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BRIX HYDROMETERS – SPECIFICATION

(*Second Revision*)

भारतीय मानक मसौदा

ब्रिक्स हाइड्रोमीटर – विशिष्टि

(दूसरा पुनरीक्षण)

ICS 17.060

Glass, Glassware & Laboratoryware Sectional Committee, CHD 10

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FOREWORD

(Formal Clauses to be added later)

This standard was first published in 1974 for Brix hydrometers which are mainly used by the sugar industry for determining the percentage of total dissolved solid content. However, keeping in view that most of the sugar units were in the practice of using these hydrometers with built-in thermometers and also that International Organization for Standardization (ISO), has published documents on this item, the Sectional Committee responsible for the preparation of this standard, revised it in 1986 in order to help the manufacturers to produce Brix thermo-hydrometers also for sugar industry in rational shapes and sizes in conformity with this standard.

The second revision of this standard is undertaken in view of the technological advancements taken place in the industry. Several editorial changes such as inclusion of ICS No., Hindi Title, Reference Clause, and statuary changes such as the BIS Certification Marking clause as per the BIS Act 2016 have also been incorporated.

Brix hydrometers and thermo-hydrometers prescribed in this standard are based on L50 series of density hydrometers [*see* **IS 3104 (Part 1): 1982** and **IS 3104 (Part 2): 1982**].

In the formulation of this standard due weightage has been given to the available data relating to tables for conversion of degree Brix to relative density (20°/4°C) and corrections on account of thermal expansions of glass, liquid solutions, etc.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 2022 'Rules for rounding off numerical values (second revision)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

BRIX HYDROMETERS – SPECIFICATION
(*Second Revision*)

1 SCOPE

This standard prescribes requirements and methods of sampling and test for Brix hydrometers and Brix thermo-hydrometers meant for use in sugar industry for determining the percentage by mass of sucrose in a pure sucrose solution at 20°C.

2 REFERENCE

The standards listed below contain provisions which through reference in this text, constitute provisions of and necessary adjuncts to this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated.

IS No.	*IS Titles*
1382 : 1981	Glossary of terms relating to glass and glassware (*first revision*)
8787 : 2018	Principles of design, construction and use of liquid-in-glass thermometers (*first revision*)
6274 : 1971	Method of calibrating liquid-in-glass thermometers
3104 (Part 1) : 1982	Specification for density hydrometers: Part 1 Requirements (*first revision*)
5717 : 2003	Laboratory glassware - Pyknometers (*second revision*)
4825 : 1982	Specification for liquid - In - Glass solid - Stem reference thermometers (*first revision*)
9621 : 1980	Principles of construction and adjustment of glass hydrometers

3 TERMINOLOGY

3.1 For the purpose of this standard, the definitions given in IS 1382 in addition to those given below, shall apply.

3.2 Bulb — The wider portion of a hydrometer containing the loading material.

3.3 Stem — The thin tubing attached to the upper part of the bulb containing the indicating scale.

3.4 Degree Brix — The percentage by mass of sucrose in a pure sucrose solution at 20°C.

4 TEMPERATURE OF CALIBRATION AND RANGE OF SCALES

4.1 Temperature of Calibration — The hydrometers and thermo-hydrometers shall be calibrated at 20°C.

4.2 Range of Scales — The hydrometers and thermo-hydrometers in a set shall cover the entire range from 0 to 100° Brix in steps of 10 degrees each hydrometer.

5 SURFACE TENSION

5.1 Brix hydrometers and thermo-hydrometers shall be graduated on the basis of 'high' surface tension category, that is, 75 mN/m.

6 REFERENCE MARK

6.1 A reference mark consisting of a short horizontal straight line with a ‘V' at each end (like) shall be marked on the paper scale a few millimetres above the topmost graduation mark.

6.2 A fine, clear and permanent line of uniform thickness shall be etched on the stem of the hydrometer coincident with the horizontal portions of the reference mark, but slightly longer than the reference mark, so that the ends of the etched line project into the 'V' at either ends of the reference mark. This arrangement ensures that any displacement of the paper scale is readily apparent.

6.2.1 Similarly, a suitable datum line shall be marked for thermometer scale also in thermo-hydrometers.

7 DESIGNATION

7.1 Brix hydrometers and thermo-hydrometers shall be designated by the letter 'B' and the minimum value of the range of scale separated by an oblique stroke. For example, a Brix hydrometer or thermo-hydrometer having a range from 10 to 20° Brix shall be designated as B/10.

8 REQUIREMENTS

8.1 The brix hydrometers and brix thermo-hydrometers shall conform to the design requirements given in IS 9621.

8.2 Materials

8.2.1 *Glass*

The bulb and stem of hydrometers and thermo-hydrometers shall be made of colourless transparent glass, resistant to chemicals and thermal shock encountered in use. It shall be as free as possible from strain and visual defects.

8.2.1.1 The recommended coefficient of cubical thermal expansion of glass used in the manufacture of Brix hydrometers is 25.0×10^{-6} per degree Celsius.

NOTE — The conventional value for the coefficient of cubical thermal expansion of glass used in the manufacture of hydrometers is 25×10^{-6} per °C. In case of a significant departure from this value, the actual coefficient shall be indicated on the hydrometers and thermo-hydrometers so that appropriate correction may be applied to the readings by making reference to Table 4 (*see* **B-4.3.1**).

