.5
	20.0	1748. 1743.	884.8 884.5	550.8 551.3	383.1 383.7	287.2 287.8	187.4 188.0	138.8 139.4	110.4 111.1	90.11 90.92	69.33 71.20	25.93 47.9
ď	25.0	1738.	884.2	551.8	384.4	288.5	188.6	140.0	111.7	91.71	72.B0	58.2
₹	27.5 30.0	1733. 1729.	885.7	552.3 552.8	305.0 385.7	207.2 287.8	107.2 189.8	140.6 141.2	112.3 112.9	92.47 93.21	74.22 75.51	64.5
щ	35.0	1720.	885.3	553.9	387.1	291.2	191.0	142.3	114.1	94.63	77.78	68.3
Ħ	40.0 45.0	1712. 1705.	885.1 884.9	555.0 556.2	388•4 389•8	292.5 293.8	192.2 193.4	143.4 144.5	115.2 116.4	95.98 97.27	79.79 81.60	71.3
SSS	50.0	1698.	884.9	557.4	391.1	295.1	194.6	145.6	117.5	98.52	83.26	75.8
PRESSURE,	55.0 60.0	1691. 1685.	884.9 885.1	558.6 559.8	392.5 393. 9	296.5 297.8	195.7 196.9	146.7 147.8	118.5 119.6	99.72 100.9	84.80 86.25	77.7
_	45.0	1679.	885.4	561.1	395.3	299.1	198.1	148.8	120.6	102.0	87.62	81.0
	70.0 75.0	1674. 1670.	885.8 886.2	562.4 563.7	396.7 398.1	300.5 301.8	199.2 200.4	149.9 150.9	121.7 122.7	103.1 104.2	88.92 90.16	82.5 83.9
	80.0	1666.	84648	565.0	399.5	303.1	201.5	151.9	123.7	105.2	91.36	85.2
	85.0 90.0	1662. 1658.	887.5 888.2	566.4 567.8	400.9 402.3	304.4 305.7	202.6 203.7	153.0 154.0	124.6 125.6	106.2 107.2	92.50 93.61	86.5 87.7
	95.0	1655.	889.1	569.3	403.8	307.1	204.9	155.0	126.6	108.2	94.68	88.7
	100.0	1653.	890.0	570.7	405.2	308.4	206.0	155.9	127.5	109.1	95.72	90.0
_					TE	MPERATUI	RE, °C					
\												
			425	450	475	500	550	600	650	700	750	800
		400										
	.1	24.45	25.49	26.52	27.55	28.57	30.61	32.61	34.60	36.55	38.48	
	.1 .5 1.0	24.45 24.44 24.42		26.52 26.51	27.55 27.55 27.55	28.58 28.58	30.61 30.62 30.63	32.61 32.63 32.64	34.60 34.61 34.63	36.55 36.57 36.59	38.48 38.49 38.52	40.3
	.5 1.0 2.5	24.45 24.44 24.42 24.39	25.49 25.48 25.47 25.46	26.52 26.51 26.52	27.55 27.55 27.57	28.58 28.58 28.61	30.62 30.63 30.67	32.63 32.64 32.70	34.61 34.63 34.69	36.57 36.59 36.66	38.49 38.52 38.58	40.3 40.4 40.4
	.5 1.0 2.5 5.0 7.5	24.45 24.44 24.42 24.39 24.37 24.40	25.49 25.48 25.47	26.52 26.51	27.55 27.55	28.58 28.58	30.62 30.63	32.63 32.64	34.61 34.63	36.57 36.59	38.49 38.52	40.3 40.4 40.4 40.6
	.5 1.0 2.5 5.0 7.5	24.45 24.44 24.42 24.39 24.37 24.40 24.49	25.49 25.48 25.47 25.46 25.46 25.52 25.62	26.52 26.51 26.52 26.55 26.62 26.73	27.55 27.55 27.57 27.62 27.71 27.83	28.58 28.58 28.61 28.68 28.78 28.91	30.62 30.63 30.67 30.76 30.88 31.03	32.63 32.64 32.70 32.81 32.94 33.09	34.61 34.63 34.69 34.81 34.95 35.10	36.57 36.59 36.66 36.78 36.92 37.07	38.49 38.52 38.58 38.71 38.84 38.99	40.3 40.4 40.4 40.6 40.7 40.8
	.5 1.0 2.5 5.0 7.5 10.0 12.5	24.45 24.44 24.42 24.39 24.37 24.40 24.49 24.65 24.93	25.49 25.48 25.47 25.46 25.46 25.52	26.52 26.51 26.52 26.55 26.62	27.55 27.55 27.57 27.62 27.71	28.58 28.58 28.61 28.68 28.78	30.62 30.63 30.67 30.76 30.88	32.63 32.64 32.70 32.81 32.94	34.61 34.63 34.69 34.81 34.95	36.57 36.59 36.66 36.78 36.92	38.49 38.52 38.58 38.71 38.84	40.3 40.4 40.4 40.6 40.7 40.8 41.0
	.5 1.0 2.5 5.0 7.5 10.0 12.5 15.0	24.45 24.44 24.42 24.39 24.37 24.40 24.49 24.65 24.93 25.36	25.49 25.48 25.47 25.46 25.46 25.52 25.62 25.62 26.03 26.37	26.52 26.51 26.52 26.55 26.62 26.73 26.90 27.13 27.42	27.55 27.55 27.57 27.62 27.71 27.83 28.00 28.21 28.49	28.58 28.61 28.68 28.78 28.91 29.08 29.29 29.54	30.62 30.63 30.67 30.76 30.88 31.03 31.20 31.40 31.63	32.63 32.64 32.70 32.81 32.94 33.09 33.26 33.46 33.68	34.61 34.63 34.69 34.81 34.95 35.10 35.27 35.46 35.67	36.57 36.59 36.66 36.78 36.92 37.07 37.24 37.42 37.62	38.49 38.52 38.58 38.71 38.84 38.99 39.16 39.34 39.53	40.3 40.4 40.4 40.6 40.7 40.8 41.0 41.2
g,	.5 1.0 2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5	24.45 24.44 24.42 24.37 24.37 24.40 24.49 25.36 26.03	25.49 25.48 25.46 25.46 25.52 25.62 25.78 26.03 26.37 26.85 27.52	26.52 26.51 26.52 26.55 26.62 26.73 26.90 27.13	27.55 27.55 27.57 27.62 27.71 27.83 28.00 28.21 28.49 28.82 29.24	28.58 28.58 28.61 28.68 28.78 28.91 29.08 29.29	30.62 30.63 30.67 30.76 30.88 31.03 31.20 31.40	32.63 32.64 32.70 32.81 32.94 33.09 33.26 33.46 33.68 33.92	34.61 34.63 34.69 34.81 34.95 35.10 35.27 35.46	36.57 36.59 36.66 36.78 36.92 37.07 37.24 37.42	38.49 38.52 38.58 38.71 38.84 38.99 39.16 39.34 39.53 39.73	40.3 40.4 40.4 40.6 40.7 40.8 41.0 41.2 41.3
МРа	.5 1.0 2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5 25.0	24.45 24.44 24.42 24.39 24.37 24.40 24.49 24.65 24.93 25.36 26.03 27.14	25.49 25.48 25.47 25.46 25.52 25.62 25.62 25.78 26.03 26.37 26.85 27.52 28.45	26.52 26.51 26.52 26.55 26.62 26.73 26.90 27.13 27.42 27.81 28.31 28.96	27.55 27.55 27.57 27.62 27.71 27.83 28.00 28.21 28.49 28.89 29.24 29.75	28.58 28.61 28.61 28.68 28.78 28.91 29.08 29.29 29.54 29.54 29.81 30.64	30.62 30.63 30.67 30.76 30.88 31.03 31.20 31.40 31.53 31.90	32.63 32.64 32.70 32.81 32.94 33.09 33.26 33.46 33.68 33.92 34.19	34.61 34.63 34.69 34.81 34.95 35.10 35.27 35.46 35.67 35.67 36.42	36.57 36.59 36.66 36.72 37.07 37.24 37.42 37.62 37.84 38.07 38.32	38.49 38.52 38.58 38.71 38.84 38.99 39.16 39.34 39.53 39.73 39.73	40.3 40.4 40.4 40.6 40.7 40.8 41.0 41.2 41.3 41.7 42.0
•	.5 1.0 2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5 25.0 27.5	24.45 24.44 24.42 24.39 24.37 24.40 24.49 25.36 26.03 27.14 29.18 33.97 43.99	25.49 25.48 25.47 25.46 25.52 25.62 25.78 26.03 26.37 26.85 27.52 28.45 29.18	26.52 26.51 26.55 26.62 26.73 26.90 27.13 27.42 27.81 28.31 28.76 29.78	27.55 27.55 27.57 27.62 27.71 27.83 28.00 28.21 28.49 28.82 29.24	28.58 28.58 28.61 28.68 28.78 28.91 29.08 29.29 29.54 29.85 30.21 30.64 31.14	30.62 30.63 30.67 30.68 31.03 31.20 31.40 31.63 31.90 32.55 32.55	32.63 32.64 32.70 32.81 32.94 33.09 33.26 33.46 33.68 33.92 34.19 34.49 34.82 35.17	34.61 34.63 34.69 34.81 34.95 35.10 35.27 35.46 35.67 35.67 36.15 36.42 36.71	36.57 36.59 36.66 36.78 36.92 37.07 37.24 37.42 37.62 37.62 37.84 38.32 38.32	38.49 38.52 38.58 38.71 38.84 38.99 39.16 39.34 39.53 39.73 39.73 40.18	40.3 40.4 40.6 40.7 40.8 41.0 41.2 41.3 41.5 41.7 42.0
•	.5 1.0 2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5 25.0 27.5 30.0	24.45 24.44 24.42 24.39 24.37 24.49 24.65 24.93 25.36 26.03 27.14 29.18 33.97 55.78	25.49 25.48 25.46 25.46 25.52 25.62 25.78 26.03 26.37 26.85 27.85 27.81 31.84	26.52 26.51 26.52 26.55 26.62 26.73 27.42 27.81 28.31 28.96 29.78 30.85	27.55 27.55 27.57 27.62 27.71 27.83 28.00 28.21 28.49 28.82 29.24 29.75 30.36 31.10 33.08	28.58 28.58 28.61 28.68 28.78 29.08 29.29 29.54 29.85 30.21 30.64 31.14 31.73 33.19	30.62 30.63 30.67 30.76 30.88 31.03 31.40 31.63 31.90 32.21 32.55 32.94 33.37 34.37	32.63 32.64 32.70 32.81 32.94 33.09 33.26 33.46 33.68 33.92 34.19 34.49 34.82 35.17 35.97	34.61 34.63 34.69 34.81 34.95 35.10 35.27 35.46 35.67 35.90 36.15 36.42 36.71 37.02	36.57 36.59 36.66 36.78 36.92 37.07 37.24 37.62 37.62 37.84 38.07 38.32 38.58 38.58	38.49 38.52 38.58 38.71 38.84 39.16 39.34 39.53 39.73 39.95 40.18 40.42 40.68 41.23	40.3 40.4 40.4 40.6 40.7 40.8 41.0 41.2 41.3 41.5 42.0 42.4 42.4
•	.5 1.0 2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5 25.0 27.5	24.45 24.44 24.42 24.39 24.37 24.40 24.49 25.36 26.03 27.14 29.18 33.97 43.99	25.49 25.48 25.47 25.46 25.52 25.62 25.78 26.03 26.37 26.85 27.52 28.45 29.81 31.86 39.42	26.52 26.51 26.55 26.62 26.73 26.90 27.13 27.42 27.81 28.31 28.76 29.78	27.55 27.55 27.55 27.62 27.71 27.83 28.00 28.21 26.49 28.82 29.24 29.75 30.36 31.10	28.58 28.58 28.68 28.78 28.71 29.08 29.29 29.54 29.85 30.21 30.64 31.73	30.62 30.63 30.67 30.68 31.03 31.20 31.40 31.63 31.90 32.55 32.55	32.63 32.64 32.70 32.81 32.94 33.09 33.26 33.46 33.68 33.92 34.19 34.49 34.82 35.17	34.61 34.63 34.69 34.81 35.27 35.46 35.67 35.90 34.15 36.42 36.71 37.02	36.57 36.59 36.66 36.78 36.92 37.07 37.24 37.42 37.62 37.62 37.84 38.32 38.32	38.49 38.52 38.58 38.71 38.84 38.99 39.16 39.34 39.53 39.73 39.95 40.18 40.42	40.4 40.4 40.6 40.6 41.2 41.3 41.7 42.0 42.2 42.9 43.5
•	.5 1.0 2.5 5.0 7.5 10.0 12.5 15.0 20.0 22.5 25.0 27.5 30.0 40.0 45.0	24.45 24.44 24.42 24.39 24.37 24.49 24.65 24.93 25.36 26.03 27.14 49.18 33.97 43.99 61.31 65.07 68.01	25.49 25.48 25.47 25.46 25.52 25.62 25.62 25.78 26.03 26.37 26.85 27.52 28.45 29.81 31.86 39.42 48.61 54.39	26.52 26.51 26.52 26.55 26.62 26.73 26.90 27.13 27.42 27.81 28.31 28.96 29.78 30.85 34.03 39.02 45.05	27.55 27.55 27.57 27.62 27.71 27.83 28.00 28.21 28.49 28.82 29.24 29.75 30.36 31.10 35.88 39.58	28.58 28.61 28.61 28.68 28.79 29.08 29.54 29.85 30.21 30.64 31.14 31.73 33.19 35.11 37.64	30.62 30.63 30.67 30.76 31.03 31.40 31.40 31.43 32.55 32.94 33.37 35.59 37.03 38.71	32.63 32.64 32.70 32.81 33.09 33.26 33.46 33.48 33.92 34.19 34.82 35.17 35.97 36.90 37.95	34.61 34.63 34.69 34.81 35.10 35.27 35.46 35.67 35.69 36.15 36.71 37.02 37.70 38.47 39.32	36.57 36.59 36.66 36.78 36.92 37.07 37.24 37.62 37.84 38.32 38.58 38.58 39.47 40.13 40.84	38.49 38.52 38.58 38.71 38.84 38.99 39.16 39.53 39.73 39.95 40.42 40.42 40.48 41.83 42.47 43.47	40.3 40.4 40.4 40.7 40.8 41.0 41.2 41.5 41.7 42.0 42.4 42.9 43.5 44.7
PRESSURE, MPa	.5 1.0 2.5 5.0 10.0 12.5 10.0 17.5 20.0 22.5 25.0 27.5 30.0 35.0 40.0 45.0 50.0	24.45 24.44 24.42 24.39 24.37 24.40 24.49 25.36 26.03 27.14 29.18 33.97 43.99 55.78 61.31 65.07	25.49 25.46 25.47 25.46 25.52 25.52 25.62 25.78 26.03 26.37 26.85 27.52 28.45 27.52 28.45 27.52 28.45 27.52 28.45 27.52 28.45 27.52 28.45 27.52 28.45 27.52 28.45 27.52 28.45 27.52 28.45 29.42 48.61 54.62 54.62 54.62 54.62 54.62 54.62 54.62 54.62 54.62 55.52 57.52	26.52 26.51 26.52 26.62 26.73 26.73 27.42 27.81 28.31 28.96 29.78 30.85 34.03 45.05 50.50 50.50	27.55 27.55 27.57 27.62 27.71 27.83 28.00 28.21 28.49 28.82 29.24 29.75 30.36 31.10 33.08 35.88 39.58 43.80	28.58 28.61 28.68 28.79 28.79 29.08 29.29 29.54 30.64 31.73 33.19 35.11	30.62 30.63 30.67 30.76 30.88 31.03 31.20 31.40 31.63 31.90 32.91 32.94 33.37 34.37 34.37 34.57 37.03	32.63 32.64 32.70 32.81 32.94 33.09 33.26 33.46 33.46 33.49 34.49 34.49 35.17 35.97 36.90 37.95 39.14	34.61 34.63 34.69 34.81 35.10 35.27 35.46 35.67 35.67 36.42 36.71 37.02 37.70 38.47 39.32 40.26 41.27	36.57 36.59 36.66 36.78 37.07 37.24 37.62 37.62 37.84 38.32 38.32 38.32 38.32 40.86 41.65	38.47 38.58 38.71 38.84 38.97 39.16 39.33 39.93 40.42 40.42 40.48 41.23 42.47 43.18	40.3 40.4 40.6 40.7 40.8 41.3 41.5 42.0 42.2 42.4 43.5 44.1 45.3
•	.5 1.0 2.5 5.0 7.5 10.0 12.5 15.0 22.5 25.0 27.5 30.0 40.0 45.0 55.0 60.0 65.0	24.45 24.44 24.42 24.39 24.37 24.49 24.65 24.93 25.36 26.03 27.14 29.18 33.97 43.99 55.78 61.31 65.07 68.01 70.48 72.64	25.49 25.48 25.47 25.46 25.52 25.62 25.62 25.78 26.03 26.37 26.85 27.52 28.45 29.81 31.86 39.42 48.61 54.73 62.80 65.80 65.80	26.52 26.51 26.52 26.62 26.73 26.90 27.13 27.42 27.81 28.96 29.78 34.03 39.02 45.05 50.50 54.89 58.45	27.55 27.57 27.62 27.71 27.83 28.00 28.21 28.49 28.82 29.75 30.36 31.10 35.88 39.36 48.07 51.89	28.58 28.58 28.61 28.68 28.78 29.79 29.54 29.29 30.64 31.14 31.73 33.19 35.11 37.56 40.48 43.72 47.03 50.19	30.62 30.63 30.67 30.98 31.03 31.20 31.40 31.63 31.90 32.55 32.94 33.37 35.59 37.03 38.71 40.59 42.64	32.63 32.64 32.70 32.81 33.09 33.26 33.46 33.48 33.92 34.19 34.82 35.17 36.90 37.97 36.90 37.91 40.44 41.85	34.61 34.69 34.81 35.10 35.27 35.46 35.67 35.67 36.42 36.71 37.02 37.70 38.47 39.32 40.26 41.27 42.35	36.57 36.59 36.66 36.78 36.92 37.07 37.24 37.62 37.84 38.32 38.58 38.58 40.13 40.85 41.65 42.49 43.38	38.47 38.58 38.71 38.89,73 39.16 39.33 39.73 39.93 40.42 40.42 40.42 41.83 42.47 43.16 43.89 44.65	40.34 40.47 40.67 40.78 41.23 41.77 42.02 42.49 43.57 44.17 45.03 46.7
•	.5 1.0 2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5 25.0 35.0 40.0 50.0 50.0	24.45 24.44 24.42 24.39 24.37 24.40 24.49 25.36 26.03 27.14 29.18 33.97 55.78 61.31 61.31 70.48	25.49 25.46 25.46 25.46 25.52 25.62 25.78 26.03 26.37 26.85 27.52 28.45 27.52 28.45 39.42 48.61 54.96 65.60 68.01 70.13	26.52 26.52 26.52 26.52 26.62 26.73 27.13 27.42 27.81 28.31 28.31 28.96 29.78 30.85 34.03 39.02 45.05 50.50 54.89 58.45 61.42	27.55 27.57 27.62 27.62 27.83 28.00 28.21 28.49 29.75 30.36 31.10 33.08 37.58 43.84 48.07 51.89 55.22 58.13	28.58 28.58 28.61 28.68 28.91 29.09 29.54 29.29 29.53 30.11 30.64 31.73 35.11 37.56 40.48 43.72 47.03 50.19	30.62 30.63 30.67 30.76 31.03 31.20 31.43 31.43 32.55 32.95 32.95 33.37 34.37 35.59 40.59 42.64 44.81	32.63 32.64 32.70 32.81 32.94 33.09 33.26 33.46 33.46 33.49 34.19 34.89 35.17 35.97 36.90 37.95 39.14 40.44 41.85 43.36	34.61 34.69 34.81 35.10 35.27 35.46 35.67 35.42 36.42 36.70 37.02	36.57 36.59 36.66 36.78 37.07 37.24 37.62 37.84 38.32 38.32 38.38 40.86 41.65 42.49 43.38 44.32	38.49 38.58 38.71 38.99 39.16 39.53 39.73 39.75 40.18 40.42 41.23 41.83 41.47 43.16 43.16 44.65 45.45	40.33 40.44 40.44 40.77 40.87 41.02 41.57 42.02 42.49 43.57 44.17 45.03 46.74 47.42
•	.5 1.0 2.5 5.0 12.5 10.0 12.5 25.0 22.5 25.0 35.0 45.0 55.0 65.0 70.0 80.0	24.45 24.44 24.42 24.39 24.37 24.40 24.49 25.36 26.03 27.14 29.18 33.97 43.99 55.78 61.31 65.07 68.07 70.48 72.64 72.64	25.49 25.46 25.47 25.46 25.52 25.62 25.78 26.03 26.87 27.52 28.45 27.52 29.81 31.86 39.42 48.61 59.39 62.80 65.60 68.01 70.13 72.04	26.52 26.52 26.52 26.52 26.62 26.73 27.42 27.42 27.81 28.96 29.78 30.85 34.03 39.02 45.05 50.50 54.89 58.45 61.42 63.97 66.23	27.55 27.57 27.62 27.71 27.62 27.71 28.40 28.21 28.49 29.24 29.24 29.75 30.36 35.88 37.88 43.84 48.07 51.89 55.22 58.13 60.69 62.97	28.58 28.58 28.68 28.68 28.91 29.09 29.54 29.29 29.54 30.64 31.73 33.19 35.11 37.56 40.48 43.72 47.03 50.19 53.12	30.62 30.63 30.67 30.88 31.03 31.20 31.40 31.43 31.90 32.94 33.37 34.37 35.59 37.03 38.71 40.59 42.64 44.81 47.02 49.23	32.63 32.64 32.70 32.81 32.94 33.09 33.26 33.46 33.48 33.49 34.49 34.49 35.17 35.97 36.90 37.95 39.14 40.44 41.85 43.36 44.93 46.56	34.61 34.69 34.81 35.10 35.27 35.46 35.67 35.40 36.71 37.02 37.70 38.47 37.02 40.26 41.27 42.35 43.50 44.70 45.72	36.57 36.59 36.66 36.79 37.24 37.24 37.62 37.84 38.32 38.32 38.38 40.86 41.65 42.49 43.38 44.33 45.30 46.31	38.49 38.58 38.71 38.99 39.16 39.37 39.53 39.95 40.18 40.48 41.23 41.23 41.23 42.47 43.18 43.89 44.65 45.45 46.28 47.11	40.3 40.4 40.6 40.6 41.3 41.3 41.3 41.3 42.2 42.4 43.5 44.7 45.0 47.4 48.9 48.9
•	.5 1.0 2.5 5.0 7.5 10.0 12.5 17.5 20.0 22.5 25.0 27.5 35.0 40.0 45.0 55.0 65.0 70.0 85.0 80.0	24.45 24.44 24.42 24.39 24.37 24.49 24.65 26.03 27.14 29.18 33.97 45.07 61.31 70.48	25.49 25.48 25.47 25.46 25.52 25.62 25.62 25.78 26.37 26.85 27.52 27.52 28.45 27.82 27.82 28.45 27.82 27.82 28.45 27.82 27.82 28.45 27.82	26.52 26.55 26.55 26.65 26.62 26.73 26.90 27.14 28.31 28.96 29.78 30.85 34.03 39.02 45.05 50.50 54.89 561.42 63.97 66.25 70.10	27.55 27.57 27.62 27.62 27.83 28.00 28.21 28.49 29.75 30.36 31.10 33.08 37.58 43.84 48.07 51.89 55.22 58.13	28.58 28.61 28.68 28.71 29.08 29.29 29.54 29.85 30.21 30.64 31.73 33.19 35.11 37.56 40.48 43.72 47.03 50.19 53.12	30.62 30.63 30.67 30.88 31.03 31.20 31.63 32.55 32.94 33.37 35.59 37.03 38.71 40.59 42.64 44.81 47.02 49.23 51.39 53.46	32.63 32.64 32.70 32.81 33.09 33.26 33.68 33.92 34.49 34.82 35.17 35.97 36.90 37.95 39.14 40.44 41.85 43.36 44.93 40.85 40.85	34.61 34.69 34.81 35.50 35.50 35.67 35.67 35.67 36.42 36.71 37.02 37.70 38.47 37.02 40.26 41.27 42.35 43.50 44.70	36.57 36.59 36.66 36.78 36.92 37.07 37.24 37.62 37.84 38.32 38.58 38.58 40.13 40.13 40.13 41.65 42.49 43.38 44.32 45.30	38.49 38.58 38.71 38.89 39.16 39.33 39.73 39.73 40.18 40.42 41.83	40.34 40.67 40.67 41.35 41.35 41.35 42.4 42.4 42.4 42.4 43.4 45.07 47.27 48.77 48.77 49.75
•	.5 1.0 2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 27.5 30.0 35.0 40.0 45.0 50.0 65.0 65.0 65.0 80.0 80.0	24.45 24.44 24.42 24.39 24.37 24.40 24.49 25.36 26.03 27.14 29.18 33.97 55.78 61.31 45.07 68.01 70.48 72.64 74.57 79.45 80.87	25.49 25.48 25.46 25.46 25.52 25.62 25.62 25.62 26.03 26.37 26.85 27.52 28.45 29.81 31.86 39.42 48.61 54.96 65.60 68.01 70.13 70.73 70.74 70.73	26.52 26.55 26.55 26.55 26.62 26.73 27.42 27.43 27.42 27.81 28.31 28.31 28.31 28.31 28.35 34.03 39.02 45.05 50.50 54.89 64.23 68.23 68.23	27.55 27.57 27.62 27.71 27.83 28.00 28.21 28.49 28.82 29.75 30.36 33.08 33.08 33.84 48.07 51.89 55.22 58.13 60.69 62.97	28.58 28.68 28.61 28.68 28.91 29.08 29.29 30.21 30.64 31.73 33.19 35.11 37.56 40.48 43.72 47.03 50.19 53.79 58.22	30.62 30.63 30.67 30.88 31.03 31.40 31.63 31.90 32.55 32.94 33.37 34.37 35.59 37.03 38.71 40.59 42.64 44.81 47.02 51.39	32.63 32.64 32.70 32.81 32.94 33.09 33.26 33.46 33.49 34.49 34.49 34.82 35.17 35.97 37.95 39.14 40.44 41.85 43.36 44.82 49.85	34.61 34.69 34.81 35.10 35.27 35.46 35.67 35.67 35.47 36.42 36.71 37.02 37.70 38.32 40.26 41.27 42.35 43.50 44.72 42.35 43.50 44.72 42.35 43.50 44.72 48.52	36.57 36.56 36.78 36.78 37.24 37.24 37.84 37.80 38.32 38.58 39.47 40.13 40.13 41.65 42.38 44.32 45.30 47.34 47.34 48.39	38.49 38.58 38.71 38.99 39.16 39.53 39.73 39.73 40.18 40.42 40.48 41.23 41.83 41.83 41.65 45.45 45.45 47.14 48.90	40.3 40.4 40.6 40.6 41.3 41.3 41.3 41.3 42.2 42.4 42.9 44.7 45.0 46.0 46.7 47.4 48.9 49.9

Table 9. Comparison between the calculated viscosity values $\mu_{\rm calc}$ and the Skeleton Table values $\mu_{\rm S.T.}$ $[\Delta=(\mu_{\rm calc}-\mu_{\rm S.T.})/\delta\mu]$

	⟨Δ⟩	(4)	$\langle \Delta^2 \rangle^{1/2}$
International Equation [Eq. (2.3)] Equation (3.1) of Watson <i>et al</i> .	0.07	0.19	0.26
	0.04 ⁵	0.15	0.21

Table 10. Kinematic viscosity ν of water substance calculated from the equation of Watson et al. with densities from the IAPS 82 formulation (ν in 10⁻⁶ m²/s)

		***************************************	-			TEM	PERATURE	, °C			· · · · · · · · · · · · · · · · · · ·	
		,	25	50	75	100	150	200	250	300	350	375
PRESSURE, MPa	.1 .5 1.0 2.5 5.0 7.5 10.0 12.5 20.0 22.5 25.0 35.0 45.0 55.0 66.0 75.0 85.0 90.0	1.793 1.792 1.790 1.785 1.777 1.768 1.745 1.738 1.731 1.745 1.731 1.710 1.704 1.692 1.669 1.669 1.669 1.669 1.630	.8931 .8929 .8925 .8916 .8901 .8886 .9871 .8857 .8843 .8857 .8804 .8746 .8746 .8746 .8746 .8726 .8746 .8726 .8467 .8467 .8467 .8467 .8467 .8467 .8468 .8469	.5537 .5536 .5536 .5535 .5531 .5532 .5531 .5530 .5529 .5526 .5525 .5525 .5524 .5524 .5527 .5527 .5527 .5528 .5527 .5528 .5527 .5528 .5527 .5528 .5527 .5528 .5527 .5528 .5527 .5528 .5527 .5528 .5527 .5528 .5527 .5528 .5527 .5528 .5528 .5527 .5528 .5527 .5528 .5527 .5528 .5527 .5528 .5527 .5528 .5527 .5528 .5527 .5528 .5527 .5528 .5527 .5528 .5527 .5528 .5527 .5528 .5527 .5528 .5527 .5528 .5528 .5527 .5528 .5527 .5528 .5527 .5528 .5527 .5528 .5527 .5528 .5527 .5528 .5527 .5528 .5527 .5528 .5527 .5528 .5527 .5528 .5527 .5528 .5527 .5528 .5527 .5528 .5527 .5528 .5527 .5528 .5527 .5528 .5527 .5528	.3876 .3876 .3878 .38878 .3880 .3883 .3890 .3892 .3897 .3903 .3903 .3903 .3911 .3916 .3922 .3934 .3934 .3934 .3934 .3934 .3953 .3953 .3953 .3953 .3953 .3953	.3070 .3077	.1993 .1997 .2001 .2008 .2012 .2016 .2020 .2024 .2027 .2035 .2042 .2049 .2057 .2057 .2057 .2059	3.272 .1559 .1559 .1563 .1574 .1574 .1578 .1581 .1585 .1589 .1592 .1596 .1603 .1610 .1617 .1624 .1630 .1630 .1630 .1630 .1630 .1630 .1630 .1644 .1650	43.84 8.604 4.198 1.545 1.334 1.334 1.336 1.346 1.349 1.357 1.367 1.364 1.367 1.374 1.401 1.407 1.401 1.407 1.413 1.419 1.425 1.435 1.443	.1315 .1320	71.61 .49605 .3606 .2631 .11.49 .11.54 .11.59 .11.69 .11.70 .11.80 .11.80 .11.80 .11.90 .12.97 .12.10	
	100.0	1.581	•8576	•5555	.3994 TEMP	.3085	°C	.1688	.1454	.1326	,1256	,1236
		400	425	450	475	500	550	600	650	700	750	800
PRESSURE, MPa	.1 .5 1.0 2.5 5.0 7.5 10.0 12.5 15.0 17.5 22.5 25.0 27.5 30.0 35.0 40.0 45.0 55.0 60.0 65.0 70.0 85.0 90.0 90.0 90.0	75.86 15.08 7.487 2.929 1.409 .9011 .6466 .4932 .3902 .3158 .2589 .2134 .1751 .1120 .1229 .1173 .1173 .1173 .1173 .1174 .1186 .1191 .1196 .1200 .1205 .1200 .1205 .1210 .1210	82.02 16.33 8.113 3.186 1.543 .9949 .7207 .5560 .4459 .3671 .3078 .2615 .2244 .1939 .1689 .1232 .1201 .1192 .1190 .1191 .1193 .1196 .1199 .1203 .1206 .1210 .1214 .1218	88.42 17.61 8.761 3.451 1.600 1.090 .7954 .6184 .5005 .4163 .3533 .3044 .2654 .2338 .2078 .140 .1312 .1255 .1230 .1218 .1212 .1210 .1211 .1212 .1215 .1217 .1217 .1217 .1217	95.04 18.94 9.431 3.724 1.622 1.188 .8710 .6811 .5547 .4647 .37/3 .3452 .3037 .2701 .2425 .2002 .1709 .1513 .1321 .1282 .1259 .1246 .1238 .1233 .1231 .1229 .1229 .1229 .1229 .1230	101.9 20.32 10.12 4.005 1.926 1.287 .9478 .7445 .6092 .5128 .4409 .3851 .3408 .3049 .2753 .1298 .1973 .1740 .1576 .1464 .1389 .1341 .1309 .1288 .1253 .1264 .1258 .1253 .1253	116.2 23.19 11.57 4.591 2.247 1.492 1.105 .8738 .7197 .6099 .5279 .4644 .4139 .3729 .3389 .2482 .2195 .1978 .1813 .1686 .1590 .1517 .1462 .1420 .1388 .1364 .1345 .1345	131.4 26.24 13.09 5.209 2.582 1.706 1.269 1.007 .8332 .7091 .6163 .5444 .4872 .4406 .4021 .2980 .2446 .2387 .2182 .2020 .1890 .1785 .1700 .1631 .1576 .1530 .1493 .1493 .1462	147.3 29.44 14.70 5.858 2.911 1.930 1.439 1.146 .9502 .8109 .7068 .6260 .5617 .5093 .4658 .3981 .3480 .3097 .2797 .2558 .2364 .2206 .2075 .1799 .1734 .1679 .1633	164.1 32.80 16.38 6.537 3.285 2.162 1.616 1.289 1.071 .9157 .7976 .6378 .5792 .5306 .4548 .3985 .3553 .3213 .2939 .2715 .2530 .2376 .2246 .2135 .2040 .1959 .1889 .1828	181.7 36.31 18.14 7.245 3.413 2.403 1.799 1.437 1.196 1.024 .8931 .7953 .7157 .6507 .5968 .5125 .4498 .4015 .3634 .3326 .3072 .2862 .2684 .2534 .2404 .2293 .2196 .2111 .2037	199.9 39.97 19.98 7.982 3.095 2.653 1.988 1.589 1.324 1.135 .9732 .8832 .7955 .7239 .6644 .5713 .5020 .4486 .4062 .3718 .3435 .3199 .2999 .2828 .2681 .2553 .2441 .2343 .2256

Table 11.	Viscosity μ and kinematic viscosity ν of liquid
	water (l) and of water vapor (g) at saturation as calculated
	from the equation of Watson et al.

Т	$\mu_{\ell} \times 10^6$	$\mu_{\sigma} \times 10^6$	$v_{\stackrel{\text{l}^2}{\text{m}^2/\text{s}}}^{\times 10^6}$	$v_a \times 10^6$
-	μ _ε ~ 10	κ _g ^ 10	V ^ 10	V ^ 10
°C	Pa.s	Pa.s	m ² /s	m ² /s
Ü		14.3		m / 2
			·	
.00	1793.	9.216	1.793	1900.
.01	1792.	9.216	1.793	1878.
10.00	1307.	9.461	1.307	1006.
20.00	1002.	9.727	1.004	562.0
30.00	797.7	10.01	.8012	329.3
40.00	653.2	10.31	·65B4	201.3
50.00	547.0	10.62	⊸5537 _	127.R
60.00	466.5	10.93	+4745	83.91
70.00	404.0	11.26	•4132	56.80
80.00	354.4	11.59	.3647	39.51
90.00	314.5	11.93	+3258	28.17
100.00	281.8	12.27	+2941	20.53
110.00	254.8	12.61	•2679	15.27
120.00 130.00	232.1	12.96	+2461	11.56
140.00	213.0	13.30	•2278	8.894
150.00	196.6	13.65	•2123	6.946
160.00	182.5	13.99	.1990	5.497
170.00	170.3 159.6	14.34 14.68	.1876	4.402
180.00	150.2	15.02	•1778	3.565
190.00	141.8	15.02 15.37	1693	2.915
200.00	134.4	15.71	•1619 •1554	2.405 2.001
210.00	127.6	16.06	•1354 •1497	1.676
220.00	121.6	16.41	•1497 •1447	1.414
230.00	114.0	16.76	.1402	1.199
240.00	110.9	17.12	1363	1.023
250.00	106.2	17.49	1329	11023 18766
260.00	101.7	17.88	1298	.7542
270.00	97.55	18.28	•1271	.6513
280.00	93.56	18.70	.1247	.5640
290.00	89.71	19.15	1225	.4896
300.00	85.95	19.45	1206	4257
-310.00-	62.21	-20-21	-1 190	3706
320.00	78.45	20.84	.1176	.3226
330.00	74.57	21.40	.1163	.2805
340.00	70.45	22.55	.1153	.2433
350.00	65.87	23.81	.1146	.2098
360.00	60.39	25.71	.1144	.1790
370.00	52.25	29.57	.1153	.1476
371.00	50.97	30.33	.1156	.1440
372.00	49.39	31.31	.1161	·1399 ′
373.00	48.01	33.14	.1193	.1365

4. Viscosity near the Critical Point

The theory of dynamic critical phenomena asserts that the viscosity of gases diverges at the critical point. In practice, one observes a critical enhancement in the viscosity in the immediate vicinity of the critical point. The international equation presented in Sec. 2 and the alternative equation presented in Sec. 3 do not account for a critical viscosity enhancement. As a consequence, the singular behavior of the viscosity is not incorporated in Figs. 1–3 which display the behavior implied by these equations. The phenomenon is restricted to a small region near the critical point and is commonly neglected for engineering purposes.

In Fig. 4, we plot the viscosity of steam as a function of density at temperature close to the critical temperature $T_{\rm c}$. The data points shown in this figure are based on the measurements of Rivkin and co-workers²¹ as reinterpreted by Watson *et al.*⁶ The issues associated with the interpretation of the measurements of Rivkin *et al.* have been described elsewhere.²² There exists some uncertainty concerning the precise values of $T-T_{\rm c}$ to be assigned to the measurements of Rivkin *et al.*, ^{22,23} which affects an accurate determination of the viscosity values deduced from the original experimental measurements. Nevertheless we do think that the values

deduced by Watson and co-workers⁶ from the measurements of Rivkin *et al.* as displayed in Fig. 4 represent an adequate estimate of the magnitude of the critical viscosity enhancement in the critical region.

The equation of Watson et al. was designed so as to enable one to incorporate a representation of the viscosity enhancement observed near the critical point. For this purpose, Eq. (3.1) is to be generalized to

$$\mu = \mu_0(\overline{T}) \times \mu_1'(\overline{\rho}, \overline{T}) \times \mu_2(\overline{\gamma}_T). \tag{4.1}$$

Here $\mu_2(\vec{\chi}_T)$ is a function of a symmetrized compressibility defined as

$$\bar{\chi}_T = \bar{\rho} \left(\frac{\partial \bar{\rho}}{\partial \bar{P}} \right)_T. \tag{4.2}$$

In order to specify the function $\mu_2(\bar{\chi}_T)$, we consider a near-critical range circumscribed by

$$0.997 \leqslant \overline{T} \leqslant 1.0082,$$
 (4.3)

Outside the range defined in Eq. (4.3), μ_2 is unity everywhere

 $0.755 \le \bar{\rho} \le 1.290$.

$$\mu_2 = 1. \tag{4.4}$$

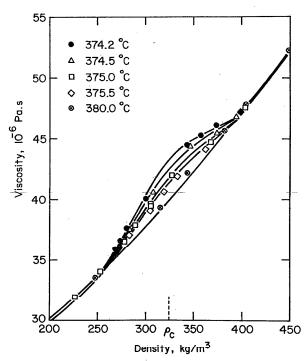


Fig. 4. Viscosity \(\mu\) as a function of density at temperatures close to the critical temperature of steam. The data points are deduced from measurements reported by Rivkin et al., and the curves represent values calculated from the equation of Watson, Basu, and Sengers.