8.2.2 *Loading Material*

8.2.2.1 The loading material shall be confined to the bottom of the bulb. After the instrument has been maintained in a horizontal position for 1 hour at 80°C and subsequently cooled in that position, it shall meet the requirement of **8.3**.

NOTE — The use of mercury as a loading material is not permitted.

8.2.2.2 There shall be no loose material whatsoever in any other part of the instrument.

8.3 Pattern, Workmanship and Finish

8.3.1 The hydrometers and thermo-hydrometers shall be of a pattern as shown in Fig. 1A and 1B. They shall be circular in cross section, robust and symmetrical around the main axis. They shall float vertically in sucrose solutions of appropriate density at 20°C corresponding to their lowest graduation and the inclination, if any, from the vertical shall not exceed 1.5°.

8.3.2 In thermo-hydrometers, the thermometer scale shall conform to the design requirements given in IS 8787 and those given in Table 1.

TABLE 1 Requirements for Thermometer for a Brix Thermo-Hydrometer
(*Clause* 8.3.2)

SL No.	CHARACTERISTIC	REQUIREMENT
(1)	**(2)**	**(3)**
i)	Range of thermometer	0° to 40°C
ii)	Immersion	Total
iii)	Subdivision	0.5°C
iv)	Scale error at any point	± 0.5°C
v)	Scale length (*Min*)	64 mm
vi)	Extension of scale on either side	4 graduations
vii)	Expansion chamber to withstand temperature rise up to (*Min*)	85°C

NOTE — The bulb of the thermometer should form an integral part of hydrometer.

8.4 Scales

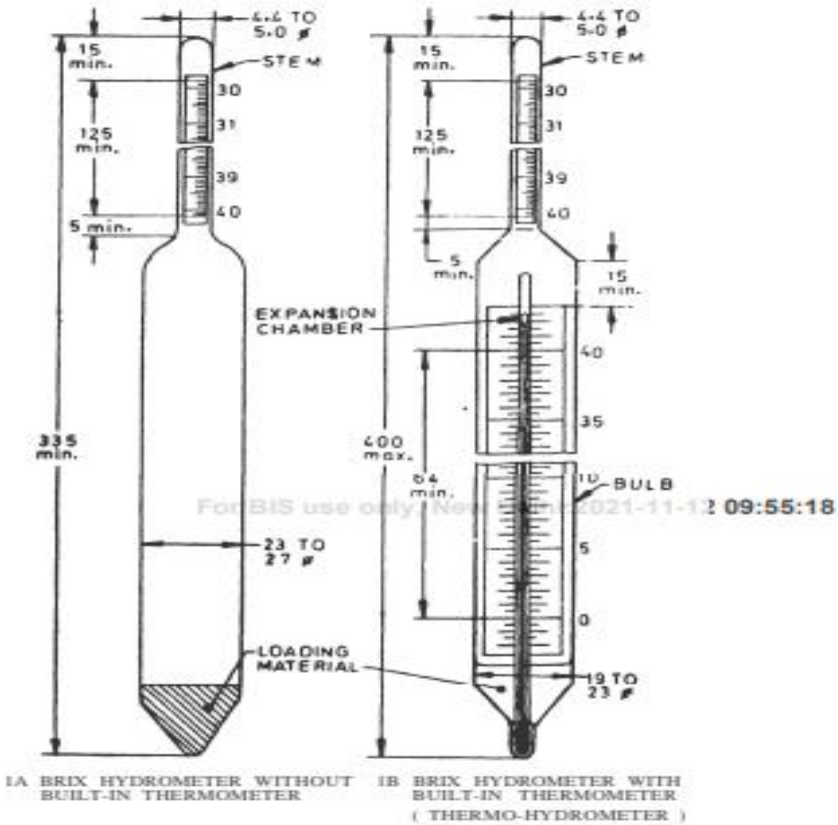
8.4.1 The scales and the inscriptions shall be marked on a smooth matt surface of white or off-white colour. It shall be straight and free from twist. Neither the scales nor the graduations shall distort or discolour when the instrument is maintained at a temperature of 80°C for 24 hours. The hydrometer scale shall be fully enclosed in the hydrometer with all graduation marks clearly visible on the stem.

8.4.2 The graduation lines shall be distinct and of uniform thickness not exceeding 0.2 mm. There shall be no evident local irregularities in their spacing. They shall be perpendicular to the axis of the hydrometer.

8.4.3 The graduations of thermometers when provided shall be in accordance to **9.1** of IS 8787.

8.4.4 The highest and the lowest graduation lines indicating the nominal range of the hydrometer shall be long lines and the distance between them shall be divided into 100 equal parts. Thus the value of the scale interval shall be 0.1° Brix.

8.4.4.1 In addition to the above, two to four extra smallest scale divisions shall be marked on either ends of the scale.



All dimensions in millimeters
FIG. 1 BRIX HYDROMETERS

8.4.5 The length of long lines shall be not less than half the circumference of the stem that of medium lines one-third of the circumference, and of short lines one-fifth of the circumference.

8.4.6 *Sequence of Graduation Lines*

8.4.6.1 Every tenth graduation line shall be a long line. There shall be a medium line between two consecutive long lines and four short lines between consecutive medium and long lines.

8.4.6.2 The sequence of graduation lines in thermometers of thermo-hydrometers shall be in accordance to **9.1.1** of IS 878.