Inside the region defined in Eq. (4.3), μ_2 is

$$\begin{array}{lll} \mu_2 = 0.922 \bar{\chi}_T^{0.0263}, & \text{if} & \bar{\chi}_T \!\!\!\! > \!\!\! 22; \\ \mu_2 = 1, & \text{if} & \bar{\chi}_T \!\!\!\! < \!\!\! 22. \end{array} \tag{4.5}$$

The function μ_2 is an approximation to a more complete theoretical expression derived by Bhattacharjee and coworkers.^{24,25}

A complication arises from the fact that the IAPS 82 formulation no longer yields an accurate representation of the compressibility in the near-critical range [Eq. (4.3)]. Hence, it is not advisable to evaluate $\mu_2(\bar{\chi}_T)$ from the IAPS 82 formulation. However, an accurate equation of state for steam in the critical region, based on the critical scaling laws, has been formulated by Levelt Sengers and co-workers as reported elsewhere in this journal. ^{17,26} With this scaled equation of state, $\bar{\chi}_T$ can be calculated as a function of density as well as a function of pressure for the values of $T-T_c$ assigned by Watson *et al.* to the experimental data. The curves in Fig. 4 represent the values thus calculated from Eq. (4.1). We conclude that Eq. (4.1) reproduces the critical viscosity enhancement within experimental accuracy.

5. Acknowledgments

We are indebted to R. S. Basu and J. T. R. Watson for a close collaboration in the earlier stage of this research. We are also indebted to the members of the Special Committee of IAPS listed in Appendix E for their many contributions to the development of the formulation for the viscosity of water substance described in this paper. In addition, we thank J. Kestin for valuable advice, J. T. R. Watson for a critical

review of the material reproduced in Appendix I, and to L. Haar and J. S. Gallagher for providing us with a copy of their computer program for the IAPS 82 formulation.

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6. References

¹R. C. Hendriks, R. B. McClintock, and G. J. Silvestri, J. Eng. Power Trans. ASME **99**, 644 (1977).

²K. Scheffler, N. Rosner, J. Straub, and U. Grigull, Brennst. Waerme Kraft 30, 73 (1978).

³A. A. Aleksandrov, A. I. Ivanov, and A. B. Matveev, Teploenergetika 22(4), 59 (1975). [English translation: Therm. Eng. (USSR) 22(4), 77 (1975)].

⁴A. Nagashima, J. Phys. Chem. Ref. Data 6, 1133 (1977).

⁵A. Nagashima, J. Phys. Chem. Ref. Data 12, 403 (1983).

⁶J. T. R. Watson, R. S. Basu, and J. V. Sengers, J. Phys. Chem. Ref. Data 9, 1255 (1980).

7"The 1968 IFC Formulation for Scientific and General Use, prepared by the International Formulation Committee of the 6th International Conference on the Properties of Steam," American Society of Mechanical Engineers, New York, 1968.

⁶C. A. Meyer, R. B. McClintock, G. J. Silvestri, and R. C. Spencer, ASME Steam Tables, 4th ed. (American Society of Mechanical Engineers, New York, 1979).

S. L. Rivkin, A. A. Aleksandrov, and E. A. Kremenevskaya, Thermodynamic Derivatives for Water and Steam (Winston, Washington, D.C., 1978).

¹⁰J. V. Sengers, R. S. Basu, B. Kamgar-Parsi, and J. Kestin, Mech. Eng. 104, 60 (1982).

¹¹L. Haar, J. S. Gallagher, and G. S. Kell, in *Proceedings of the 8th Symposium on Thermophysical Properties*, edited by J. V. Sengers (American Society of Mechanical Engineers, New York, 1982), Vol. II, p. 298.

¹²L. Haar, J. S. Gallagher, and G. S. Kell, NBS/NRC Steam Tables (Hemisphere, Washington, D.C., 1984).

¹³ Release on Provisional Formulation 1982 for the Thermodynamic Properties of Ordinary Water Substance for Scientific and General Use," International Association for the Properties of Steam, 1984.

¹⁴J. Kestin, J. V. Sengers, and R. C. Spencer, Mech. Eng. 105, 72 (1983).

¹⁵B. Kamgar-Parsi and J. V. Sengers, "Comments on the Calculation of the Viscosity of Water and Steam," Technical Report No. BN 979, Institute for Physical Science and Technology, University of Maryland, College Park, 1982.

¹⁶ The International Practical Temperature Scale of 1968," Metrologia 5, 35 (1969).

¹⁷J. Kestin, J. V. Sengers, B. Kamgar-Parsi, and J. M. H. Levelt Sengers, J. Phys. Chem. Ref. Data 13, 175 (1984).

¹⁸K. Scheffler, M. Rosner, and M. Reimann, "International Input of the Dynamic Viscosity of Water Substance," revised edition (Institut A für Thermodynamik, Technische Hochschule, Munich, 1974).

¹⁹K. Scheffler, J. Straub, and U. Grigull, in *Proceedings of the 7th Symposium on Thermophysical Properties*, edited by A. Cezairliyan (American Society of Mechanical Engineers, New York, 1977), p. 684.

²⁰K. Stephan and A. Laesecke (private communication).

²¹S. L. Rivkin, A. Ya. Levin, L. B. Izrailevskii, and K. G. Kharitonov, in *Proceedings of the 8th International Conference on the Properties of Water and Steam*, edited by P. Bury, H. Perdon, and B. Vodar (Editions Européennes Thermiques et Industries, Paris, 1975), p. 153.

²²R. S. Basu, J. V. Sengers, and J. T. R. Watson, Int. J. Thermophys. 1, 33 (1980).

²³A. A. Aleksandrov and A. B. Matveev, High Temp. (USSR) 19, 208 (1981).

²⁴J. K. Bhattacharjee, R. A. Ferrell, R. S. Basu, and J. V. Sengers, Phys. Rev. A 24, 1469 (1981).

²⁵R. S. Basu and J. V. Sengers, in *Proceedings of the 8th Symposium on Thermophysical Properties*, edited by J. V. Sengers (American Society of Mechanical Engineers, New York, 1982), Vol. I, p. 434.

²⁶J. M. H. Levelt Sengers, B. Kamgar-Parsi, F. W. Balfour, and J. V. Sengers, J. Phys. Chem. Ref. Data 12, 1 (1983).

Appendix I

The Eighth International Conference on The Properties of Steam, Giens, France, September 1974

Release

on

Dynamic Viscosity of Water Substance, September 1975
Unrestricted publication allowed in all countries.
Issued by the International Association for the Properties of Steam.

President: Professor Joseph Kestin Brown University_ Providence, Rhode Island 02912 USA Executive Secretary: Dr. Howard J. White, Jr. Office of Standard Reference Data National Bureau of Standards Washington, DC 20234 USA

Amended in accordance with a resolution adopted by the Executive Committee of IAPS at its 1982 meeting in Ottawa, Canada.

After the Eighth International Conference on the Properties of Steam (ICPS) held in Giens, France, in September 1974, the Secretariat issued an *Announcement*. This stated that the International Association for the Properties of Steam (IAPS) has been instructed to prepare new representations of the viscosity and thermal conductivity of steam to replace those announced as a result of the Sixth ICPS in a Supplementary Release dated November 1964. The representations contained in that Supplementary Release are now considered obsolete.

The Eighth ICPS designated a Special Committee, consisting of representatives of France, the Federal Republic of Germany, Japan, the USA, and the USSR, with Professor J. Kestin of the USA, the IAPS President, as its convenor, for the purpose of finalizing the new representations.

The Special Committee met in Schliersee near Munich in April 1975 and in Ottawa in September 1975, and completed its work with respect to the representation of the dynamic viscosity of water substance.

In accordance with a resolution of the Eighth Conference, the material included in the present release was circulated to and approved by the Heads of all National Delegations attending the Eighth Conference (Canada, Czechoslovakia, Federal Republic of Germany, France, Hong Kong, Hungary, Japan, Netherlands, Poland, Switzerland, United Kingdom, United States of Ameria, and the Union of Soviet Socialist Republics).

This Release on Dynamic Viscosity is issued by the Secretariat under the full authority of the Eighth Conference, and presents in the accompanying Appendices the *International Representation of the Dynamic Viscosity of Water Substance*, 1975.

A Release, presenting the International Representation of the Thermal Conductivity, 1977, has been issued separately.

A full report of the meeting of the Working Group in Schliersee near Munich, Federal Republic of Germany, and in Ottawa, Canada is contained in the *Official Reports of the* Secretary which can be obtained by writing to Dr. Howard J. White, Jr.
Office of Standard Reference Data
National Bureau of Standards
Washington, DC 20234 USA

Attachments

Appendices A, B, C, D, and E.

Appendix A

The Special Committee considers that the existing data in the literature, which have been collected in the document, "International Input of the Dynamic Viscosity of Water Substance," by K. Scheffler, N. Rosner, and M. Reimann, Institute A fuer Thermodynamik, Technische Universitaet Muenchen, September 1973, revised December 1974, are not sufficiently accurate and precise to allow definition of a two-dimensional representation that satisfies all of the criteria for smoothness and physical plausibility that can logically be required of it. The Special Committee draws attention to this fact and hopes that additional measurements of superior quality will become available in the future. At the present time, the Special Committee issues a formulation consisting of a table and an equation.

Part 1, Appendix B, contains a Table of Critically Evaluated Experimental Data which have been reduced to a uniform grid. The Table and the algorithm used for the reduction are given in the paper, "Draft of the Skeleton Table for Dynamic Viscosity of Water and Steam," by N. Rosner, M. Reimann, K. Scheffler, and U. Grigull, Institute A fuer Thermodynamik, Technische Universitaet Muenchen, January 1975. The table gives tolerances which constitute estimates of the reliability of the values given and which have been agreed upon by the Special Committee.

Part 2, Appendix C, contains a Recommended Interpolation Equation. This equation fits the data given in Table 1 within the tolerances assigned and is considered to be as good a formulation of these data as is available at the present time. A discussion of the equation and its derivation is given in the Draft of the Skeleton Tables for Dynamic Viscosity of Water and Steam, by A. A. Aleksandrov, A. I. Ivanov, and A. B. Matveev, presented to the meeting of Working Group II on transport properties of the IAPS, Moscow, USSR, May 1974 and in the Draft of the Skeleton Tables of the Dynamic Viscosity of Water and Steam, Part II, by A. A. Aleksandrov, A. I. Ivanov, and A. B. Matveev, presented to the meeting of Working Group II on transport properties of the IAPS, Giens, France, September 1974.

Part 3, Appendix D, gives a table of values at the selected grid points obtained from the equation given in Part 2. These represent smoothed and internally consistent values of the experimental data and are included for practical convenience.

The Special Committee recognizes that:

- (a) Table 1 represents an objective rendering of existing experimental data even though its values do not correspond to the Special Committee's conception of "smoothness,"
- (b) The Interpolation Equation as well as Table 2 do not adequately represent the anomaly which is associated with the dynamic viscosity of pure substances in the critical re-

gion (see paper, "Transport Properties of Gases and Binary, Liquids near the Critical State," by J. V. Sengers in "Transport Phenomena—1973," J. Kestin, ed., AIP Conference Proceedings No. 11, American Institute of Physics, New York, 1973, p. 229).

The Special Committee is of opinion that the corrections needed to represent this anomaly are of the same order of magnitude as the tolerances in the region, except for a rectangle defined by $|\rho/\rho_{\rm c}-1| \approx 0.1$ and $|T/T_{\rm c}-1| \approx 0.005$, and may be disregarded at the present time.

Appendix B

Part 1. Table of Critically Evaluated Experimental Data (Reduced to a Uniform Grid)

Upper value: viscosity of water or steam, μ in μ Pa s (=10⁻⁶ kg/m s).

Lower value: uncertainty in the viscosity, $\pm \Delta \mu$ in μ Pa s (=10⁻⁶ kg/m s).

Pressure P in MPa: Temperature T in °C.

Appendix B, Part 1. Dynamic Viscosity of Water and Steam

$P \setminus T$	0	-25	50	75-	100	150	200
0.1	1791	890.9	547.1	377.3	12.42	14.29	16.26
	18	8.9	5.5	3.8	0.25	0.29	0.33
0.5	1790	891.2	546.7	378.0	281.7	182.3	16.05
	18	8.9	5.5	3.8	2.8	1.8	0.32
1.0	1789	891.1	546.8	378.2	281.9	182.4	15.92
	18	8.9	5.5	3.8	2.8	1.8	0.32
2.5	1786	890.8	547.1	378.5	282.3	182.8	134.6
	18	8.9	5.5	3.8	2.8	1.8	1.4
5.0	1780	890.3	547.7	379.2	283.1	183.4	135.2
	18	8.9	5.5	3.8	2.8	1.8	1.4
7.5	1774	889.8	548.3	379.8	283.8	184.1	135.9
	18	8.9	5.5	3.8	2.8	1.8	1.4
10.0	1768	889.4	548.7	380.4	284.7	184.7	136.4
	18	8.9	5.5	3.8	2.9	1.9	1.4
12.5	1762	889.1	549.1	381.0	285.3	185.3	137.0
	18	8.9	5.5	3.8	2.9	1.9	1.4
15.0	1756	888.7	549.5	381.6	286.0	186.0	137.6
	18	8.9-	-5.5	-3.8-	-2.9 -	1 .9	-1. 4
17.5	1750	888.5	550.0	382.3	286.7	186.6	138.2
	18	8.9	5.5	3.8	2.9	1.9	1.4
20.0	1744	888.2	550.4	382.9	287.4	187.3	138.8
	17	8.9	5.5	3.8	2.9	1.9	1.4
22.5	1738	887.9	550.9	383.5	288.0	187.9	139.4
	17	8.9	5.5	3.8	2.9	1.9	1.4
25.0	1733	887.6	551.3	384.2	288.7	188.5	140.0
	17	8.9	5.5	3.8	2.9	1.9	1.4
27.5	1728	887.4	551.8	384.8	289.4	189.1	140.6
	17	8.9	5.5	3.9	2.9	1.9	1.4
30.0	1723	887.2	552.3	385.5	290.0	189.8	141.2
:05.0	17	8.9	5.5	3.9	2.9	1.9	1.4
35.0	1713	886.8	553.3	386.7	291.4	191.0	142.3
	17	8.9	5.5	3.9	2.9	1.9	1.4
40.0	1705	886.6	554.3	388.0	292.7	192.2	143.5
	17	8.9	5.5	3.9	2.9	1.9	1.4
45.0	1697	886.5	555.3	389.3	294.0	193.4	144.6
	17	8.9	5.6	3.9	2.9	1.9	1.5
50.0	1690	886.4	556.3	390.6	295.4	194.6	145.8
	17	8.9	5.6	3.9	3.0	2.0	1.5
55.0	1684	886.5	557.4	392.0	296.7	195.8	146.9
	17	8.9	5.6	3.9	3.0	2.0	1.5
60.0	1679	886.7	558.5	393.3	298.0 3.0	197.0	148.0 1.5
65.0	17	8.9	5.6	3.9		2.0	1.3
65.0	1674	886.9 8.9	559.7 5.6	394.6 4.0	299.4 3.0	198.2 2.0	1.5
70.0	17 1670	887.3	560.9	395.9	300.7	2.0 199.4	150.1
70.0			5.6	393.9 4.0	3.0	2.0	1.5
75.0	17	8.9					
75.0	1666	887.7	562.0	397.3 4.0	302.0 3.0	200.6 2.0	151.2 1.5
90.0	·17	8.9	5.6		303.4		152.3
80.0	1662	888.3	563.3	398.6 4.0	303.4 3.0	201.8 2.0	152.5
95 A	17 1659	8.9 888.8	5.6 564.5	400.0	304.6	203.0	153.3
85.0			5.7	4.0	3.1	2.0	1.5
00.0	17	8.9		4.0 401.4	305.9	204.2	154.3
90.0	1656	889.5	565.8	4.0	3.1	2.0	1.5
05.0	17 1652	8.9	5.7 567.1	4.0 402.8	3.1 307.3	2.0 205.4	155.4
95.0	1653	890.3	567.1 5.7	402.8 4.0	307.3	203.4	1.6
100.0	17	8.9			308.6	206.5	156.4
100.0	1651	891.1 8.9	568.4 5.7	404.2 4.0	308.6	2.01	1.6

J. V. SENGERS AND B. KAMGAR-PARSI

Appendix B, Part 1. Dynamic Viscosity of Water and Steam—Continued

$P \setminus T$	250	300	350	375	400	425	450
0.1	18.30	20.36	22.43	23.45	24.47	25.49	26.50
	0.37	0.41	0.45	0.47	0.49	0.51	0.53
0.5	18.16	20.25	22.32	23.43	24.44	25.49	26.53
	0.36	0.41	0.45	0.47	0.49	0.51	0.53
1.0	18.09	20.21	22.29	23.40	24.43	25.49	26.53
	0.36	0.40	0.45	0.47	0.49	0.51	0.53
25	17.85	20.07	22.22	23.37		25.49	26.54
2.5					24.41		
- I	0.36	0.40	0.44	0.47	0.49	0.51	0.53
5.0	106.5	19.88	22.15	23.33	24.42	25.52	26.60
	1.1	0.40	0.44	0.47	0.49	0.51	0.53
7.5	107.2	19.75	22.12	23.34	24.46	25.58	26.68
	1.1	-0.40	0.44	0.47	0.49	0.51	0.53
10.0	107.8	87.1	22.16	23.39	24.52	25.65	26.75
	1.1	1.7	0.44	0.47	0.49	0.51	0.53
12.5	108.5	88.0	22.35	23.57	24.69	25.81	26.91
	1.1	1.8	0.45	0.47	0.49	0.52	0.54
15.0	109.1	89.0	22.84	23.88	24.98	26.06	27.13
13.0							
17.5	1.1	1.8	0.46	0.48	0.50	0.52	0.54
17.5	109.8	89.9	67.3	24.49	25.37	26.38	27.42
	1.1	1.8	2.0	0.49	0.51	0.53	0.55
20.0	110.4	90.8	69.5	25.85	26.03	26.83	27.80
	1.1	1.8	2.1	0.52	0.52	0.54	0.56
22.5	111.1	91.6	71.4	48.2	27.11	27.50	28.31
	1.1	1.8	2.1	3.9	0.54	0.55	0.57
25.0	111.7	92.4	73.0	58.8	29.10	28.43	28.99
2010	1.1	1.9	2.2	1.2	0.58	0.57	0.58
27.5	112.3	93.1	74.4	62.4	33.88	29.81	29.84
21.3	1.1	1.9	2.2	1.2	0.68	0.60	0.60
20.0							30.97
30.0	112.9	93.9	75.7	64.9	43.97	31.84	
	1.1	1.9	2.3	1.3_	0.88_	_0.64_	0.62
35.0	114.1	95.3	78.0	68.6	56.4	39.47	34.19
	1.1	1.9	2.3	1.4	1.1	0.79	0.68
40.0	115.3	96.5	79.9	71.3	62.1	49.26	39.16
	1.2	1.9	2.4	1.4	1.2	0.99	0.78
45.0	116.4	97.8	81.7	73.7	65.8	55.6	44.87
,	1.2	2.0	2.5	1.5	1.3	1.1	0.90
50.0	117.6	99.0	83.4	75.9	68.2	60.1	50.5
,,,,,,,,	1.2	2.0	2.5	2.3	2.0	1.8	1.5
FF 0							55.3
55.0	118.7	100.2	84.9	77.8	70.9	63.6	
	1.2	2.0	2.6	2.3	2.1	1.9	1.7
60.0	119.7	101.3	86.3	79.5	73.1	66.1	59.2
	1.2	2.0	2.6	2.4	2.2	2.0	1.8
65.0	120.8	102.5	87.7	81.1	75.2	68.1	62.3
	1.2	2.1	2.6	2.4	2.3	2.0	1.9
70.0	121.9	103.6	89.0	82.5	76.9	70.5	64.9
	1.2	2.1	2.7	2.5	2.3	2.1	2.0
75.0	122.9	104.6	90.3	83.9	78.5	72.2	66.9
, , , ,	1.2	2.1	2.7	2.5	2.4	2.2	2.0
90.0					79.9	74.0	68.3
80.0	123.9	105.6	91.4	85.2			
	1.2	2.1	2.7	2.6	2.4	2.2	2.1
85.0	124.9	106.6	92.6	86.4	81.4	75.8	70.2
	1.3	2.1	2.8	2.6	2.4	2.3	2.1
90.0	125.9	107.6	93.7	87.5	82.7	77.2	72.3
	1.3	2.2	2.8	2.6	2.5	2.3	2.2
95.0	126.9	108.6	94.7	88.7	83.6	78.6	73.8
	1.3	2.2	2.8	2.7	2.5	2.4	2.2
100.0	127.9	109.6	95.8	89.8	85.0	79.8	74.6
100.0	1.3	2.2	2.9	2.7	2.6	2.4	2.2