8.4.7 *Figuring of Graduation Lines*

8.4.7.1 The highest and the lowest graduation lines referring to the nominal range of the hydrometer and thermohydrometer shall be figured in full. At least every tenth graduation line shall be figured. Graduation lines within the nominal range and the inscription shall be marked in black. Graduation lines outside the nominal range may be marked in colour other than black.

8.4.7.2 The figuring of thermometers, when provided shall be in accordance with **9.1.2** of IS 8787.

8.5 Dimensions

The dimensions of hydrometers shall be as given in Table 2.

Table 2 Dimensions for Brix Hydrometers
(*Clause* 8.5)

SL NO.	DIMENSIONS	VALUES	
		Hydrometer	Thermo-hydrometer
(1)	**(2)**	**(3)**	**(4)**
i)	Overall length, *Max*	325	400
ii)	Length of scale, *Min*	125	125
iii)	Diameter of the bulb:		
	Min	23	19
	Max	27	23
iv)	Diameter of the stem:		
	Min	4.4	4.4
	Max	5.0	5.0

8.5.1 The cross section of the stem shall remain unchanged for at least 5 mm below the lowest graduation line.

8.5.2 The stem shall extend at least 15 mm above the uppermost graduation line on the scale.

8.5.3 The volume of the bulb below the lowest graduation line shall be between 50 and 65 cm^3.

8.5.4 Recommended stem diameters for the ten ranges of the hydrometers are given in Table 3 for the guidance of manufacturers. These stem diameters are suitable for a volume (below the lowest graduation mark) of 58 cm^3 and provide for a scale length of about 150 mm.

Table 3 Recommended Stem Diameters for Brix Hydrometers
(*Clause* 8.5.4)

SL NO.	RANGE OF HYDROMETERS SCALE	STEM DIAMETER
(1)	**(2)**	**(3)**
	BRIX	mm
i)	0 to 10	4.4
ii)	10 to 20	4.5
iii)	20 to 30	4.6
iv)	30 to 40	4.6
v)	40 to 50	4.7
vi)	50 to 60	4.8
vii)	60 to 70	4.8

viii)	70 to 80	4.9
ix)	80 to 90	4.9
x)	90 to 100	4.9

8.6 Accuracy

8.6.1 The error at any point on the scale of the hydrometer shall not exceed ± 0.1°Brix.

8.6.1.1 The accuracy of the hydrometers shall be tested in accordance with the method prescribed in **Annex A**.

8.6.2 The accuracy of the thermometer scale shall be tested in accordance with the method prescribed in IS 6274.

9 MARKING AND PACKING

9.1 Marking

Brix hydrometers shall be marked legibly and indelibly with the following information:

a) Maker's name or recognized trade-mark, if any;

b) Calibration temperature, that is, '20°C';

c) Reference mark; and

d) Designation.

9.2 BIS Certification Marking

The product(s) conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the *Bureau of Indian Standards Act, 2016* and the Rules and Regulations framed thereunder, and the products may be marked with the Standard Mark.

9.3 Packing

Brix hydrometers or thermo-hydrometers shall be packed as agreed to between the purchaser and the supplier.

10 SAMPLING

10.1 Representative samples shall be drawn and adjudged for conformity to this standard as prescribed in IS 3104 (Part 1).

11 METHOD OF USING BRIX HYDROMETER

11.1 The methods of applying corrections and determining percentage of sucrose in a solution are given in **Annex B**.

ANNEX A

(*Clause* 8.6.1.1**)**

METHOD OF TESTING ACCURACY OF BRIX HYDROMETERS

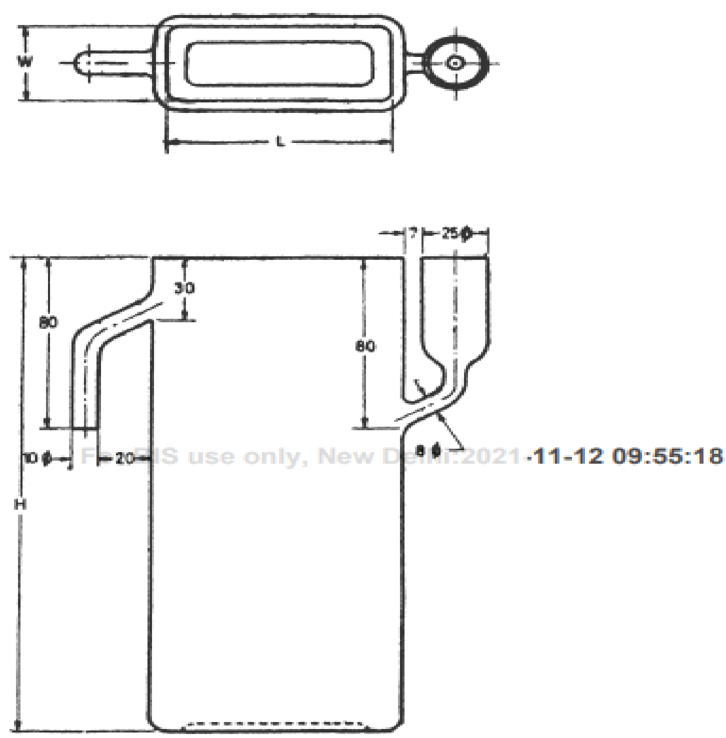
A-1 GENERAL

A-1.1 Accuracy of Brix hydrometers shall be tested by comparison against a similar standardized hydrometer for routine purpose. However, in the case of a dispute this shall be done by verifying the readings of the Brix hydrometer or thermo-hydrometer by determining relative density (20°/4°C) of a liquid with the help of a pyknometer (*see* **IS 5717**) at appropriate temperature, and converting the value so obtained into degrees Brix.

A-1.2 In the case of testing by comparison, sucrose solution of known concentration shall be used. Alternatively, mixtures of organic liquids like xylene and tetrachloroethylene which have low surface tension (of the order of 35 mN/m) may be used with advantage to avoid surface contamination and removal of surface film periodically. In that case suitable correction shall be applied to the readings of each instrument (*see* **A-4.1.2**).

A-2 APPARATUS

A-2.1 A vessel provided with an arrangement for overflowing of liquid in such a way that the surface film is constantly removed shall be used for taking readings of hydrometers. A recommended type of overflow vessel is shown in Fig. 2.



L = 135 ± 5, W = 55 ± 3 and H = 430 ± 5

All dimensions in millimetres.

FIG. 2 OVERFLOW VESSEL

A-2.2 Thermometer — Solid-stem liquid-in-glass type, of a suitable range and capable of reading with an accuracy of ± 0.1 degree Celsius (*see* **IS 4825**).

A-2.3 Pyknometer — 25 ml capacity of Type 4 (*see* **IS 5717**).

A-2.4 Water-Bath — capable of maintaining a temperature of 20°C.

A-3 LIQUIDS

A-3.1 Sucrose Solution — in water, made to cover at least four points on the scale of the hydrometer.

A-3.2 Xylene

A-3.3 Tetrachloroethylene

A-4 PROCEDURE

A-4.1 Comparison Method

A-4.1.1 *Method Using Sucrose Solution* — Pour the sucrose solution into the overflow vessel almost to the brim. Stir well to drive out any air bubbles that might be present in it and fill the vessel up to the brim. Insert the standardized Brix hydrometer along with that under test into the solution and allow them to attain the temperature of the liquid. Note the readings of the two hydrometers.

A-4.1.1.1 Any difference in the reading of the Brix hydrometer under test from that of the standardized hydrometer shall be treated as error at that point (*see* **B-4.2**). Repeat the test to cover at least four points on the scale.

A-4.1.2 *Method Using Xylene and Tetrachloroethylene* — Follow the procedure described in **A-4.1.1** using mixtures of xylene and tetrachloroethylene instead of a solution in sucrose. Note the readings of the two hydrometers and apply correction for departure of surface tension from 75 mN/m as follows:

$$C = \frac{\pi \rho D}{g_n m} \, (\, \sigma - 75 \,) \times 10^{-3}$$

Where,

C = correction in terms of relative density (20°/4°C) (this has to be converted to degree Brix before adding to each observed reading),

P = relative density (20/4°C) equivalent to the observed readings in degree Brix of the hydrometers,

D = diameter in mm of the stem of the hydrometers,

σ = surface tension of the liquid mixture in mN/m,

g_n = acceleration due to gravity in m/s^2 (9.791 387/m/s^2 taken as the standard acceleration due to gravity), and

m = mass in g of the hydrometers.

NOTE — The International value of acceleration due to gravity, g, is 9.806 65 m/s^2.

A-4.1.2.1 Any difference in the corrected readings of the Brix hydrometer under test from that of the standardized hydrometer shall be treated as error at that point. Repeat the test to cover at least four points on the scale.

A-4.2 Pyknometer Method — Weigh a clean dry pyknometer and fill it to a level slightly above the mark on the neck with a solution of sucrose containing a known quantity at 20°C taking care to see that no air gets entrapped in it. Place the pyknometer in the bath for half an hour such that it is immersed in it to a level slightly below the mark. When the pyknometer and its contents have attained the bath temperature, adjust the liquid level such that the meniscus just touches the mark on the neck of the pyknometer. Remove the pyknometer from the bath, wipe with a dry cloth, dry and weigh to determine the mass of the liquid.

A-4.2.1 The true mass of the liquid is calculated by adding to the observed mass of the liquid a correction for the buoyancy effect of the air. This correction is calculated from the following formula:

$$C = p\,(V - m/d)$$

Where,

C = correction factor,

P = density of air at the temperature of experiment,

V = volume in ml of the liquid in the pyknometer at 20°C,

m = observed mass in g of the liquid, and

d = density of the weights at the temperature of experiment.

A-4.2.2 Calculate the relative density (20/4°C) of the liquid by dividing the mass of the liquid obtained as above, by the volume at 20°C and subsequently find out the equivalent value in degrees Brix from Table 6. Any departure from this value in the reading of the Brix hydrometer tables for the same solution at 20°C separately shall be taken as error at corresponding point on the scale.

ANNEX B
(*Clause* 11.1 **)**
METHOD OF USING BRIX HYDROMETERS

B-1 GENERAL

B-1.1 The determination of percentage of sucrose by mass in sucrose solution with a Brix hydrometer involves:

a) reading the hydrometer in the liquid at known temperature; and

b) applying to the observed reading corrections, as necessary, for:

i) scale error of the hydrometer (*see* **A-4.1.1.1**, **A-4.1.2.1** and **A-4.2.2**);

ii) correction due to the departure of coefficient of cubical expansion of glass of hydrometer from 25 × 10-6°C (*see* **Table 4**); and

iii) the difference between the temperature of observation and the standard temperature of calibration of hydrometer (*see* **Table 5**).