Appendix B. Part 1. Dynamic Viscosity of Water and Steam—Continued

$P \setminus T$	475	500	550	600	650	700	750	800
0.1	27.51	28.52	30.53	32.55	34.6	36.6	38.6	40.5
	0.55	0.86	0.92	0.98	1.0	1.1	1.2	1.2
0.5	27.57	28.64	30.67	32.77	34.7	36.7	38.5	40.3
	0.55	0.86	0.92	0.98	1.0	1.1	1.2	1.2
1.0	27.58	28.65	30.68	32.79	34.8	36.8	38.5	40.4
	0.55	0.86	0.92	0.98	1.0	1.1	1.2	1.2
2.5	27.59	28.66	30.72	32.84	34.8	36.8	38.6	40.4
	0.55	0.86	0.92	0.99	1.0	1.1	1.2	1.2
5.0	27.66	28.73	30.82	32.77	34.9	36.9	38.7	40.6
	0.55	0.86	0.92	0.98	1.1	1.1	1.2	1.2
7.5	27.76	28.81	30.94	32.87	34.9	37.0	38.8	40.7
-	0.56	0.86	0.93	-0.99-	1.1	1.1	1.2	1.2
10.0	27.82	28.95	31.08	33.02	35.1	37.2	39.0	40.9
10.0	0.56	0.87	0.93	0.99	1.1	1.1	1.2	1.2
12.5	27.98	29.09	31.19	33.2	35.2	37.4	39.2	41.1
12.5	0.56	0.87	0.94	1.0	1.1	1.1	1.2	1.2
15.0	28.18	29.30	31.44	33.4	35.5	37.6	39.4	41.2
15.0	0.56	0.88	0.94	1.0	1.1	1.1	1.2	1.2
17.5	28.42	29.49	31.70	33.7	35.7	37.8	39.6	
17.5	0.57	0.88	0.95	1.0	1.1	1.1	1.2	41.4
20.0	28.76	29.81	31.98	33.9	35.9	38.0	39.8	1.2 41.6
20.0	0.58	0.89	0.96	1.0	1.1	1.1	1.2	1.3
22.5	29.17	30.17	32.38	34.2	36.2	38.2	39.8	
22.3	0.58	0.91	0.97	1.0	1.1	1.2	1.2	41.9
25.0	29.70	30.56	32.73	34.6	36.5			1.3
23.0			0.98			38.5	40.2	41.9
27.5	0.59	0.92		1.0	1.1	1.2	1.2	1.3
27.5	30.33	31.08	33.11	34.9	36.8	38.7	40.4	42.2
20.0	0.61	0.93	0.99	1.1	1.1	1.2	1.2	1.3
30.0	31.06	31.68	33.6	35.3	37.2	39.0	40.7	42.5
25.0	0.62	0.95	1.0	1.1	1.1	1.2	L.2	1.3
35.0	33.17	33.10	34.6	36.1	37.9	39.8	41.3	43.0
40.0	0.66	0.99	1.0	1.1	1.1	1.2	1.2	1.3
40.0	36.06	35.2	35.7	37.5	38.8	40.4	42.0	43.7
45.0	0.72	1.1	1.1	1.1	1.2	1.2	1.3	1.3
45.0	39.90	37.6	37.4	38.6	40.0	41.2	43.1	44.4
	0.80	1.1	1.1	1.2	1.2	1.2	1.3	1.3
50.0	44.0	40.5	39.1	40.0	40.6	42.2	43.7	45.3
	1.3	1.2	1.2	1.2	1.2	1.3	1.3	1.4
55.0	48.4	43.9	41.0	41.4	41.8	42.5	44.6	45.9
	1.5	1.3	1.2	1.2	1.3	1.3	1.3	1.4
60.0	52.3	47.6	43.1	41.7	42.9	43.2	44.8	46.6
	1.6	1.4	1.3	1.3	1.3	1.3	1.3	1.4
65.0	55.5	50.8	45.1	43.2	43.9	44.2	45.4	46.8
	1.7	1.5	1.4	1.3	1.3	1.3	1.4	1.4
70.0	58.8	53.7	47.5	44.8	44.3	44.4	46.2	47.4
	1.8	1.6	1.4	1.3	1.3	1.3	1.4	1.4
75.0	61.3	56.2	49.7	45.7	45.5	45.6	46.8	48.1
	1.8	1.7	1.5	1.4	1.4	1.4	1.4	1.4
80.0	63.6	58.7	52.1	47.4	47.0	46.6	47.3	48.6
	1.9	1.8	1.6	1.4	1.4	1.4	1.4	1.5
85.0	65.5	60.8	54.0	49.9	47.6	47.6	48.1	49.0
	2.0	1.8	1.6	1.5	1.4	1.4	1.4	1.5
90.0	67.3	62.8	55.8	51.4	48.9	49.1	48.9	49.7
,	2.0	1.9	1.7	1.5	1.5	1.5	1.5	1.5
95.0	69.1	64.6	57.7	53.6	50.9	49.5	49.8	50.3
- 3.0	2.1	1.9	1.7	1.6	1.5	1.5	1.5	1.5
100.0	69.8	66.1	59.3	55.1	52.1	50.5	51.1	51.0
	47.0	00.1	27.3	1.7	1.6	20.2	J1.1 .	21.0

Appendix C

Part 2. Recommended Interpolating Equation

The values appearing in Appendix D may be reproduced within the stated tolerances by the use of the formula given below, wherein

 μ denotes the dynamic viscosity

 ρ denotes density (For preference and to reproduce the values given in Appendix D, the density should be computed with the aid of the Provisional IAPS Formulation 1982 for the Thermodynamic Properties of Ordinary Water Substance for Scientific and General Use. If another density formulation is used, a relative departure of $\Delta\rho/\rho$ induces at most a relative departure $\pm \Delta\mu/\mu = 2.5 \Delta\rho/\rho$ in viscosity.)

T denotes absolute temperature on the 1968 Practical Temperature Scale

 T^* and ρ^* denote numerical constants which are close to, but do not represent the corresponding critical constants

 a_k and b_{ii} are numerical constants.

$$\mu = \mu_0 \exp\left[\frac{\rho}{\rho^*} \sum_{i=0}^{5} \sum_{j=0}^{4} b_{ij} \left(\frac{T^*}{T} - 1\right)^i \left(\frac{\rho}{\rho^*} - 1\right)^j\right],\tag{1}$$

where

$$\frac{\mu_0}{\mu \text{Pa s}} = \left(\frac{T}{T^*}\right)^{1/2} \left[\sum_{k=0}^3 a_k \left(\frac{T^*}{T}\right)^k\right]^{-1}.$$
 (2)

The constants appearing in the preceding equations have the

numerical values given below and in Table a for b_{ii} :

$$T^* = 647.27 \text{ K}$$

$$\rho^* = 317.763 \text{ kg/m}^3$$

$$a_0 = 0.018 158 3$$

$$a_1 = 0.017 762 4$$

$$a_2 = 0.010 528 7$$

$$a_3 = -0.003 674 4$$

$$(3)$$

$$(4)$$

The correlating equation presented in this Appendix is valid in the range

$$0 < T < 800 \,^{\circ}\text{C}$$

in temperature, and

$$0 < \rho < 1050 \text{ kg/m}^3$$

in density, which corresponds to an approximate pressure range

$$0 < P < 100 \text{ MPa}$$
.

Its domain of validity can be extended to

$$P = 1000$$
 MPa in the range 0 °C < $T < 100$ °C,

$$P = 350 \text{ MPa}$$
 in the range $100 \,^{\circ}\text{C} < T < 560 \,^{\circ}\text{C}$.

The equation adopted in this Appendix is not the only possible interpolation formula. An alternative form was given in the paper, "Correlation of Viscosity for Water and Steam," by A. Nagashima, M. Ikeda, and I. Tanishita, Proc. Eighth ICPS, Giens, France, 1974.

TABLE a. Numerical values of the coefficients b_{ij}

i =	0	1	2	3	4	5
j = 0	0.501 938	0.162 888	- 0.130 356	0.907 919	- 0.551 119	0.146 543
1	0.235 622	0.789 383	0.673 665	1.207 552	0.067 066 5	- 0.084 337 0
2	- 0.274 637	- 0.743 539	- 0.959 456	- 0.687 343	- 0.497 089	0.195 286
3	0.145 831	0.263 129	0.347 247	0.213 486	0.100 754	-0.032932
4	- 0.027 044 8	- 0.025 309 3	0.026 775 8	- 0.082 290 4	0.060 225 3	- 0.020 259 5

Appendix D

Viscosity of Compressed Water and Superheated Steam

Viscosity in μ Pa s ($\equiv 10^{-6}$ kg/m s) Pressure P in MPa Temperature T in °C. Smoothed values obtained with the aid of Eqs. (1) and (2) of Appendix C together with the constants listed therein, and density values based on the Provisional IAPS Formulation 1982 for the Thermodynamic Properties of Ordinary Water Substance for Scientific and General Use.

Note: The tabular entries contain more significant digits than is justified by the tolerances listed in the Table in Appendix B to assist in programming.

Appendix D--Continued

Dynamic viscosity of water and steam calculated with density values from
the Provisional IAPS Formulation 1982 for the Thermodynamic Properties of
Ordinary Water Substance for Scientific and General Use

						ጥክ	MPERATUR	E, °C				
٠		0	25	50	75	100	150	200	250	300	350	375
	.1	1792	890.8	547.1	378.4	12.28	14.19	16,18	18.22	20.29	22.37	23.4
	.5	1791.	890.7	547.1	378.5	282.4	182.0	16.07	18.15	20.25	22.35	23.39
	1.0	1790.	890.6	547.2	378.6	282.6	182.1	15.93	18.07	20.20	22.32	23.37
	2.5 5.0	1786.	890.3 889.8	547.5 547.9	379.0 379.6	283.0 283.6	182.5 183.2	133.9 134.5	17.83	20.06	22.24	23.32
	7.5	1775.	889.3	548.3	380.2	284.3	183.8	135.1	106.1 106.8	19.86	22.16 22.13	23.27 23.28
	10.0	1769.	888.9	548.7	380.9	284.9	184.4	135.7	107.5	86.42	7 22.18	23.3
	12.5	1764.	888.5	549.1	381.5	285.6	185.1	136.3	108.2	87.40	22.39	23.5
αŝ	15.0	1759.	888.1	549.5	382.1	286.3	185.7	136.9	108.8	88.32	22.91	23.84
MPa	17.5 20.0	1754. 1749.	887.7 887.4	550.0 550.4	382.7 383.4	286.9 287.6	186.3 186.9	137.5 138.1	109.5 110.1	89.21 90.06	66.85 69.21	24.45
	22.5	1744.	887.1	550.9	384.0	288.2	187.6	138.7	110.7	90.88	71.10	47.65
யி	25.0	1739.	884.8	551.3	384.6	288.9	188.2	139.3	111.4	91.67	72.71	58.08
떩	27.5	1735.	886.6	551.8	385.2	289.5	188.8	139.9	112.0	92.43	74.14	61.8
SS	30.0 35.0	1731.	886.4 886.0	552.3 553.3	385.9 387.2	290.2 291.5	189.4 190.6	140.5 141.6	112.6 113.8	93.18 94.61	75.43 77.71	64.49
PRESSURE,	40.0	1714.	885.8	554.3	388.4	292.8	191.8	142.8	114.9	95.98	79.71	71.2
죠.	45.0	1707.	885.6	555.3	389.7	294.2	193.1	143.9	116.1	97.29	81.52	73.61
	50.0	1700.	885.5	556+4	391.0	295.5	194.3	145.0	117.2	98.55	83.19	75.70
	55.0 60.0	1694.	885.6 885.7	557.5 558.6	392.3 393.6	296.8 298.1	195.5 196.7	146.1 147.2	118.3	99.76 100.9	84.73 86.19	77.57
	65.0	1682.	885.9	559.7	395.0	299.4	197.9	148.3	120.4	102.1	87.57	80.85
	70.0	1676.	886.2	560.9	396.3	300.8	199.0	149.3	121.5	103.2	88.88	82.3
	75.0	1672.	886.6	562.1	397.6	302.1	200.2	150.4	122.5	104.3	90.14	83.73
	80.0 85.0	1667.	887.1 887.7	563.3 564.5	399.0 400.3	303.4 304.7	201.4	151.5 152.5	123.5 124.5	105.4	91.35	85.05
	90.0	1659.	888.3	565.8	401.7	304.7	203.8	153.6	125.5	106.4 107.4	92.52 93.65	86.32
	95.0	1656.	889.1	567.1	403.1	307.4	204.9	154.6	126.5	108.4	94.75	88.71
	100.0	1653.	889.9	568.4	404.4	308.7	206.1	155.7	127.5	109.4	95.82	87.84
`		•			11	RATURE,	5					
		400	425	450	475	500	550	600	650	700	750	800
	.1	24,45	25.49	26.52	27.55	28.57	30.61	32.61	34.60	36.55	38.48	40.37
	.5	24.45 24.44	25.49 25.48	26.52 26.52	27.55 27.55	28.57 28.58	30.61	32.61 32.63	34.60 34.61	36.55 36.57	38.48 38.50	40.37
	.5 1.0	24.45 24.44 24.42	25.49 25.48 25.47	26.52 26.52 26.51	27.55 27.55 27.55	28.57 28.58 28.58	30.61 30.61 30.63	32.61 32.63 32.64	34.60 34.61 34.63	36.55 36.57 36.59	38.48 38.50 38.52	40.37 40.39 40.42
	.5 1.0 2.5 5.0	24.45 24.44 24.42 24.39 24.38	25.49 25.48 25.47 25.46 25.47	26.52 26.52 26.51 26.52 26.55	27.55 27.55 27.55 27.55 27.57 27.61	28.57 28.58 28.58 28.61 28.67	30.61 30.61 30.63 30.67 30.76	32.61 32.63 32.64 32.70 32.81	34.60 34.61 34.63 34.70 34.82	36.55 36.57 36.59 36.66 36.79	38.48 38.50 38.52 38.59 38.73	40.37 40.39 40.42 40.50 40.63
	.5 1.0 2.5 5.0 7.5	24.45 24.44 24.42 24.39 24.38 24.40	25.49 25.48 25.47 25.46 25.47 25.52	26.52 26.52 26.51 26.52 26.55 26.61	27.55 27.55 27.55 27.55 27.57 27.61 27.70	28.57 28.58 28.58 28.61 28.67 28.77	30.61 30.61 30.63 30.67 30.76 30.87	32.61 32.63 32.64 32.70 32.81 32.93	34.60 34.61 34.63 34.70 34.82 34.95	36.55 36.57 36.59 36.66 36.79 36.93	38.48 38.50 38.52 38.59 38.73 38.88	40.37 40.39 40.42 40.50 40.63 40.78
	.5 1.0 2.5 5.0 7.5 10.0	24.45 24.44 24.42 24.39 24.38 24.40 24.49	25.49 25.48 25.47 25.46 25.47 25.52 25.62	26.52 26.52 26.51 26.52 26.55 26.61 26.72	27.55 27.55 27.55 27.55 27.57 27.61 27.70 27.82	28.57 28.58 28.58 28.61 28.67 28.77 28.90	30.61 30.61 30.63 30.67 30.76 30.87 31.01	32.61 32.63 32.64 32.70 32.81 32.93 33.08	34.60 34.61 34.63 34.70 34.82 34.95 35.11	36.55 36.57 36.59 36.66 36.79 36.93 37.09	38.48 38.50 38.52 38.59 38.73 38.88 39.04	40.37 40.39 40.42 40.50 40.63 40.78 40.94
	.5 1.0 2.5 5.0 7.5 10.0 12.5	24.45 24.44 24.42 24.39 24.38 24.40 24.49 24.65	25.49 25.48 25.47 25.46 25.47 25.52 25.62 25.77	26.52 26.52 26.51 26.52 26.55 26.61 26.72 26.88	27.55 27.55 27.55 27.55 27.57 27.61 27.70 27.82 27.98	28.57 28.58 28.58 28.61 28.67 28.77 28.90 29.06	30.61 30.61 30.63 30.67 30.76 30.87 31.01 31.18	32.61 32.63 32.64 32.70 32.81 32.93 33.08 33.26	34.60 34.61 34.63 34.70 34.82 34.95 35.11 35.28	36.55 36.57 36.59 36.66 36.79 36.93 37.09 37.27	38.48 38.50 38.52 38.59 38.73 38.88 39.04 39.21	40.37 40.39 40.42 40.50 40.63 40.78 40.94 41.11
P _E	.5 1.0 2.5 5.0 7.5 10.0 12.5 15.0	24.45 24.44 24.42 24.39 24.38 24.40 24.49 24.65 24.65	25.49 25.48 25.47 25.46 25.47 25.52 25.62 25.72 26.01 26.34	26.52 26.51 26.52 26.55 26.61 26.72 26.88 27.10 27.39	27.55 27.55 27.55 27.57 27.61 27.70 27.82 27.98 28.19 28.46	28.57 28.58 28.58 28.61 28.67 28.77 28.90 29.06 29.27 29.52	30.61 30.61 30.63 30.67 30.76 30.87 31.01 31.18 31.38 31.62	32.61 32.63 32.64 32.70 32.81 32.93 33.08 33.26 33.45 33.68	34.60 34.61 34.63 34.70 34.82 34.95 35.11 35.28 35.48 35.69	36.55 36.57 36.59 36.66 36.79 36.93 37.09 37.27 37.46	38.48 38.50 38.52 38.59 38.73 38.88 39.04 39.21 39.39 39.59	40.37 40.39 40.42 40.50 40.63 40.78 40.94 41.11 41.29 41.48
МРа	.5 1.0 2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0	24.45 24.44 24.42 24.39 24.38 24.40 24.49 24.65 24.91 25.32 25.96	25.49 25.48 25.47 25.46 25.47 25.52 25.62 25.77 26.01 26.34 26.80	26.52 26.52 26.51 26.52 26.55 26.61 26.72 26.88 27.10 27.39 27.77	27.55 27.55 27.55 27.55 27.57 27.61 27.70 27.82 27.98 28.19 28.46 28.79	28.57 28.58 28.58 28.61 28.67 28.77 28.90 29.06 29.27 29.52 29.82	30.61 30.61 30.63 30.67 30.76 30.87 31.01 31.18 31.38 31.62 31.89	32.61 32.63 32.64 32.70 32.81 32.93 33.08 33.26 33.45 33.45 33.45 33.92	34.60 34.61 34.63 34.70 34.82 34.95 35.11 35.28 35.48 35.69 35.92	36.55 36.57 36.59 36.66 36.79 36.93 37.09 37.27 37.46 3/.66 37.88	38.48 38.50 38.52 38.59 38.73 38.88 39.04 39.21 39.39 39.39 39.59 39.80	40.37 40.39 40.42 40.50 40.63 40.78 40.94 41.11 41.29 41.48 41.68
Æ	.5 1.0 2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5	24,45 24,44 24,42 24,39 24,40 24,49 24,65 24,91 25,32 25,96	25.49 25.48 25.47 25.46 25.47 25.52 25.62 25.77 26.01 26.34 26.80 27.44	26.52 26.52 26.51 26.52 26.55 26.61 26.72 26.88 27.10 27.39 27.77 28.26	27.55 27.55 27.55 27.55 27.57 27.61 27.70 27.82 27.98 28.19 28.46 28.79 29.20	28.57 28.58 28.58 28.61 28.67 28.77 28.90 29.06 29.27 29.52 29.82 30.18	30.61 30.61 30.63 30.67 30.76 30.87 31.18 31.38 31.62 31.89 32.19	32.61 32.63 32.64 32.70 32.81 32.93 33.08 33.26 33.45 33.68 33.68 33.92 34.20	34.60 34.61 34.63 34.70 34.82 35.11 35.28 35.48 35.69 35.69 35.69	36.55 36.57 36.59 36.66 36.79 36.93 37.09 37.27 37.46 37.66 37.88 38.12	38.48 38.50 38.52 38.59 38.73 38.88 39.04 39.21 39.39 39.59 39.59 40.03	40.37 40.39 40.42 40.50 40.63 40.78 40.94 41.11 41.29 41.48 41.68 41.89
Æ	.5 1.0 2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5 25.0	24.45 24.44 24.42 24.39 24.38 24.40 24.45 24.65 24.65 24.61 25.32 25.96 27.03	25.49 25.48 25.47 25.46 25.52 25.52 25.62 25.77 26.01 26.34 26.80 27.44 28.36 29.70	26.52 26.52 26.51 26.52 26.55 26.61 26.72 26.88 27.10 27.39 27.77 28.26 28.90	27.55 27.55 27.55 27.55 27.57 27.61 27.70 27.82 27.98 28.19 28.46 28.79 29.20 29.70	28.57 28.58 28.58 28.61 28.67 28.77 28.90 29.06 29.27 29.52 29.82 30.18 30.61	30.61 30.63 30.63 30.67 30.76 30.87 31.01 31.18 31.38 31.62 31.89 32.19 32.19	32.61 32.63 32.64 32.70 32.81 32.93 33.08 33.26 33.45 33.68 33.68 33.68 33.69 33.69 33.65	34.60 34.61 34.63 34.70 34.82 34.95 35.11 35.28 35.48 35.69 35.92 36.18 36.45	36.55 36.57 36.59 36.66 36.79 36.93 37.09 37.27 37.46 37.88 38.12 38.38	38.48 38.50 38.52 38.52 38.73 38.88 39.04 39.21 39.39 39.59 39.80 40.03 40.26	40.37 40.39 40.42 40.50 40.63 40.78 40.94 41.11 41.29 41.48 41.68
Æ	.5 1.0 2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5 25.0 27.5 30.0	24.45 24.44 24.42 24.39 24.49 24.49 24.45 24.91 25.32 25.96 27.03 29.00 33.73 43.83	25.49 25.48 25.47 25.46 25.52 25.52 25.62 25.77 26.01 26.34 26.80 27.44 28.36 29.70	26.52 26.52 26.51 26.55 26.61 26.72 26.88 27.10 27.37 27.37 28.26 28.90 29.71	27.55 27.55 27.55 27.55 27.57 27.61 27.70 27.82 27.98 28.19 28.46 28.79 29.20 29.70 30.32 31.06	28.57 28.58 28.58 28.61 28.67 28.77 28.90 29.06 29.27 29.52 29.82 30.61 31.12 31.71	30.61 30.61 30.63 30.67 30.67 30.87 31.01 31.18 31.38 31.62 31.89 32.19 32.54 33.37	32.61 32.63 32.64 32.70 32.81 32.93 33.08 33.26 33.45 33.68 33.92 34.20 34.50 34.84	34.60 34.61 34.63 34.70 34.82 34.95 35.11 35.28 35.48 35.69 35.69 36.45 36.75	36.55 36.57 36.57 36.66 36.79 36.93 37.09 37.27 37.46 3/.66 37.88 38.12 38.38 38.64	38.48 38.50 38.52 38.59 38.73 38.88 39.04 39.21 39.39 39.59 40.03 40.03 40.26 40.51	40.37 40.39 40.42 40.50 40.63 40.74 41.11 41.29 41.48 41.68 41.89 42.15 42.59
Æ	.5 1.0 2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5 25.0 27.5 30.0	24.45 24.44 24.42 24.39 24.39 24.40 24.65 24.91 25.96 27.03 29.00 33.73 43.83 55.78	25.49 25.48 25.47 25.46 25.47 25.52 25.62 25.77 26.01 26.34 26.80 27.44 28.36 29.70 31.73	26.52 26.52 26.51 26.52 26.55 26.61 26.72 26.88 27.10 27.39 27.77 28.26 28.90 29.71 30.78 33.97	27.55 27.55 27.55 27.57 27.61 27.70 27.82 27.98 28.19 28.46 28.79 29.20 29.70 30.32 31.06	28.57 28.58 28.58 28.61 28.67 28.77 28.90 29.06 29.27 29.52 29.82 30.18 30.61 31.71 33.19	30.61 30.61 30.63 30.67 30.76 30.87 31.01 31.18 31.62 31.89 32.19 32.54 32.93 32.93	32.61 32.63 32.64 32.70 32.81 32.93 33.08 33.45 33.45 33.45 33.45 33.45 33.45 33.45 33.45 33.45 33.45 33.52 34.20 34.50 34.84 35.20 36.02	34.60 34.61 34.63 34.70 34.82 35.11 35.28 35.48 35.69 35.92 36.45 36.75 37.77	36.55 36.57 36.59 36.66 36.79 37.27 37.27 37.46 37.88 38.12 38.38 38.64 38.93	38.48 38.50 38.52 38.59 38.73 38.88 39.04 39.21 39.39 39.59 39.59 40.03 40.03 40.26 40.51 40.77 41.33	40.37 40.39 40.42 40.50 40.63 40.78 40.94 41.11 41.48 41.48 41.48 41.48 42.51 42.35 43.10
PRESSURE, MP ₂	.5 1.0 2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5 25.0 27.5 30.0 35.0	24.45 24.44 24.42 24.39 24.49 24.65 24.65 25.96 27.03 29.00 33.73 43.83 55.78	25.49 25.48 25.47 25.46 25.52 25.62 25.77 26.01 26.34 26.80 27.44 28.36 27.44 28.36 39.35 48.69	26.52 26.52 26.51 26.52 26.55 26.61 26.72 26.88 27.10 27.37 28.26 28.90 29.71 30.78 33.97 39.05	27.55 27.55 27.55 27.57 27.61 27.70 27.82 27.98 28.19 28.46 28.19 28.49 29.20 29.70 30.32 31.06 33.06 35.92	28.57 28.58 28.58 28.61 28.67 28.70 29.06 29.07 29.52 29.27 29.52 30.18 30.61 31.71 33.71 35.16	30.61 30.63 30.67 30.76 30.87 31.01 31.18 31.38 31.62 31.89 32.19 32.54 32.54 32.54 32.54 33.37	32.61 32.63 32.64 32.70 32.81 32.93 33.08 33.26 33.45 33.68 33.68 33.68 33.68 33.68 33.68 33.68 33.68 33.68 33.68 33.68 33.68 33.68 33.68 33.68 33.68	34.60 34.61 34.63 34.70 34.82 34.95 35.11 35.13 35.13 35.92 36.45 36.45 37.07 37.07 38.56	36.55 36.57 36.59 36.66 36.79 37.09 37.27 37.46 37.66 37.68 38.12 38.38 38.93 39.55	38.48 38.50 38.52 38.52 38.73 38.89 39.04 39.21 39.39 39.59 40.03 40.03 40.26 40.51 40.77 41.33	40.37 40.39 40.42 40.50 40.63 40.78 40.94 41.11 41.29 41.48
Æ	.5 1.0 2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5 25.0 27.5 36.0 40.0	24.45 24.44 24.49 24.39 24.49 24.49 24.65 24.91 25.32 27.03 27.03 33.73 43.83 55.78 61.29	25,49 25,48 25,47 25,46 25,47 25,52 25,77 26,01 26,01 26,80 27,44 28,36 29,70 31,70 39,35 48,69	24,52 26,52 26,52 26,55 26,65 26,67 26,72 26,80 27,39 27,73 27,73 28,90 29,71 33,97 39,07 39,07	27.55 27.55 27.55 27.57 27.61 27.70 27.82 27.82 27.98 28.19 28.79 29.20 29.70 30.32 33.06 33.06 33.71	28.57 28.58 28.61 28.61 28.67 28.70 29.06 29.06 29.27 27.52 29.82 30.61 31.12 33.19 35.68	30.61 30.61 30.63 30.67 30.76 30.87 31.01 31.18 31.62 31.89 32.19 32.54 32.93 32.93	32.61 32.63 32.64 32.70 32.81 32.93 33.08 33.26 33.45 33.45 33.45 34.50 34.50 34.50 34.50 34.50 34.50 34.50	34.60 34.61 34.63 34.70 34.82 35.11 35.28 35.49 35.49 35.49 35.72 36.18 36.75 36.75 37.77 38.56	36.55 36.57 36.57 36.66 36.79 37.09 37.27 37.46 37.88 38.12 38.38 38.64 39.55 40.24	38.48 38.50 38.59 38.59 38.73 38.88 39.04 39.21 39.39 40.03 40.03 40.26 40.57 41.33 41.94	40.37 40.39 40.42 40.50 40.78 40.78 41.11 41.29 41.48 41.68 41.89 42.11 42.35 43.10 43.40
Æ	.5 1.0 2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5 25.0 27.5 30.0 35.0 45.0 55.0	24.45 24.44 24.42 24.39 24.40 24.45 24.91 25.32 25.96 27.03 33.73 43.83 55.78 61.29 67.69 70.30	25.49 25.48 25.46 25.47 25.52 25.62 25.62 25.77 26.01 26.80 27.48 28.36 29.70 31.73 39.35 48.60 29.70 55.07	26.52 26.52 26.51 26.52 26.55 26.61 26.78 27.10 27.37 27.77 28.76 29.71 30.78 33.75 45.22 50.71	27.55 27.55 27.55 27.57 27.67 27.70 27.88 28.19 28.19 29.70 30.32 31.04 33.06 33.06 33.97 34.44.08	28.57 28.58 28.58 28.61 28.67 28.77 28.90 29.27 29.06 29.27 29.82 30.61 31.71 33.19 35.16 40.70 44.02	30.61 30.63 30.63 30.67 30.87 31.18 31.38 31.62 31.89 32.54 32.93 33.37 34.40 35.65 37.15 38.88 40.88	32.61 32.63 32.64 32.70 32.81 32.81 33.26 33.45 33.45 33.68 33.92 34.50	34.60 34.61 34.61 34.70 34.82 35.11 35.28 35.48 35.69 35.48 36.75 37.07 37.77 37.77 37.77 40.41	36.55 36.57 36.57 36.64 36.79 36.79 37.07 37.27 37.46 37.88 38.138 38.64 38.138 39.55 40.24 40.78	38.48 38.50 38.52 38.59 38.73 38.88 39.04 39.24 39.39 39.39 40.02 40.02 40.07 41.33 41.94 42.60 43.30	40.37 40.37 40.49 40.50 40.63 40.78 40.78 41.11 41.48 41.48 41.48 42.59 43.10 42.59 43.40 44.43 44.85
Æ	.5 1.0 2.5 5.0 7.5 10.0 12.5 15.0 22.5 22.5 25.0 27.5 30.0 40.0 45.0 55.0 60.0	24.45 24.44 24.42 24.39 24.48 24.49 24.45 24.91 25.32 27.03 27.03 33.73 43.83 61.29 65.00 67.89 70.30 72.40	25.49 25.48 25.46 25.47 25.52 25.62 25.77 26.01 26.80 27.44 28.36 29.70 31.73 48.69 55.07 59.44 62.76	26.52 26.52 26.51 26.52 26.61 26.61 26.72 26.88 27.10 27.37 28.20 29.71 30.78 33.97 39.05 45.25 50.71	27.55 27.55 27.55 27.55 27.57 27.60 27.82 28.19 28.19 28.47 29.20 29.70 30.32 31.06 33.92 44.08 44.08	28.57 28.58 28.58 28.61 28.67 28.70 29.00 29.27 29.58 30.61 31.12 31.71 35.14 37.48 40.70 44.02 47.37	30.61 30.61 30.63 30.67 30.87 31.01 31.38 31.38 31.89 32.19 32.54 32.93 33.37 35.65 38.88 40.84 42.96	32.61 32.63 32.64 32.70 32.81 32.93 33.92 33.45 33.45 33.92 34.20 34.50 34.84 35.20 36.02 36.98 38.07 39.30 40.45	34.60 34.61 34.63 34.70 34.82 35.11 35.28 35.48 35.68 35.92 36.18 36.75 37.77 38.56 40.41 41.45	36.55 36.57 36.59 36.66 36.79 37.07 37.07 37.46 37.88 38.13 38.38 38.64 38.95 40.24 40.78 40.78	38.48 38.50 38.52 38.59 38.73 38.78 39.04 39.39 39.39 40.03 40.03 40.26 40.51 40.71 40.73 41.73 41.74 42.60 43.30 44.81	40.37 40.39 40.42 40.50 40.63 40.74 41.11 41.29 41.23 41.48 41.89 42.11 42.35 43.10 43.65 44.85 44.85 45.17
Æ	.5 1.0 2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5 25.0 27.5 30.0 35.0 40.0 45.0 55.0 60.0 60.0	24.45 24.44 24.49 24.39 24.40 24.49 24.65 24.91 25.96 27.03 27.03 33.73 43.83 55.78 61.29 67.89 70.30 72.40 74.28	25.49 25.48 25.47 25.46 25.47 25.52 25.62 25.62 25.72 26.01 26.34 28.36 27.44 28.36 39.35 48.69 55.04 65.46 65.76 65.76	26.52 26.52 26.51 26.51 26.52 26.56 26.69 27.10 27.37 28.26 28.70 29.71 30.78 33.97 45.22 50.51 50.51 50.51	27.55 27.55 27.55 27.57 27.61 27.82 27.82 28.19 28.46 28.79 29.20 29.70 30.32 31.06 33.92 34.06 35.92	28.57 28.58 28.58 28.61 28.67 28.77 28.90 29.02 29.27 29.32 30.18 30.61 31.12 31.71 33.19 35.16 40.70 44.02 47.37 50.33	30.61 30.61 30.63 30.67 30.76 31.01 31.18 31.62 31.62 31.89 32.19 32.54 32.54 32.93 33.37 35.65 37.15 38.88 40.84 42.96	32.61 32.63 32.64 32.70 32.81 32.93 33.08 33.45 33.69 33.45 33.69 34.20 34.50 34.50 34.80 36.98 38.07 39.30 40.65 42.12 43.67	34.60 34.61 34.63 34.70 34.95 35.11 35.28 35.48 35.48 36.75 36.75 36.75 36.75 37.77 37.77 37.77 40.41	36.55 36.57 36.57 36.66 36.79 36.79 37.07 37.27 37.46 37.88 38.38 38.38 38.55 40.54 40.98 41.79 42.65 43.57	38.48 38.50 38.52 38.59 38.73 38.78 39.04 39.21 39.39 40.03 40.03 40.51 40.77 41.73 41.74 42.60 43.30 44.03 44.03 44.03 44.03	40.37 40.39 40.42 40.50 40.63 40.78 41.11 29 41.48 41.89 42.35 42.59 43.10 43.40 44.85 45.50 46.17
Æ	.5 1.0 2.5 5.0 7.5 10.0 12.5 15.0 22.5 22.5 25.0 27.5 30.0 40.0 45.0 55.0 60.0	24.45 24.44 24.42 24.39 24.38 24.40 24.45 24.91 25.36 27.03 29.00 33.73 43.83 55.78 61.29 65.00 67.89 70.30 72.40 74.28 75.97	25.49 25.48 25.47 25.46 25.52 25.62 25.62 25.62 26.80 27.44 26.80 27.43 26.80 27.70 31.73 31.73 37.35 48.69 55.07 59.44 62.76 63.46 67.79	26.52 26.52 26.51 26.52 26.61 26.78 26.78 27.10 27.77 28.20 29.71 30.78 30.78 30.78 30.78 30.78 30.79	27.55 27.55 27.55 27.57 27.60 27.82 27.98 28.19 28.69 29.70 30.32 33.06 33.06 33.97 44.08 48.36 58.16 58.16	28.57 28.58 28.58 28.61 28.67 28.70 29.00 29.27 29.58 30.61 31.12 31.71 35.14 37.48 40.70 44.02 47.37	30.61 30.63 30.63 30.67 30.7 30.87 31.01 31.38 31.69 32.19 32.59 32.59 32.59 32.59 32.59 32.59 32.59 32.59 32.74 32.93	32.61 32.63 32.64 32.70 32.81 32.93 33.92 33.45 33.45 33.92 34.20 34.50 34.84 35.20 36.02 36.98 38.07 39.30 40.45	34.60 34.61 34.63 34.70 34.82 35.11 35.28 35.48 35.69 36.15 36.75 37.77 38.56 37.07 37.77 38.56 40.41 41.45 41.45 42.57 43.79	36.55 36.57 36.59 36.66 36.79 37.07 37.07 37.46 37.88 38.13 38.38 38.64 38.95 40.24 40.78 40.78	38.48 38.50 38.52 38.59 38.73 38.78 39.04 39.39 39.39 40.03 40.03 40.26 40.51 40.71 40.73 41.73 41.74 42.60 43.30 44.81	40.37 40.39 40.42 40.50 40.63 40.78 41.11 129 41.48 41.89 42.35 42.59 42.59 43.65 44.24 45.50 46.17 47.58
Æ	.5 1.0 2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 27.5 30.0 35.0 40.0 45.0 55.0 60.0 60.0 75.0	24.45 24.44 24.42 24.39 24.48 24.40 24.49 24.65 24.91 25.32 25.96 27.03 33.73 43.83 55.78 61.29 67.89 70.30 72.40 74.28 75.99 77.57 79.07	25.49 25.49 25.47 25.46 25.47 25.52 25.62 25.67 26.80 27.44 28.36 29.70 31.73 39.35 48.69 55.07 59.44 62.76 65.46 67.76 67.79 71.61	26.52 26.52 26.51 26.51 26.52 26.61 26.72 26.72 26.77 27.77 28.70 29.71 30.78 33.97 39.05 50.71 55.06 58.52 61.37 65.91	27.55 27.55 27.57 27.57 27.57 27.67 27.70 27.82 28.19 28.79 29.70 30.33.06 33.06 33.06 33.71 44.08 46.36 52.16 53.16 60.57	28.57 28.58 28.61 28.61 28.67 28.77 28.90 29.00 29.27 27.52 29.82 30.61 31.12 31.19 33.19 37.68 40.70 44.70 47.37 53.38 55.93	30.61 30.63 30.63 30.67 30.87 31.08 31.38 31.38 31.62 31.89 32.54 32.54 32.54 32.54 32.54 32.54 32.71 34.40 35.71 35.88 42.96 47.41 47.60	32.61 32.63 32.64 32.70 32.81 32.93 33.26 33.45 33.45 33.45 33.45 33.45 34.50	34.60 34.61 34.63 34.70 34.82 35.18 35.28 35.28 35.48 35.92 36.18 36.75 37.77 37.77 38.56 40.41 40.41 40.41 41.45 42.57 43.75 44.98 46.24 47.52	36.55 36.57 36.57 36.64 36.79 36.79 37.07 37.07 37.46 37.88 38.38 38.38 38.38 38.94 38.95 40.24 40.78 41.79 42.65 43.57 44.55 45.51 46.55	38.48 38.50 38.52 38.59 38.73 38.88 39.04 39.39 39.39 39.39 40.02 40.51 40.26 40.51 40.27 41.33 41.94 42.60 43.30 44.81 45.61 46.44 47.29 48.15	40.37 40.37 40.42 40.50 40.63 40.91 41.12 41.29 41.48 41.89 43.42 42.11 42.35 42.11 42.35 42.11 42.59 43.10 43.62 44.85 46.17 46.87 47.58 48.31 49.94
Æ	.5 1.0 2.5 5.0 7.5 10.0 12.5 15.0 22.5 22.5 25.0 27.5 30.0 40.0 45.0 55.0 60.0 60.0 70.0 75.0 85.0	24.45 24.44 24.42 24.39 24.48 24.49 24.45 24.91 25.96 27.03 27.03 27.00 33.73 43.83 55.78 61.29 65.00 74.28 75.99 70.30 72.40 74.28 75.99 70.30 72.40 74.28 75.99	25.49 25.48 25.46 25.47 25.52 25.62 25.62 25.77 26.01 26.34 29.70 31.73 48.69 55.07 55.44 62.76 67.79 71.61 73.28	26.52 26.52 26.51 26.52 26.61 26.61 26.77 26.88 27.10 27.37 28.20 29.71 30.78 33.97 39.05 45.25 61.30 63.79 65.91 67.81	27.55 27.55 27.55 27.57 27.60 27.82 27.98 28.19 28.49 29.20 29.70 30.32 31.06 33.92 41.08 48.36 52.16 53.10 56.59 62.79	28.57 28.58 28.68 28.61 28.67 28.70 29.00 29.02 29.27 29.52 30.61 31.12 31.71 35.16 37.68 40.70 44.03 55.93 56.21	30.61 30.61 30.63 30.67 30.87 31.01 31.38 31.62 31.18 32.54 32.93 33.37 32.55 32.57 32.57 32.57 32.57 33.47 32.57 33.47 35.65 37.15 38.88 40.84 42.94 47.41 49.60 51.70	32.61 32.63 32.64 32.70 32.81 32.93 33.92 33.45 33.45 33.92 34.20 34.50 34.50 34.50 34.50 34.50 34.50 34.50 34.50 34.50 36.02 36.98 38.07 39.30 40.65	34.60 34.61 34.63 34.70 34.85 35.18 35.28 35.18 35.92 36.18 36.75 37.77 38.56 40.41 41.45 74.75 44.98 46.24 47.52	36.55 36.57 36.59 36.66 36.79 37.07 37.07 37.46 37.88 38.13 38.38 38.64 38.95 40.24 40.24 41.79 42.65 40.24 41.79 42.65 40.24 41.79 42.65 40.24 41.79 42.65 40.24 41.79 42.65 40.24 41.79 42.65 40.24 41.79 42.65 40.24 41.79 42.65 40.25	38.48 38.50 38.52 38.59 38.73 38.78 39.04 39.39 39.39 40.03 40.03 40.51 40.71 40.71 40.73 41.74 42.60 43.30 44.03 44.03 44.03 44.03 44.03 44.03 44.03 44.03 44.03 44.03 44.03 44.03 44.03 44.03 47.09 48.15 46.44 47.29 48.15	40.37 40.39 40.42 40.50 40.63 40.78 41.12 41.12 41.18 41.18 42.13 42.19 42.13 42.19 42.14 43.65 44.85 44.85 44.85 48.87 44.87 44.87 44.87 44.87 44.87 44.87 44.87 47.58 48.31 49.78
₩	.5 1.0 2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 27.5 30.0 35.0 40.0 45.0 55.0 60.0 60.0 75.0	24.45 24.44 24.42 24.39 24.48 24.40 24.49 24.65 24.91 25.32 25.96 27.03 33.73 43.83 55.78 61.29 67.89 70.30 72.40 74.28 75.99 77.57 79.07	25.49 25.49 25.47 25.46 25.47 25.52 25.62 25.67 26.80 27.44 28.36 29.70 31.73 39.35 48.69 55.07 59.44 62.76 65.46 67.76 67.79 71.61	26.52 26.52 26.51 26.51 26.52 26.61 26.72 26.72 26.77 27.77 28.70 29.71 30.78 33.97 39.05 50.71 55.06 58.52 61.37 65.91	27.55 27.55 27.57 27.57 27.57 27.67 27.70 27.82 28.19 28.79 29.70 30.33.06 33.06 33.06 33.71 44.08 46.36 52.16 53.16 60.57	28.57 28.58 28.61 28.61 28.67 28.77 28.90 29.00 29.27 27.52 29.82 30.61 31.12 31.19 33.19 37.68 40.70 44.70 47.37 53.38 55.93	30.61 30.63 30.63 30.67 30.87 31.08 31.38 31.38 31.62 31.89 32.54 32.54 32.54 32.54 32.54 32.54 32.71 34.40 35.71 35.88 42.96 47.41 47.60	32.61 32.63 32.64 32.70 32.81 32.93 33.26 33.45 33.45 33.45 33.45 33.45 34.50	34.60 34.61 34.63 34.70 34.82 35.18 35.28 35.28 35.48 35.92 36.18 36.75 37.77 37.77 38.56 40.41 40.41 40.41 41.45 42.57 43.75 44.98 46.24 47.52	36.55 36.57 36.57 36.64 36.79 36.79 37.07 37.07 37.46 37.88 38.38 38.38 38.38 38.94 38.95 40.24 40.78 41.79 42.65 43.57 44.55 45.51 46.55	38.48 38.50 38.52 38.59 38.73 38.88 39.04 39.39 39.39 39.39 40.02 40.51 40.26 40.51 40.27 41.33 41.94 42.60 43.30 44.81 45.61 46.44 47.29 48.15	40.37 40.37 40.42 40.50 40.63 40.91 41.12 41.29 41.48 41.89 43.42 42.11 42.35 42.11 42.35 42.11 42.59 43.10 43.62 44.85 46.17 46.87 47.58 48.31 49.94