B-2 READING OF HYDROMETERS

B-2.1 A convenient method for observing the hydrometer reading in a transparent liquid is to observe the same in a rectangular jar.

B-2.2 The hydrometer and the jar should be clean and dry.

B-3 PROCEDURE

B-3.1 Pour the liquid, whose concentration is to be measured, slowly along the sides of the jar so as not to entrap any air bubble. Allow the liquid in the jar to stand for some time so as to acquire the ambient temperature. If necessary the liquid may be stirred in such a way that no air bubble is formed.

B-3.2 Hold the hydrometer near the tip of the stem and insert it slowly in the liquid till it reaches near the point of balance and then release. The hydrometer will come to rest after a few up and down motions. If the hydrometer has not dripped beyond the point of rest, press the top of the stem slightly so that the hydrometer dips in the liquid a few millimetres beyond the point of test.

B-3.3 Watch the hydrometer when it moves up and down in the liquid. If the stem or the liquid surface is unclean the liquid meniscus formed with the stem will be distorted or dragged with the movement of the hydrometer, otherwise it will remain unchanged with the movement of the hydrometer.

B-3.4 Observe the temperature of the liquid and read the scale at the intersection of liquid surface with the stem of the hydrometer. Note the temperature of the liquid again to ensure that no significant change in temperature of the liquid has taken place during the observation period.

NOTE 1 — The hydrometer should not touch the sides of the vessel when the reading is taken. In reading the hydrometer scale the eye is placed slightly below the plane of the surface of the liquid. It is raised slo wly until the surface, seen as an ellipse, becomes a straight line. The point where this line cuts the hydrom eter scale should be taken as the reading of the hydrometer.

NOTE 2 — In case of viscous liquids allow the hydrometer to settle down to the final position giving ade quate time for this purpose.

B-4 APPLICATION OF CORRECTIONS FOR FINAL READING

B-4.1 General

Corrections are applied to the observed reading of a Brix hydrometer, wherever necessary, as follows.

B-4.2 Corrections for Scale Error

In Case there is any difference between the readings of the hydrometer in use and the readings under the same conditions of a similar hydrometer which is known to be standardized (*see* **A-4.1.1.1**, **A-4.1.2.1** and **A-4.2.2**), the difference so obtained shall be applied for all conditions of use.

B-4.3 Correction for Departure from the Conventional Value of the Coefficient of Cubical Thermal Expansion of Glass of Hydrometer

In case of a departure from the conventional value of the coefficient of cubical thermal expansion of glass used in the manufacture of Brix hydrometer, from 0.000025°C, application to be observed reading of a correction determined as follows, becomes necessary:

$$C = \rho\,(0.000025 - \gamma)\,(t - t_3)$$

Where,

C = correction in terms of relative density 20/4°C (this is to be converted to degree Brix b efore adding to the observed reading at t°(C);

ρ
= relative density 20/4°C equivalent to the observed reading in degree Brix of the hydrom eter;

γ = coefficient of cubical thermal expansion per degree Celcius of glass of the hydrometer:

t = temperature of observation in degree Celsius; and

t_3 = standard temperature of calibration, that is, 20°C.

Example:

Let the reading of hydrometer be 15° Brix.

The corresponding relative density 20/4°C (see Table 6) is 1.05916.

Let the coefficient of thermal cubical expansion of glass of the hydrometer be 0.000 010°C and t_1 the temperature of observation be 30°C.

Then C = 1.05916 (0.000025 – 0.000010) (30 – 20)

= 1.05916 × 0.000015 × 10

= 0.00016 relative density 20/4°C.

Now from Table 6 it can be seen that near 15°Brix for a difference of 0.1° Brix the difference in relative density is 0.00043. Therefore, 0.000 16 relative density corresponds to 0.037°Brix. Hence, the correction to be added is 0.037°Brix.

B-4.3.1 For the purpose of Brix hydrometers, Table 4 gives this correction. This has been calculated, assuming the value of $(t - t_2) = 1$, in the above equation. Therefore, the value has to be multiplied by the actual value of $(t - t_2)$ before adding to the observed reading. The sign (+) or (-) of the correction will accordingly depend on value of $(t - t_2)$.

Table 4 Correction Applicable To The Reading Of Brix Hydrometers On Account Of Departure From The Standard Coefficient Of Cubical Thermal Expansion Of Glass
(*Clauses* 8.2.1.1, B-1.1 and B-4.3.1)

READING OF BRIX HYDROMETER	VALUE OF 0.000025 – γ		
(1)	(2)	(3)	(4)
°Brix	°Brix	°Brix	°Brix
0 to 10	0.0026	0.0038	0.0051
10 to 20	0.0025	0.0037	0.0050
20 to 30	0.0024	0.0036	0.0048
30 to 40	0.0023	0.0035	0.0046
40 to 50	0.0023	0.0034	0.0045
50 to 60	0.0022	0.0033	0.0044
60 to 70	0.0022	0.0032	0.0043
70 to 80	0.0021	0.0032	0.0043
80 to 90	0.0021	0.0032	0.0042
90 to 100	0.0021	0.0032	0.0042

γ = coefficient of cubical thermal expansion of glass of Brix hydrometer.

B-4.4 Correction for Difference of Temperature

In case a Brix hydrometer is used at a temperature other than the temperature of its calibration (20° C), correction for difference of temperature has also to be applied as given in Table 5.