Appendix E Special Committee Membership		Prof. A. A. Tarzimanov Prof. B. Vodar Prof. J. V. Sengers	(USSR) (France) (USA)			
Dr. A. A. Aleksandrov	(USSR)	Mr. J. Yata	(Japan)			
Dr. P. Bury	(France)		, - ,			
Prof. J. Kestin (Chairman)	(USA)					
Prof. T. Minamiyama	(Japan)	Annandiy II				
Prof. A. Nagashima	(Japan)	Appendix II				
Dr. M. Reimann	(FRG)	Tables of densities calcula	ted from the Provisional			
Mr. K. Scheffler	(FRG)	IAPS Formulation 1982 for the T	Thermodynamic Properties			
Dr. J. Straub	(FRG)	of Ordinary Water Substance for	Scientific and General Use.			

Table IIA. Densities calculated from the Provisional IAPS Formulation 1982 for the Thermodynamic Properties of Ordinary Water Substance for Scientific and General Use at a uniform grid of pressures and temperatures. (Density in kg/m³)

						TEMPERA	TURE, °C					
		0	25	50	75	100	150	200	250	300	350	375
	.1	999.83	997.06	988.03	974.86	.5896	.5164	.4604	.4156	.3790	.3483	.3348
	•5	1000.0	997.24	988.20	975.04	958.58	917.07	2.3537	2.1083	1.9137	1.7540	1.6842
	1.0	1000.3	997.47	9B8.42	975.26	958.81	917.36	4.8566	4.2984	3.8771	3.5402	3.3948
	2.5	1001.0	998.14	989.08	975.93	959.52	918.21	865.47	11.497	10.113	9.1117	8.6979
	5.0	1002.3	999.26 1000.4	990.16	977 • 03	960.68	919.61	867.35	800.27	22.073	19.255	18.203
	7.5 10.0	1004.8	1000.4	991.23 992.31	978.13 979.22	961.83 962.98	921.00	869.21	803.13	37.433	30.846	28.766
	12.5	1006.1	1002.6	993.37	980.30	964.12	922.38 923.74	871.03 872.83	805.90 808.60	715.58 720.89	44.611 62.031	40.763 54.803
	15.0	1007.3	1003.7	994.43	981.37	965.25	925.08	874.60	811.22	725.87	87.191	71.998
	17.5	1008.5	1004.8	995.48	982.44	966.37	926.42	876.34	813.78	730.57	583.32	94.750
rd .	20.0	1009.7	1005.8	996.53	983.50	967.48	927.74	878.06	816.28	735.02	600.78	130.42
M.	22.5	1010.9	1006.9	997.57	984.56	969.58	929.05	879.75	818.73	739.27	614.40	410.38
~_	25.0	1012.1	1008.0	998.60	985.61	769.68	_93 0+34	881,42	821-11	743.32	625.74	505.21
ъ	27.5	1013.3	1009.1	999.63	986.65	970.77	931.63	883.07	823.45	747.20	635.56	537.04
PRESSURE	30.0	1014.5	1010.1 1012.2	1000.7	987.68	971.86	932.90	B84.70	825.73	750.93	644. <u>2</u> 7 659.30	558.25
55	35.0 40.0	1016.9	1014.3	1002.7 1004.7	989.74 991.77	974.00 976.12	935.41 937.88	887.89 891.00	830.17 834.44	757•99 764•58	672.10	587.98 609.56
茁	45.0	1021.5	1016.4	1004.7	993.78	978.21	940.31	894.04	838.56	770.78	683.33	626.80
P.R	50.0	1023.8	1018.4	1008.7	995.77	980.27	942.69	897.02	842.54	776.64	693.39	641.32
_	55.0	1026.1	1020.4	1010.6	997.73	982.32	945.05	899.92	846.39	782.21	702.53	653.95
	60.0	1028.3	1022.4	1012.6	999.68	984.33	947.36	902.77	850.13	787.51	710.93	665.16
	65.0	1030.5	1024.4	1014.5	1001.6	986.33	949.64	905.56	853.76	792.58	718.72	675.30
	70.0	1032.7	1026.4	1016.4	1003.5	788.30	751.87	908.30	837.29	797 • 44	726.00	684.57
	75.0	1034.9	1028.3	1018.2	1005.4	990.25	954.11	910.98	860.73	802.12	732.85	693.13
	80.0	1037.0	1030.3	1020.1	1007.3	992.18	956.29	913.61	864.08	806.62	739.31	701.09
	85.0	1039.1	1032.2 1034.1	1022.0 1023.8	1009.1	994.09	958 - 45	916.20	867.34	810.97	745.45	708.55
	.00				1011.0	995.98	960.58	918.75	870.54	815.18 819.26	751.29 756.86	715.58 722.22
	90.0	1041.2	1074.0		1012 0	007 05						
_	90.0 95.0 100.0	1041.2 1043.3 1045.3	1036.0	1025.6 1027.4	1012.8 1014.6	997.85 999.70 EMPERATUR	962.68 964.75 ————————————————————————————————————	921.25 923.71	873.66 876.71	823.21	762.21	728.54
	95.0	1043.3	1036.0	1025.6	1014.6	999.70	964.75					
	95.0	1043.3	1036.0	1025.6	1014.6	999.70	964.75					
	95.0	400	1036.0 1037.8 425	1025.6 1027.4 450	1014.6 T 475	999.70 EMPERATUR 500	964.75 E, °C 550	600	650	700	750 -2118	800
	95.0 100.0	400 .3223 1.6200	1036.0 1037.8 425	1025.6 1027.4 450 .2999 1.5056	1014.6 T 475	999.70 EMPERATUR 500 -2805 1.4066	964.75 E, °C 550	600 .2483 1,2437	650 .2348 1,1757	700 -2227 1.1149	750 -2118 1.0601	800 -2019 1.0105
	95.0 100.0	400 - 3223 1.6200 3.2617	425 , 3107 1,5606 3,1394	450 .2999 1.5056 3.0263	1014.6 T 475 .2899 1.4544 2.9215	999.70 EMPERATUR 500 -2805 1.4066 2.8241	964.75 E, °C 550 .2634 1.3200 2.6480	600 .2483 1.2437 2.4932	650 .2348 1.1757 2.3558	700 -2227 1.1149 2.2331	750 -2118 1.0601 2.1227	800 -2019 1.0105 2.0228
	95.0 100.0	400 - 3223 1.6200 3.2617 8.3268	425 . 3107 1.5606 3.1394 7.9909	450 .2999 1.5056 3.0263 7.6845	.2899 1.4544 2.9215 7.4034	999.70 EMPERATUR 500 .2805 1.4066 2.8241 7.1442	964.75 E, °C 550 .2634 1.3200 2.6480 6.6808	600 .2483 1.2437 2.4932 6.2776	650 .2348 1.1757 2.3558 5.9227	700 .2227 1.1149 2.2331 5.6075	750 .2118 1.0601 2.1227 5.3253	800 -2019 1.0105 2.0228 5.0710
	95.0 100.0	400 .3223 1.6200 3.2617 8.3268 17.299 27.074	425 , 3107 1,5606 3,1394 7,9909 16,505 25,646	450 .2999 1.5056 3.0263 7.6845 15.798 24,412	.2899 1.4544 2.9215 7.4034 15.163 23.327	979.70 EMPERATUR 500 .2805 1.4066 2.8241 7.1442 14.586 22.359	964.75 E, °C 550 .2634 1.3200 2.6480 6.6808 13.573 20.695	600 .2483 1.2437 2.4932 6.2776 12.709 19.303	650 .2348 1.1757 2.3558 5.9227 11.958 18.112	700 -2227 1.1149 2.2331 5.6075 11.299 17.076	750 -2118 1.0601 2.1227 5.3253 10.713 16.164	800 -2019 1.0105 2.0228 5.0710 10.189 15.353
	75.0 100.0 .1 .5 1.0 2.5 5.0 7.5	400 .3223 1.6200 3.2617 8.3268 17.299 27.074 37.867	425 425 .3107 1.5606 3.1394 7.9909 16.505 25.646 35.547	450 .2999 1.5056 3.0263 7.6845 15.798 24.412 33.611	.2899 1.4544 2.9215 7.4034 15.163 23.327 31.952	979.70 EMPERATUR 500 .2805 1.4066 2.8241 7.1442 14.586 22.359 30.503	964.75 E, °C 550 .2634 1.3200 2.6480 6.6808 13.573 20.695 28.065	923.71 600 .2483 1.2437 2.4932 6.2776 12.709 19.303 26.068	650 .2348 1.1757 2.3558 5.9527 11.958 18.112 24.387	700 -2227 1.1149 2.2331 5.6075 11.299 17.076 22.741	750 -2118 1.0601 2.1227 5.3253 10.713 16.164 21.679	800 -2019 1.0105 2.0228 5.0710 10.189 15.353 20.564
	95.0 100.0 .1 .5 1.0 2.5 7.5 10.0 12.5	400 -3223 1.6200 3.2617 8.3268 17.299 27.074 37.867 49.986	425 425 .3107 1.5606 3.1394 7.9909 16.505 25.646 35.547 46.378	450 .2999 1.5056 3.0263 7.6845 15.798 24.412 33.611 43.498	.2899 1.4544 2.9215 7.4034 15.163 23.327 31.952 41.104	979.70 EMPERATUR 500 .2805 1.4066 2.8241 7.1442 21.4586 22.359 30.503 39.060	964.75 E, °C 550 -2634 1.3200 2.6480 6.6808 13.573 20.695 28.065 35.702	400 .2483 1.2437 2.4932 6.2779 19.303 26.068 33.016	650 .2348 1.1757 2.3558 5.9227 11.958 18.112 24.387 30.789	700 -2227 1.1149 2.2331 5.6075 11.299 17.076 22.941 28.896	750 .2118 1.0601 2.1227 5.3253 10.713 16.164 21.677 27.258	800 -2019 1.0105 2.0228 5.0710 10.189 15.353 20.364 25.821
	75.0 100.0 .1 .5 1.0 2.5 5.0 7.5 10.0 12.5 15.0	400 .3223 1.6200 3.2617 8.3268 17.279 27.074 37.867 49.986 63.889	425 425 , 3107 1, 5606 3, 1394 7, 9909 16, 505 25, 646 35, 547 46, 378 58, 370	450 .2999 1.5056 3.0263 7.6845 15.798 24.412 33.611 43.498 54.200	.2899 1.4544 2.9215 7.4034 15.163 23.327 31.952 41.104 50.859	979.70 EMPERATUR 500 .2805 1.4066 2.8241 7.1442 14.586 22.359 30.503 39.060 48.077	964.75 E, °C 550 .2634 1.3200 2.6480 6.6808 13.573 20.695 28.065 35.702 43.627	600 .2483 1.2437 2.4932 6.2776 12.709 19.303 26.068 33.016 40.154	650 .2348 1.1757 2.3558 5.9227 11.958 18.112 24.387 30.789 37.321	700 .2227 1.1149 2.2331 5.6075 11.299 17.076 22.941 28.896 34.943	750 .2118 1.0601 2.1227 5.3253 10.713 16.164 21.679 27.258 32.903	800 -2019 1.0105 2.0228 5.0710 10.189 15.353 20.564 25.821 31.124
	95.0 100.0 .1 .5 1.0 2.5 5.0 7.5 10.0 12.5 15.0 17.5	400 .3223 1.6200 3.2617 8.3268 17.299 27.074 37.867 49.986 63.889 80.311	425 425 .3107 1.5606 3.1394 7.9909 16.505 25.646 35.547 46.378 58.370 71.837	450 .2999 1.5056 3.0263 7.6845 15.778 24.412 33.611 43.498 54.200 65.877	.2899 1.4544 2.7215 7.4034 15.163 23.327 31.952 41.104 50.859 61.304	979.70 EMPERATUR 500 .2805 1.4066 2.8241 7.1442 14.586 22.359 30.503 39.060 48.077 57.608	964.75 E, °C 550 -2634 1.3200 2.6480 6.6808 13.573 20.695 28.065 35.702 43.627 51.861	923.71 600 .2483 1.2437 2.4932 6.2776 12.709 19.303 26.068 33.016 40.154 47.492	650 .2348 1.1757 2.3558 5.9227 11.958 18.112 24.387 30.789 37.321 43.989	700 -2227 1.1149 2.2331 5.6075 11.299 17.076 22.941 28.896 34.943 41.084	750 -2118 1.0601 2.1227 5.3253 10.713 16.164 21.679 27.258 32.903 38.613	728.54 800 .2019 1.0105 2.0228 5.0710 10.189 15.353 20.564 25.821 31.124 36.474
Pa	95.0 100.0 .1 .5 1.0 2.5 5.0 12.5 15.0 17.5 15.0 17.5 20.0	400 -3223 1.6200 3.2617 8.3268 17.299 27.074 37.867 49.986 63.889 80.311 100.54	425 .3107 1.5606 3.1394 7.9909 16.505 25.646 35.547 46.378 58.370 71.837 87.227	450 .2999 1.5056 3.0263 7.6845 15.798 24.412 33.611 43.498 54.200 65.877 78.732	.2899 1.4544 2.9215 7.4034 15.163 23.327 31.952 41.104 50.859 61.304 72.546	979.70 EMPERATUR 500 .2805 1.4066 2.8241 7.1442 14.586 22.339 30.503 39.060 48.077 57.608 67.711	964.75 E, °C 550 .2634 1.3200 2.6480 6.6808 13.573 20.695 28.065 35.702 43.627 51.861 60.427	923.71 600 .2483 1.2437 2.4932 6.2776 12.709 19.303 26.068 33.016 40.154 47.492 55.039	650 .2348 1.1757 2.3558 5.9227 11.958 18.112 24.387 30.789 37.321 43.989 50.796	700 -2227 1.1149 2.2331 5.6075 11.299 17.076 22.941 28.896 34.943 41.084 47.319	750 .2118 1.0601 2.1227 5.3253 10.713 16.164 21.679 27.258 32.903 38.613 44.390	800 -2019 1.0105 2.0228 5.0710 10.189 15.353 20.564 25.821 31.124 36.474 41.871
МРа	95.0 100.0 .1 .5 1.0 2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5	400 .3223 1.6200 3.2617 8.3268 17.299 27.074 37.867 49.986 63.889 80.311 100.54 127.18	425 425 .3107 1.5606 3.1394 7.9909 16.505 25.646 35.547 46.378 58.370 71.837 87.227	450 .2999 1.5056 3.0263 7.6845 15.798 24.412 33.611 43.498 54.200 65.877 78.732 93.023	.2899 1.4544 2.9215 7.4034 15.163 23.327 31.952 41.104 50.859 61.304 72.546 84.708	979.70 EMPERATUR 500 .2805 1.4066 2.8241 7.1442 14.586 22.359 30.503 39.060 48.077 57.608 67.711 78.452	964.75 E, °C 550 -2634 1.3200 2.6480 6.6808 13.573 20.695 28.065 35.702 43.627 51.861	923.71 600 .2483 1.2437 2.4932 6.2776 12.709 19.303 26.068 33.016 40.154 47.492	650 .2348 1.1757 2.3558 5.9227 11.958 18.112 24.387 30.789 37.321 43.989	700 -2227 1.1149 2.2331 5.6075 11.299 17.076 22.941 28.896 34.943 41.084	750 -2118 1.0601 2.1227 5.3253 10.713 16.164 21.679 27.258 32.903 38.613	800 .2019 1.0105 2.0228 5.0710 10.189 15.353 20.564 25.821 31.124 36.474
M.	95.0 100.0 .1 .5 1.0 2.5 10.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5 25.0	400 .3223 1.6200 3.2617 8.3268 17.299 27.074 37.867 49.986 63.889 80.311 100.54 127.18 166.63	425 425 .3107 1.5606 3.1394 7.9909 16.505 25.646 35.547 46.378 58.370 71.837 87.227 105.21 126.82	450 .2999 1.5056 3.0263 7.6845 15.798 24.412 33.611 43.498 54.200 65.877 78.732 93.023 109.09	.2899 1.4544 2.9215 7.4034 15.163 23.327 31.952 41.104 50.859 61.304 72.546	979.70 EMPERATUR 500 .2805 1.4066 2.8241 7.1442 14.586 22.339 30.503 39.060 48.077 57.608 67.711	964.75 E, °C 550 .2634 1.3200 2.6480 6.6808 13.573 20.695 28.065 35.702 43.627 51.861 60.427 69.345	923.71 600 .2483 1.2437 2.4932 6.2776 12.709 19.303 26.068 33.016 40.154 47.492 55.039 62.803	650 .2348 1.1757 2.3558 5.9227 11.958 18.112 24.387 30.789 37.321 43.989 50.796 57.745	700	750 .2118 1.0601 2.1227 5.3253 10.713 16.164 21.679 27.258 32.903 38.613 4.390 50.233 56.143 62.120	800 .2019 1.0105 2.0228 5.0710 10.189 15.353 20.564 25.821 31.124 36.474 41.871 47.314 52.803 58.338
MP.	95.0 100.0 .1 .5 1.0 2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5	400 .3223 1.6200 3.2617 8.3268 17.299 27.074 37.867 49.986 63.889 80.311 100.54 127.18	425 425 .3107 1.5606 3.1394 7.9909 16.505 25.646 35.547 46.378 58.370 71.837 87.227	450 .2999 1.5056 3.0263 7.6845 15.798 24.412 33.611 43.498 54.200 65.877 78.732 93.023	.2899 1.4544 2.9215 7.4034 15.163 23.327 31.952 41.104 50.859 61.304 72.546 84.708 97.935	979.70 EMPERATUR 500 .2805 1.4066 2.8241 7.1442 14.586 22.359 30.503 39.060 48.077 57.608 67.711 78.452 89.904	964.75 E, °C 550 .2634 1.3200 2.6480 13.573 20.695 28.065 35.702 43.627 51.861 60.427 69.345 78.640 88.333 98.445	600 .2483 1.2437 2.4932 6.2776 12.709 19.303 26.068 33.016 40.154 47.492 55.039 62.803 70.794 79.018 87.481	650 .2348 1.1757 2.3558 5.9227 11.958 18.112 24.387 30.789 30.789 50.796 57.745 64.839 72.081 79.474	700 .2227 1.1149 2.2331 5.6075 11.299 17.076 22.941 28.896 34.943 41.084 47.319 53.651 60.080 66.608 73.234	750 -211B 1.0401 2.1227 5.3253 10.713 16.164 21.679 27.258 32.903 38.613 44.390 50.233 56.143 62.120 68.163	728.54 800 .2019 1.0105 2.0228 5.0710 10.189 15.353 20.564 25.821 31.124 36.474 41.871 47.314 52.803 58.338 63.919
MP.	95.0 100.0 .1 .5 1.0 2.5 10.0 7.5 10.0 17.5 12.5 15.0 22.5 22.5 23.0 27.5 30.0 27.5 30.0 27.5 30.0 27.5	400 .3223 1.6200 3.2617 8.3268 17.299 27.074 37.867 49.986 63.889 80.311 100.54 127.18 166.63 239.22 358.05 474.89	425 .3107 1.5606 3.1394 7.9909 16.505 25.646 35.547 46.378 58.370 71.837 87.227 105.21 126.82 153.74 188.66 291.94	450 .2999 1.5056 3.0263 7.6845 15.798 24.412 33.611 43.498 54.200 65.877 78.732 93.023 109.09 127.38 148.45 201.63	1014.6 -2899 1.4544 2.9215 7.4034 15.163 23.327 31.952 41.104 50.859 61.304 72.546 84.708 97.935 112.40 128.29 165.19	979.70 EMPERATUR 500 .2805 1.4066 2.8241 7.1442 14.586 22.359 30.503 39.060 48.077 57.608 67.711 78.452 89.904 102.15 115.26 144.43	964.75 E, °C 550 -2634 1.3200 2.6480 6.6808 13.573 20.695 28.065 35.702 43.627 51.861 60.427 69.345 78.640 88.333 98.445 120.00	923.71 600 .2483 1.2437 2.4932 6.2776 12.709 19.303 26.068 33.016 40.154 47.492 55.039 62.803 70.794 79.018 87.481 105.15	650 .2348 1.1757 2.3558 5.9227 11.958 18.112 24.387 30.789 37.321 43.989 50.796 57.745 64.839 72.081 79.474 74.710	700 .2227 1.1149 2.2331 5.6075 11.299 17.076 22.941 28.896 34.943 41.084 47.319 53.651 60.080 66.608 73.234 86.779	750 -2118 1.0601 2.1227 5.3253 10.713 16.164 21.679 27.258 32.903 38.613 44.390 50.233 56.143 62.120 68.163 80.446	800 -2019 1.0105 2.0228 5.0710 10.189 15.353 20.564 25.821 31.124 36.474 41.871 47.314 52.803 58.338 63.919 75.214
MP.	75.0 100.0 .1 .5 1.0 2.5 5.0 12.5 10.0 12.5 20.0 22.5 25.0 30.0 35.0 40.0	400 .3223 1.6200 3.2617 8.3268 17.299 27.074 37.867 49.986 63.889 80.311 100.54 127.18 166.63 239.22 358.05 474.89 523.67	425 425 .3107 1.5606 3.1394 7.9909 16.505 25.646 35.547 46.378 58.370 71.837 87.227 105.21 126.82 153.74 188.66 291.94 394.56	450 .2999 1.5056 3.0263 7.6845 15.798 24.412 33.611 43.498 54.200 65.877 78.732 109.09 127.38 148.45 201.63 270.91	.2899 1.4544 2.9215 7.4034 15.163 23.327 31.952 41.104 50.859 61.304 72.546 84.708 97.935 112.40 128.29 165.19 209.98	979.70 EMPERATUR 500 .2805 1.4066 2.8241 7.1442 14.586 22.359 30.503 39.060 48.077 57.608 67.711 78.452 89.904 102.15 115.26 144.43 177.97	964.75 E, °C 550 .2634 1.3200 2.6480 6.6808 13.573 20.695 28.065 35.702 43.627 51.861 60.427 69.345 78.640 88.333 98.445 120.00 143.42	923.71 600 .2483 1.2437 2.4932 6.2776 12.709 19.303 26.068 33.016 40.154 47.492 55.039 62.803 70.794 79.018 87.481 105.15	650 .2348 1.1757 2.3558 5.9227 11.958 18.112 24.387 30.789 37.321 43.989 50.796 57.745 64.839 72.081 79.474 94.710 110.55	700 .2227 1.1149 2.2331 5.6075 11.299 17.076 22.941 28.896 34.943 41.084 47.319 53.651 60.080 64.608 73.234 86.779 100.71	750 .2118 1.0601 2.1227 5.3253 10.713 16.164 21.679 27.258 32.903 38.613 44.390 50.233 56.143 62.120 68.163 80.446 92.985	800 .2019 1.0105 2.0228 5.0710 10.189 15.353 20.564 25.821 31.124 36.474 41.871 47.314 52.803 58.338 63.919 75.214 86.682
M.	95.0 100.0 .1 .5 1.0 2.5 5.0 7.5 10.0 12.5 15.0 22.5 25.0 27.5 30.0 22.5 25.0 27.5 30.0 40.0 40.0 45.0	400 .3223 1.6200 3.2617 8.3268 17.299 27.074 37.867 49.986 63.889 80.311 100.54 127.18 166.63 239.22 358.05 474.89 523.67 554.78	425 -3107 1.5606 3.1394 7.9909 16.505 25.646 35.547 46.378 58.370 71.837 87.227 105.21 126.82 153.74 188.66 291.94 394.56 457.49	450 	.2899 1.4544 2.9215 7.4034 15.163 23.327 31.952 41.104 50.859 61.304 72.546 84.708 897.935 112.40 128.29 165.19 209.98	979.70	964.75 E, °C 550 -2634 1.3200 2.6480 6.6808 13.573 20.695 28.065 35.702 43.627 51.861 60.427 69.345 78.640 88.333 98.445 120.00 143.42 168.69	600 .2483 1.2437 2.4932 6.2776 12.709 19.303 26.068 33.016 40.154 47.492 55.039 62.803 70.794 79.018 87.481 105.15 123.81 143.44	650 .2348 1.1757 2.3558 5.9227 11.958 18.112 24.387 30.789 37.321 43.989 50.796 57.745 64.839 72.081 79.474 94.710 110.55 126.96	700 -2227 1.1149 2.2331 5.6075 11.299 17.076 22.941 28.896 34.943 41.084 47.319 53.651 60.080 66.608 73.234 86.779 100.71 115.01	750 -2118 1.0601 2.1227 5.3253 10.713 16.164 21.679 27.258 32.903 38.613 44.390 50.233 56.143 62.120 68.163 80.446 92.985	728.54 800 .2019 1.0105 2.0228 5.0710 10.189 15.353 20.564 25.821 31.124 36.474 41.871 47.314 47.314 52.803 58.338 63.919 75.214 86.682 98.312
	95.0 100.0 100.0 1.5 1.0 2.5 5.0 12.5 15.0 12.5 15.0 22.5 25.0 22.5 25.0 30.0 40.0 45.0 45.0	400 .3223 1.6200 3.2617 8.3268 17.299 27.074 37.867 49.986 63.889 80.311 100.54 127.18 166.63 239.22 358.05 474.89 523.67 554.78 577.99	425 .3107 1.5606 3.1394 7.9909 14.505 25.646 35.547 46.378 58.370 71.837 87.227 105.21 126.82 133.74 188.66 291.94 394.56 457.49 498.16	450 .2999 1.5056 3.0263 7.6845 15.798 24.412 33.611 43.498 54.200 65.877 78.732 93.023 109.09 127.38 148.45 201.63 270.91 343.37 402.28	.2899 1.4544 2.9215 7.4034 15.163 23.327 31.952 41.104 50.859 61.304 72.546 84.708 897.935 112.40 128.29 128.19 209.98 261.70 315.11	979.70 EMPERATUR 500 .2805 1.4066 2.8241 7.1442 14.586 22.359 30.503 39.060 48.077 57.608 67.711 78.452 89.904 102.15 115.26 144.43 177.97 215.87 255.97	964.75 E, °C 550 .2634 1.320 2.6480 6.6808 13.573 20.695 28.065 35.702 43.627 51.861 60.427 69.345 78.640 88.333 98.445 120.00 143.42 168.67 195.65	923.71 600 .2483 1.2437 2.4932 6.2776 12.709 19.303 26.068 33.016 40.154 47.492 55.039 62.803 70.794 79.018 87.481 105.15 123.81 143.44 163.99	650 .2348 1.1757 2.3558 5.9227 11.958 18.112 24.387 30.789 37.321 43.989 50.796 57.745 64.839 72.081 79.474 94.710 110.55 126.96	700 .2227 1.1149 2.2331 5.6075 11.299 17.076 22.941 28.896 34.943 41.084 47.319 53.651 60.080 66.608 73.234 86.779 100.71 115.01 129.64	750 .2118 1.0601 2.1227 5.3253 10.713 16.164 21.679 27.258 32.903 38.613 44.390 50.233 56.143 62.120 68.163 80.446 92.985 105.77 118.77	800 .2019 1.0105 2.0228 5.0710 10.189 15.353 20.564 25.821 31.124 36.474 41.871 47.314 52.803 58.338 63.919 75.214 86.682 98.312 110.09
MP.	95.0 100.0 .1 .5 1.0 2.5 5.0 7.5 10.0 12.5 15.0 22.5 20.0 27.5 20.0 27.5 20.0 27.5 20.0 40.0 40.0 50.0 50.0 50.0 50.0 50.0 5	400 .3223 1.6200 3.2617 8.3268 17.299 27.074 37.867 49.986 63.889 80.311 100.54 127.18 166.63 239.22 358.05 474.89 523.67 554.78 577.99 596.69	425 425 .3107 1.5606 31.1394 7.9909 16.505 25.646 35.547 46.378 58.370 71.837 87.227 105.21 126.82 153.74 188.66 291.94 394.56 457.49 498.16 527.70	450 .2999 1.5056 3.0263 7.6845 15.798 24.412 33.611 43.498 54.200 65.877 78.732 93.023 109.09 127.38 201.63 20	.2899 1.4544 2.9215 7.4034 15.163 23.327 31.952 41.104 72.546 84.708 97.935 112.40 128.29 165.19 209.98 261.70 315.11 363.76	979.70	964.75 E, °C 550 .2634 1.3200 2.6480 6.6808 13.573 20.695 28.065 35.702 43.627 51.861 60.427 69.345 78.640 88.333 98.445 120.00 143.42 168.69 195.65 223.91	600 .2483 1.2437 2.4932 6.2776 12.709 19.303 26.068 33.016 40.154 47.492 55.039 62.803 70.794 79.018 87.481 105.15 123.81 143.44 163.99 185.30	650 .2348 1.1757 2.3558 5.9227 11.958 18.112 24.367 30.789 37.321 43.989 50.796 57.745 64.839 72.081 79.474 94.710 110.55 126.96 143.91 161.34	700 -2227 1.1149 2.2331 5.6075 11.299 17.076 22.941 28.896 34.943 41.084 47.319 53.651 60.080 66.608 73.234 86.779 100.71 115.01 129.64 144.58	750 -211B 1.0401 2.1227 5.3253 10.713 16.164 21.679 27.258 32.903 38.613 44.390 50.233 56.143 62.120 68.163 80.446 92.985 105.77 118.77 131.97	800 -2019 1.0105 2.0228 5.0710 10.189 15.353 20.564 25.821 31.124 36.474 41.871 47.314 47.314 52.803 58.338 63.919 75.214 86.682 98.312
M.	95.0 100.0 100.0 1.5 1.0 2.5 10.0 7.5 10.0 12.5 15.0 22.5 25.0 27.5 30.0 22.5 30.0 40.0 45.0 55.0 60.0	1043.3 1045.3 1045.3 400 3.2617 8.3268 17.299 27.074 37.867 49.986 63.889 80.311 100.54 127.18 166.63 239.22 358.05 474.89 523.67 554.78 577.99 596.69 612.45	425 .3107 1.5606 3.1394 7.9909 16.505 25.646 35.547 46.378 58.370 71.837 87.227 105.21 126.82 153.74 188.66 291.94 394.56 457.49 498.16 527.70 550.90	450 .2999 1.5056 3.0263 7.6845 15.798 24.412 33.611 43.498 54.200 65.877 78.732 93.023 109.09 127.38 148.45 201.63 270.91 343.37 402.28 446.30 479.87	.2899 1.4544 2.9215 7.4034 15.163 123.327 31.952 41.104 50.859 61.304 72.546 84.708 97.935 112.40 128.29 165.19 209.98 261.70 315.11 363.76 404.79	979.70 EMPERATUR 500 -2805 1.4066 2.8241 7.1442 14.586 22.359 30.503 39.060 48.077 57.608 67.711 78.452 89.904 102.15 115.26 144.43 177.97 215.87 256.95 298.73 338.44	964.75 E, °C 550 -2634 1.3200 2.6480 6.6808 13.573 20.695 28.065 35.702 43.627 51.861 60.427 69.345 78.640 88.333 98.445 120.00 143.42 148.69 195.65 223.91 252.85	923.71 600 .2483 1.2437 2.4932 6.2776 12.709 19.303 26.068 33.016 40.154 47.492 55.039 62.803 70.794 79.018 87.481 105.15 123.81 143.44 143.99 185.30 207.20	650 .2348 1.1757 2.3558 5.9227 11.958 18.112 24.387 30.789 37.321 43.989 50.796 57.745 64.839 72.081 79.474 94.710 110.55 126.96 143.91 161.34 179.14	700 .2227 1.1149 2.2331 5.6075 11.299 17.076 22.941 28.896 34.943 41.084 47.319 53.651 60.080 66.608 73.234 86.779 100.71 115.01 129.64 144.58 159.77	750 .2118 1.0601 2.1227 5.3253 10.713 16.164 21.679 27.258 32.903 38.613 44.390 50.233 56.143 62.120 68.163 80.446 92.985 105.77 118.77	728.54 800 .2019 1.0105 2.0228 5.0710 10.189 15.353 20.564 25.821 31.124 36.474 41.871 47.314 52.803 58.338 63.919 75.214 86.682 98.312 110.09 122.00
MP.	95.0 100.0 100.0 11.5 1.0 2.5 5.0 12.5 15.0 12.5 25.0 22.5 25.0 35.0 45.0 55.0 60.0 60.0 65.0	400 .3223 1.6200 3.2617 8.3268 17.299 27.074 37.867 49.986 63.889 80.311 100.54 127.18 166.63 237.22 358.05 474.89 523.67 554.78 577.99 596.69 612.45 626.15	425 425 .3107 1.5606 3.1394 7.9909 16.505 25.646 35.547 46.378 58.370 71.837 87.227 105.21 126.82 153.74 188.66 291.94 394.56 457.49 498.16 527.70 550.90 570.05	450 .2999 1.5056 3.0263 7.6845 15.798 24.412 33.611 43.498 54.200 65.877 78.732 109.09 127.38 148.45 201.63 270.91 343.37 402.28 446.30 479.87 506.57	.2899 1.4544 2.9215 7.4034 15.163 23.327 31.952 41.104 50.859 61.304 72.546 84.708 97.935 112.40 128.29 165.19 209.98 261.70 315.11 363.76 404.79 438.61	979.70 SOO 2805 1.4066 2.8241 7.1442 14.586 22.359 30.503 39.060 48.077 57.608 67.711 78.452 89.904 102.15 115.26 144.43 177.97 215.87 2256.95 298.73 338.44 374.29	964.75 E, °C 550 .2634 1.3200 2.6480 6.6808 13.573 20.695 28.065 35.702 43.627 51.861 60.427 69.345 78.640 88.333 98.445 120.00 143.42 168.67 195.65 223.91 252.85 281.76	923.71 600 .2483 1.2437 2.4932 6.2776 12.709 19.303 26.068 33.016 40.154 47.492 55.039 62.803 70.794 79.018 87.481 105.15 123.81 143.44 143.99 185.30 207.20 222.43	650 .2348 1.1757 2.3558 5.9227 11.958 18.112 24.367 30.789 37.321 43.989 50.796 57.745 64.839 72.081 79.474 94.710 110.55 126.96 143.91 161.34	700 -2227 1.1149 2.2331 5.6075 11.299 17.076 22.941 28.896 34.943 41.084 47.319 53.651 60.080 66.608 73.234 86.779 100.71 115.01 129.64 144.58	750 -211B 1.0601 2.1227 5.3253 10.713 16.164 21.679 27.25B 32.903 38.613 34.390 50.233 56.143 62.120 68.143 692.985 105.77 118.77 131.97 145.34	728.54 800 .2019 1.0105 2.0228 5.0710 10.189 15.353 20.564 25.821 31.124 36.474 41.871 47.314 52.803 58.338 63.919 75.214 86.682 98.312 110.09 122.00 134.02 146.13 158.30
MP.	95.0 100.0 100.0 1.5 1.0 2.5 10.0 7.5 10.0 12.5 15.0 22.5 25.0 27.5 30.0 22.5 30.0 40.0 45.0 55.0 60.0	1043.3 1045.3 1045.3 400 3.2617 8.3268 17.299 27.074 37.867 49.986 63.889 80.311 100.54 127.18 166.63 239.22 358.05 474.89 523.67 554.78 577.99 596.69 612.45	425 .3107 1.5606 3.1394 7.9909 16.505 25.646 35.547 46.378 58.370 71.837 87.227 105.21 126.82 153.74 188.66 291.94 394.56 457.49 498.16 527.70 550.90	450 .2999 1.5056 3.0263 7.6845 15.798 24.412 33.611 43.498 54.200 65.877 78.732 93.023 109.09 127.38 148.45 201.63 270.91 343.37 402.28 446.30 479.87	.2899 1.4544 2.9215 7.4034 15.163 123.327 31.952 41.104 50.859 61.304 72.546 84.708 97.935 112.40 128.29 165.19 209.98 261.70 315.11 363.76 404.79	979.70 EMPERATUR 500 -2805 1.4066 2.8241 7.1442 14.586 22.359 30.503 39.060 48.077 57.608 67.711 78.452 89.904 102.15 115.26 144.43 177.97 215.87 256.95 298.73 338.44	964.75 E, °C 550 -2634 1.3200 2.6480 6.6808 13.573 20.695 28.065 35.702 43.627 51.861 60.427 69.345 78.640 88.333 98.445 120.00 143.42 148.69 195.65 223.91 252.85	923.71 600 .2483 1.2437 2.4932 6.2776 12.709 19.303 26.068 33.016 40.154 47.492 55.039 62.803 70.794 79.018 87.481 105.15 123.81 143.44 143.99 185.30 207.20	650 .2348 1.1757 2.3558 5.9227 11.958 18.112 24.387 30.789 37.321 43.989 50.796 57.745 64.839 72.081 79.474 74.710 110.55 126.96 143.91 161.34 179.14 197.22 215.44 233.69	700 .2227 1.1149 2.2331 5.6075 11.299 17.076 22.941 28.896 34.943 41.084 47.319 53.651 60.080 66.608 73.234 86.779 100.71 115.01 129.64 144.58 159.77 175.15 190.65 206.20	750 .2118 1.0601 2.1227 5.3253 10.713 16.164 21.679 27.258 32.903 38.613 44.390 50.233 56.143 62.120 68.163 80.446 92.985 105.77 131.97 145.34 158.84 172.43	800 .2019 1.0105 2.0228 5.0710 10.189 15.353 20.564 25.821 31.124 36.474 47.314 52.803 58.338 63.919 75.214 86.482 98.312 110.09 122.00 134.02 146.13 158.30 170.51
M.	95.0 100.0 100.0 1.5 1.0 2.5 15.0 7.5 10.0 12.5 15.0 22.5 25.0 27.5 30.0 40.0 45.0 45.0 45.0 45.0 65.0 66.0 66.0 67.0	400 .3223 1.6200 3.2617 8.3268 17.279 27.074 37.867 49.986 63.889 80.311 100.54 127.18 166.63 239.22 358.05 474.89 523.67 554.78 577.99 612.45 626.15 638.30	425 425 .3107 1.5606 31.1394 7.9909 16.505 25.646 35.547 46.378 58.370 71.837 87.227 105.21 126.82 153.74 188.66 291.94 394.56 457.49 498.16 527.70 550.90 570.05 586.40	450 .2999 1.5056 3.0263 7.6845 15.798 24.412 33.611 43.498 54.200 65.877 78.732 93.023 109.09 127.38 109.09 127.38 201.63 270.91 343.37 402.28 446.30 479.87 504.57 508.62	.2899 1.4544 2.9215 7.4034 15.163 23.327 31.952 41.104 50.859 61.304 72.546 84.708 897.935 112.40 128.29 165.19 209.98 261.70 315.11 363.76 404.79 438.61	979.70	964.75 E, °C 550 .2634 1.3200 2.6480 6.6808 13.573 20.695 28.065 35.702 43.627 51.861 60.427 69.345 78.640 88.333 98.445 120.00 143.42 168.69 195.65 223.91 252.85 261.76 309.91	4000 .2483 1.2437 2.4932 6.2776 12.709 19.303 26.068 33.016 40.154 47.492 55.039 62.803 70.794 79.018 87.481 105.15 123.81 143.44 163.99 143.44 163.99 185.30 207.20 229.43 251.73	650 .2348 1.1757 2.3558 5.9227 11.958 18.112 24.387 30.789 50.796 57.745 64.839 72.081 79.474 94.710 110.55 126.96 143.91 161.34 179.14 179.12 215.44 233.69 251.82	700 .2227 1.1149 2.2331 5.6075 11.299 17.076 22.941 28.896 34.943 41.084 47.319 53.651 60.080 66.608 73.234 86.779 100.71 115.01 129.64 144.58 159.77 175.15 190.65 206.20 221.74	750 .2118 1.0601 2.1227 5.3253 10.713 16.164 21.679 27.258 32.903 38.613 44.390 50.233 56.143 62.120 68.163 80.444 92.985 105.77 118.77 131.97 145.34 158.84 172.43 186.06	800 .2019 1.0105 2.0228 5.0710 10.189 15.353 20.564 25.821 31.124 36.474 41.871 47.314 52.803 58.338 63.919 75.214 86.682 98.312 110.09 122.00 134.02 146.13 158.30 170.51 182.72
MP.	95.0 100.0 100.0 1.5 1.0 2.5 1.0 2.5 10.0 12.5 15.0 27.5 20.0 22.5 25.0 27.5 30.0 40.0 45.0 60.0 65.0 60.0 65.0 80.0 85.0 85.0	400 .3223 1.6200 3.2617 8.3268 17.299 27.074 37.867 49.986 63.889 80.311 100.54 127.18 166.63 239.22 358.05 474.89 523.67 554.78 577.99 596.69 642.45 626.15 638.30 649.26 659.27 668.49	425 425 .3107 1.5606 3.1394 7.9909 16.505 25.646 35.547 46.378 58.370 71.837 87.227 105.21 126.82 153.74 126.82 153.74 498.16 527.70 550.90 570.05 586.40 600.72 613.48	450 .2999 1.5056 3.0263 7.6845 15.798 24.412 33.611 43.498 54.200 65.877 78.732 93.023 109.09 127.38 1201.63 270.91 343.37 402.28 446.30 479.87 504.57 504.57 505.62 547.37 508.62 547.37 508.62 547.37 508.62 547.37 508.62 547.37 563.69 578.15	1014.6 475 -2899 1.4544 2.9215 7.4034 15.163 23.327 31.952 41.104 50.859 61.304 72.546 84.708 97.935 112.40 128.29 145.11 363.76 404.79 438.61 466.67 490.36 510.73 528.55	979.70	964.75 E, °C 550 -2634 1.3200 2.6480 6.6808 13.573 20.695 28.065 35.702 43.627 51.861 60.427 69.345 78.640 88.333 98.445 120.00 143.42 168.69 195.65 223.91 252.85 281.76 309.91 336.73 381.87	923.71 600 .2483 1.2437 2.4932 6.2776 12.709 19.303 26.068 33.016 40.154 47.492 55.039 62.803 70.794 79.018 87.481 105.15 123.81 143.44 163.99 185.30 229.43 2295.45 2316.41	650 .2348 1.1757 2.3558 5.9227 11.958 18.112 24.387 30.789 37.321 43.989 50.796 57.745 64.839 72.081 79.474 94.710 110.55 126.96 143.91 161.34 179.14 197.22 215.44 233.69 251.82 269.72	700 .2227 1.1149 2.2331 5.6075 11.299 17.076 22.941 28.896 34.943 41.084 47.319 53.651 60.080 66.608 73.234 86.779 100.71 115.01 129.64 144.58 159.77 175.15 190.65 206.20 221.74 237.19	750 -2118 1.0601 2.1227 5.3253 10.713 16.164 21.679 27.258 32.903 38.613 44.390 50.233 56.143 62.120 68.163 80.446 92.985 105.77 118.77 131.97 145.34 158.84 172.43 186.06 199.70 213.29	728.54 800 .2019 1.0105 2.0228 5.0710 10.189 15.353 20.564 25.821 31.124 47.314 47.314 47.314 47.314 47.314 52.803 58.338 63.919 75.214 86.482 98.312 110.09 122.00 134.02 146.13 158.30 170.51 182.72 194.90
MP.	95.0 100.0 .1 .5 1.0 2.5 10.0 7.5 112.5 15.0 22.5 25.0 27.5 30.0 40.0 45.0 60.0 65.0 70.0 85.0 85.0 85.0	1043.3 1045.3 1045.3 1.6200 3.2617 8.3268 17.299 27.074 37.867 49.986 63.889 80.311 100.54 127.18 166.63 239.22 358.05 474.89 523.67 554.79 577.99 596.69 612.45 626.15 638.30 649.26 659.27 668.49 677.05	425 .3107 1.5606 3.1394 7.9909 14.505 25.646 35.547 46.378 58.370 71.837 87.227 105.21 126.82 153.74 188.66 291.94 394.56 457.49 498.16 527.70 550.90 570.05 586.40 600.72 613.48 625.01	450 .2999 1.5056 3.0263 7.6845 15.798 24.412 33.611 43.498 54.200 65.877 78.732 93.023 19.09 127.38 148.45 201.63 270.91 343.37 402.28 446.30 479.87 528.62 547.37 563.69 578.15 591.14	1014.6 475 .2899 1.4544 2.9215 7.4034 15.163 23.327 31.952 41.104 50.859 61.304 72.546 84.708 97.935 112.40 128.29 128.29 128.40 128.29 136.61 466.67 490.36 510.73 528.55 544.37	979.70 SOO -2805 1.4066 2.8241 7.1442 14.584 22.359 30.503 39.060 48.077 57.608 67.711 78.452 89.904 102.15 115.26 144.43 177.97 215.87 256.95 298.73 338.44 374.29 405.76 4331.3 456.99 477.95	964.75 E, °C 550 .2634 1.3200 2.6480 6.6808 13.573 20.695 28.065 35.702 43.627 51.861 60.427 69.345 78.640 88.333 98.445 120.00 143.42 1488.67 195.65 223.91 252.85 281.76 309.91 336.73 361.87 3361.87	923.71 600 .2483 1.2437 2.4932 6.2776 12.709 19.303 26.068 33.016 40.154 47.492 55.039 62.803 70.794 79.018 87.481 105.15 123.81 143.44 163.79 185.30 207.20 229.43 251.73 2273.82 295.45 316.41 336.53	650 .2348 1.1757 2.3558 5.9227 11.958 18.112 24.387 30.789 37.321 43.989 50.796 57.745 64.839 72.081 79.474 74.710 110.55 126.96 143.91 161.34 179.14 197.22 215.44 233.69 251.82 269.72 287.29	700 .2227 1.1149 2.2331 5.6075 11.299 17.076 22.941 28.896 34.943 41.084 47.319 53.651 60.080 66.608 73.234 86.779 100.71 115.01 129.64 144.58 159.77 175.15 190.65 206.20 221.74 237.19 252.48	750 .2118 1.0601 2.1227 5.3253 10.713 16.164 21.679 27.258 32.903 38.613 34.390 50.233 56.143 62.120 68.163 80.446 92.985 105.77 131.97 145.34 158.84 172.43 186.06 199.70 213.29 226.80	800 .2019 1.0105 2.0228 5.0710 10.189 15.353 20.564 25.821 31.124 36.474 47.314 52.803 58.338 63.919 75.214 86.682 98.312 110.09 122.00 134.02 146.13 158.30 170.51 182.72 194.90 207.03
MP.	95.0 100.0 100.0 1.5 1.0 2.5 1.0 2.5 10.0 12.5 15.0 27.5 20.0 22.5 25.0 27.5 30.0 40.0 45.0 60.0 65.0 60.0 65.0 80.0 85.0 85.0	400 .3223 1.6200 3.2617 8.3268 17.299 27.074 37.867 49.986 63.889 80.311 100.54 127.18 166.63 239.22 358.05 474.89 523.67 554.78 577.99 596.69 642.45 626.15 638.30 649.26 659.27 668.49	425 425 .3107 1.5606 3.1394 7.9909 16.505 25.646 35.547 46.378 58.370 71.837 87.227 105.21 126.82 153.74 126.82 153.74 498.16 527.70 550.90 570.05 586.40 600.72 613.48	450 .2999 1.5056 3.0263 7.6845 15.798 24.412 33.611 43.498 54.200 65.877 78.732 93.023 109.09 127.38 1201.63 270.91 343.37 402.28 446.30 479.87 504.57 504.57 505.62 547.37 508.62 547.37 508.62 547.37 508.62 547.37 508.62 547.37 563.69 578.15	1014.6 475 -2899 1.4544 2.9215 7.4034 15.163 23.327 31.952 41.104 50.859 61.304 72.546 84.708 97.935 112.40 128.29 145.11 363.76 404.79 438.61 466.67 490.36 510.73 528.55	979.70	964.75 E, °C 550 -2634 1.3200 2.6480 6.6808 13.573 20.695 28.065 35.702 43.627 51.861 60.427 69.345 78.640 88.333 98.445 120.00 143.42 168.69 195.65 223.91 252.85 281.76 309.91 336.73 381.87	923.71 600 .2483 1.2437 2.4932 6.2776 12.709 19.303 26.068 33.016 40.154 47.492 55.039 62.803 70.794 79.018 87.481 105.15 123.81 143.44 163.99 185.30 229.43 2295.45 2316.41	650 .2348 1.1757 2.3558 5.9227 11.958 18.112 24.387 30.789 37.321 43.989 50.796 57.745 64.839 72.081 79.474 94.710 110.55 126.96 143.91 161.34 179.14 197.22 215.44 233.69 251.82 269.72	700 .2227 1.1149 2.2331 5.6075 11.299 17.076 22.941 28.896 34.943 41.084 47.319 53.651 60.080 66.608 73.234 86.779 100.71 115.01 129.64 144.58 159.77 175.15 190.65 206.20 221.74 237.19	750 -2118 1.0601 2.1227 5.3253 10.713 16.164 21.679 27.258 32.903 38.613 44.390 50.233 56.143 62.120 68.163 80.446 92.985 105.77 118.77 131.97 145.34 158.84 172.43 186.06 199.70 213.29	728.54 800 .2019 1.0105 2.0228 5.0710 10.189 15.353 20.564 25.821 31.124 47.314 47.314 47.314 47.314 47.314 52.803 58.338 63.919 75.214 86.482 98.312 110.09 122.00 134.02 146.13 158.30 170.51 182.72 194.90