B-4.5 The reading corrected by applying necessary corrections (*see* **B-4.2**, **B-4.3** and **B-4.4**) gives the final reading for the determination of sucrose content, percent by mass, in a solution at 20°C.

Table 5 Corrections for Differences of Temperature (Standard at 20°C)

(*Clause* B-4.4)

OBSERVATIONS TEMPERATURE	OBSERVED PERCENTAGE OF SUGAR													
	0	5	10	15	20	25	30	35	40	45	50	55	60	70
°C	Subtract from Observed Percentage													
0	030	049	065	0.77	0.89	099	108	116	124	131	137	141	144	1-49
5	036	0*47	056	062	073	080	086	091	097	101	1.05	108	110	114
10	032	0’38	043	048	052	057	060	064	067	070	072	074	075	077
11	031	035	040	044	04S	051	055	058	060	063	065	066	068	0’70
12	029	0-32	036	040	043	046	050	052	054	056	0-58	059	060	062
13	026	029	032	035	038	041	044	046	048	049	051	052	053	055
14	024	026	029	031	034	036	038	040	041	042	044	045	046	047
15	020	022	024	026	028	030	032	033	034	036	036	0-37	038	0*39
16	017	018	020	022	023	025	026	027	0*28	028	029	030	031	032
17	013	014	015	016	018	019	020	020	021	021	0’22	023	023	0*24
17.5	011	012	012	014	0-15	0’16	016	017	017	018	018	019	019	020
18	009	010	010	011	012	013	013	0-14	014	014	015	015	015	016
19	005	005	0-05	006	006	0-06	007	007	0’07	007	0-08	008	008	008
	Add to Observed Percentage													
21	0.04	0.05	0.06	0.06	0.06	0.07	0.07	0.07	0.07	0.08	0.08	0.08	0.08	009
22	0.10	0.10	0.11	0.12	0.12	0.13	0.14	0.14	0.15	0.15	0.16	0.16	0.16	016
23	0.16	0.16	0.17	0.17	0.19	0.20	0.21	0.21	0.22	0.23	0.24	.24	0.24	024
24	0.21	0.22	0.23	0.24	0.26	0.27	0.28	0.29	0.30	0.31	0.32	032	0.32	032
25	0.27	0.28	0.30	0.31	0.32	0.34	0.35	0.36	0.38	0.38	0.39	0.39	0.40	0.39
26	0.33	0.34	0.36	0.37	0.40	0.40	0.42	0.44	0.46	0.47	0.47	0.48	0.48	0.48
27	0.40	0.41	0.42	0.44	0.45	0.48	0.50	052	054	0.54	0.55	0.56	0.56	056
28	0.46	0.47	0.49	0.51	0.54	0.56	0.58	0.60	0.61	0.62	0.63	0.64	0.64	0.64
29	0.54	0.55	056	0.59	0.61	0.63	0.66	0.68	0.70	0.70	0.71	0.72	0.72	0.72
30	0.61	0.62	0.63	0.66	0.68	0.71	0.73	0.76	0.78	0.73	0.79	0.80	0.80	0.81
35	0.99	1.01	1.02	1.06	1.10	1.13	1.16	1.18	1.20	1.21	1.22	1.22	1.23	1.22
40	1.42	1.45	1.47	1.51	1.54	1.57	1.60	1.62	1.64	1.65	1.65	1.65	1.66	1.65
45	1.91	1.94	1.96	2.00	2.03	2.05	207	2.09	2.10	2.10	2.10	2.10	2.10	2.08
50	2.46	2.48	2.50	2.53	2.56	2.57	2.58	2.59	2.59	2.58	2.58	2.57	2.56	2.52

55	3.05	3.07	3.09	3.12	3.12	3.12	3.12	3.11	3.10	3.08	3.07	3.05	3.03	2.97
60	3.69	3.72	3.73	3.73	3.72	3.70	3.67	3.65	3.62	3.60	3.57	3.54	3.50	3.43
65	4.4	4.4	4.4	4.4	4.4	4.4	4.3	4.2	4.2	4.1	4.1	4.0	4.0	3.9
70	5.1	5.1	5.1	5.0	5.0	5.0	4.9	4.8	4.8	4.7	4.7	4.6	4.6	4.4
75	6.1	6.0	6.0	5.9	5.8	5.8	5.7	5.6	5.5	5.4	5.4	5.3	5.2	5.0
80	7.1	7.0	7.0	6.9	6.8	6.7	6.6	6.4	6.3	6.2	6.1	60	59	5.9

Table 6 Degrees Brix and Relative Density of Sugar Solution
(*Clauses* **A-4.2.2** and **B-4.2**)