Table IIB. Densities calculated from the Provisional IAPS Formulation 1982 for the Thermodynamic Properties of Ordinary Water Substance for Scientific and General Use for liquid water (£) and water vapor (g) at saturation

T	P	PL	$^{ m ho}_{ m g}$
°C	MPa	kg/m ³	kg/m ³
•00	.0006113	999.78	.004851
.01	,0006117	999.78	.004855
10,00	.001228	999.69	.009405
20.00	.002339	998.19	.01731
30.00	.004246	995 • 61	.03040
40.00	-007381	992-17	.05121
50.00	.01234	987.99	.08308
60.00	.01993	983.16	.1303
70.00	.03118	977.75	.1982
80.00	.04737	971.79	.2934
90.00	.07012	965.33	.4234
100.00	.1013	958.39	,5975
110.00	.1432	951,00	.8260
120.00	.1985	943.16	1.1208
130.00	.2700	934.88	1.4954
140.00	.3612	926.18	1,9647
150.00	.4757	917.06	2.5454
160.00	.6177	907.50	3.2564
170.00	.7915	897.51	4.1182
180.00	1.002	887.06	5.1539
190.00	1.254	876.15	6.3896
200.00	1.554	864.74	7,8542
210.00	1.906	852+82	9.5807
220.00	2.318	B40.34	11.607
230.00	2.795	827.25	13.976
240.00	3.345	813.52	16.739 19.956
250.00	3.974	799.07 783.83	23,700
260.00	4.689 5.500	767.68	28.061
270.00 280.00	6.413	750.52	33.152
290.00	7.438	732.16	39.119
300.00	8.584	712.41	46,154
310.00	9.861	690.95	54.525
320.00	11.279	667.36	64.615
330.00	12.852	641.00	77.013
340.00	14.594	610.77	92.691
350.00	16.521	574.69	113.48
360.00	18.655	528.10	143.64
370.00	21.030	453 - 15	200.32
371.00	21.283	440.75	210.66
372.00	21.539	425 • 29	223.78
373.00	21.799	402.48	242.76