DEGREES BRIX OR PERCENTAGE OF SUCROSE BY WEIGHT	RELATIVE DENSITY AT 20/4°C	DEGREES BRIX OR PERCENTAGE OF SUCROSE BY WEIGHT	RELATIVE DENSITY AT 20/4°C	DEGREES BRIX OR PERCENTAGE OF SUCROSE BY WEIGHT	RELATIVE DENSITY AT 20/4°C	DEGREES BRIX OR PERCENTAGE OF SUCROSE BY WEIGHT	RELATIVE DENSITY AT 20/4°C
(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
0.0	0.99823	25.1	1.10402	50.1	1.23012	75.1	1.37962
0.1	099862	25.2	1.10448	50.2	1.23067	75.2	1.38026
0.2	0.99901	25.3	1.10494	50.3	1.23122	75.3	1.38091
0.3	0.99940	25.4	1.10540	50.4	1.23177	75.4	1.38156
0.4	0.99979	25.5	1.10586	50.5	1.23232	75.5	1.38220
0.5	1.00017	25.6	1.10632	50.6	1.23287	75.6	1.38285
0.6	1.00056	25.7	1.10679	50.7	1.23343	75.7	1.38350
0.7	1.00095	25.8	1.10725	50.8	1.23398	75.8	1.38415
0.8	1.00134	25.9	1.10771	50.9	1.23453	75.9	1.38480
0.9	1.00173	26.0	1.10818	51.0	1.23508	76.0	1.38545
1.0	1.00212	26.1	1.10864	51.1	1.23564	76.1	1.38610
1.1	1.00251	26.2	1.10957	51.2	1.23619	76.2	1.38675
1.2	1.00290	26.3	1.10957	51.3	1.23675	76.3	1.38740
1.3	1.00329	26.4	1.11003	51.4	1.23730	76.4	1.38805
1.4	1.00368	26.5	1.11050	51.5	1.23786	76.5	1.38675
1.5	1.00406	26.6	1.11096	51.6	1.23841	76.6	1.38835
1.6	1.00445	26.7	1.11143	51.7	1.23897	76.7	1.39000
1.7	1.00484	26.8	1.11190	51.8	1.23953	76.8	1.39065
1.8	1.00523	26.9	1.11236	51.9	1.24008	76.9	1.39130
1.9	1.00562	27.0	1.11283	52.0	1.24064	77.0	1.39196
2.0	1.00602	27.1	1.11330	52.1	1.24120	77.1	1.39261
2.1	1.00641	27.2	1.11376	52.2	1.24176	77.2	1.39326
2.2	1.00680	27.3	1.11423	52.3	1.24232	77.3	1.39392
2.3	1.00719	27.4	1.11470	52.4	1.24287	77.4	1.39457
2.4	1.00758	27.5	1.11517	52.5	1.24343	77.5	1.39523
2.5	1.00797	27.6	1.11564	52.6	1.24399	77.6	1.39588
2.6	1.00836	27.7	1.11610	52.7	1.24455	77.7	1.39654
2.7	1.00876	27.8	1.11657	52.8	1.24511	77.8	1.39719
2.8	1.00915	27.9	1.11704	52.9	1.24567	77.9	1.39785

2.9	1.00954	28.0	1.11751	53.0	1.24623	78.0	1.39850
3.0	1.00993	28.1	1.11798	53.1	1.24680	78.1	1.39916
3.1	1.01033	28.2	1.11845	53.2	1.24736	78.2	1.39982
3.2	1.01072	28.3	1.11892	53.3	1.24792	78.3	1.40048
3.3	1.01112	28.4	1.11940	53.4	1.24848	78.4	1.40113
3.4	1.01151	28.5	1.11987	53.5	1.24905	78.5	1.40179
3.5	1.01190	28.6	1.12034	53.6	1.24961	78.6	1.40245
3.6	1.01230	28.7	1.12081	53.7	1.25017	78.7	1.40311
3.7	1.01269	28.8	1.12128	53.8	1.25074	78.8	1.40377
3.8	1.01309	28.9	1.12176	53.9	1.25130	78.9	1.40443
3.9	1.01348	29.0	1.12223	54.0	1.25187	79.0	1.40509
4.0	1.01388	29.1	1.12270	54.1	1.25243	79.1	1.40575
4.1	1.01428	29.2	1.12318	54.2	1.25300	79.2	1.40641
4.2	1.01467	29.3	1.12365	54.3	1.25356	79.3	1.40707
4.3	1.01507	29.4	1.12413	54.4	1.25413	79.4	1.40774
4.4	1.01547	29.5	1.12460	54.5	1.25470	79.5	1.40840
4.5	1.01586	29.6	1.12508	54.6	1.25526	79.6	1.40906
4.6	1.01626	29.7	1.12556	54.7	1.25583	79.7	1.40972
4.7	1.01666	29.8	1.12603	54.8	1.25640	79.8	1.41039
4.8	1.01706	29.9	1.12651	54.9	1.25697	79.9	1.41105
4.9	1.01746	30.0	1.12698	55.0	1.25754	80.0	1.41172
5.0	1.01785	30.1	1.12746	55.1	1.25810	80.1	1.41238
5.1	1.01825	30.2	1.12794	55.2	1.25867	80.2	1.41304
5.2	1.01865	30.3	1.12842	55.3	1.25924	80.3	1.41371
5.3	1.01905	30.4	1.12890	55.4	1.25982	80.4	1.41437
5.4	1.01945	30.5	1.12937	55.5	1.26039	80.5	1.41504
5.5	1.01985	30.6	1.12985	55.6	1.26096	80.6	1.41571
5.6	1.02025	30.7	1.13033	55.7	1.26153	80.7	1.41637
5.7	1.02065	30.8	1.13081	55.8	1.26210	80.8	1.41704
5.8	1.02105	30.9	1.13129	55.9	1.26267	80.9	1.41771
5.9	1.02145	31.0	1.13177	56.0	1.26324	81.0	1.41837
6.0	1.02186	31.1	1.13225	56.1	1.26382	81.1	1.41904
6.1	1.02226	31.2	1.13274	56.2	1.26439	81.2	1.41971
6.2	1.02266	31.3	1.13322	56.3	1.26496	81.3	1.42038
6.3	1.02306	31.4	1.13370	56.4	1.26554	81.4	1.42105
6.4	1.02346	31.5	1.13418	56.5	1.26611	81.5	1.42172
6.5	1.02387	31.6	1.13466	56.6	1.26669	81.6	1.42239
6.6	1.02427	31.7	1.13515	56.7	1.26726	81.7	1.42306
6.7	1.02467	31.8	1.13563	56.8	1.26784	81.8	1.42373
6.8	1.02508	31.9	1.13611	56.9	1.26841	81.9	1.42440
6.9	1.02548	32.0	1.13660	57.0	1.26899	82.0	1.42507
7.0	1.02588	32.1	1.13708	57.1	1.26956	82.1	1.42574
7.1	1.02629	32.2	1.13756	57.2	1.27014	82.2	1.42642
7.2	1.02669	32.3	1.13805	57.3	1.27072	82.3	1.42709
7.3	1.02710	32.4	1.13853	57.4	1.27130	82.4	1.42776
7.4	1.02750	32.5	1.13902	57.5	1.27188	82.5	1.42844
7.5	1.02791	32.6	1.13951	57.6	1.27246	82.6	1.42911
7.6	1.02832	32.7	1.13999	57.7	1.27304	82.7	1.42978
7.7	1.02872	32.8	1.14048	57.8	1.27361	82.8	1.43046
7.8	1.02913	32.9	1.14097	57.9	1.27419	82.9	1.43113

7.9	1.02954	33.0	1.14143	58.0	1.27477	83.0	1.43181
8.0	1.02994	33.1	1.14194	58.1	1.27535	83.1	1.43248
8.1	1.03035	33.2	1.14243	58.2	1.27594	83.2	1.43316
8.2	1.03076	33.3	1.14292	58.3	1.27652	83.3	1.43384
8.3	1.03116	33.4	1.14340	58.4	1.27710	83.4	1.43451
8.4	1.03157	33.5	1.14389	58.5	1.27768	83.5	1.43519
8.5	1.03198	33.6	1.14438	58.6	1.27826	83.6	1.43587
8.6	1.03280	33.7	1.14487	58.7	1.27884	83.7	1.43654
8.7	1.03321	33.8	1.14536	58.8	1.279	83.8	1.43722
8.8	1.03362	33.9	1.14585	58.9	1.2801	83.9	1.43790
8.9	1.03403	34.0	1.14634	59.0	1.28060	84.0	1.43858
9.0	1.03444	34.1	1.14584	59.1	1.28118	84.1	1.43926
9.1	1.03485	34.2	1.14733	59.2	1.28176	84.2	1.43994
9.2	1.03526	34.3	1.14782	59.3	1.28235	84.3	1.44062
9.3	1.03567	34.4	1.14831	59.4	1.28252	84.4	1.44130
9.4	1.03608	34.5	1.14880	59.5	1.28411	84.5	1.44198
9.5	1.03649	34.6	1.14930	59.6	1.28469	84.6	1.44266
9.6	1.03691	34.7	1.14979	59.7	1.28528	84.7	1.44334
9.7	1.03732	34.8	1.15029	59.8	1.28587	84.8	1.44402
9.8	1.03773	34.9	1.15078	59.9	1.28587	84.9	1.44470
9.9	1.03814	35.0	1.15128	60.0	1.28646	85.0	1.44539
10.0	1.03856	35.1	1.15177	60.1	1.28704	85.1	1.44607
10.1	1.03897	35.2	1.15226	60.2	1.28763	85.2	1.44675
10.2	1.03938	35.3	1.15276	60.3	1.28822	85.3	1.44744
10.3	1.03980	35.4	1.15326	60.4	1.28881	85.4	1.44812
10.4	1.04021	35.5	1.15375	60.5	1.28940	85.5	1.44881
10.5	1.04063	35.6	1.15425	60.6	1.28999	85.6	1.44949
10.6	1.04104	35.7	1.15475	60.7	1.29058	85.7	1.45018
10.7	1.04146	35.8	1.15524	60.8	1.29117	85.8	1.45086
10.8	1.04187	35.9	1.15574	60.9	1.29176	85.9	1.45154
10.9	1.04229	36.0	1.15624	61.0	1.29235	86.0	1.45223
11.0	1.04270	36.1	1.15674	61.1	1.29295	86.1	1.45292
11.1	1.04312	36.2	1.15724	61.2	1.29354	86.2	1.45360
11.2	1.04354	36.3	1.15773	61.3	1.29413	86.3	1.45429
11.3	1.04395	36.4	1.15823	61.4	1.29472	86.4	1.45498
11.4	1.04437	36.5	1.15873	61.5	1.29532	86.5	1.45567
11.5	1.04479	36.6	1.15923	61.6	1.29591	86.6	1.45636
11.6	1.04521	36.7	1.15973	61.7	1.29651	86.7	1.45704
11.7	1.04521	36.8	1.16023	61.8	1.29710	86.8	1.45773
11.8	1.04562	36.9	1.16073	61.9	1.2977	86.9	1.45842
11.9	1.04604	37.0	1.16124	62.0	1.29829	87.0	1.45911
12.0	1.04646	37.1	1.16174	62.1	1.29889	87.1	1.45980
12.1	1.04688	37.2	1.16224	62.2	1.29948	87.2	1.46052
12.2	1.04730	37.3	1.16274	62.3	1.30008	87.3	1.46119
12.3	1.04772	37.4	1.16324	62.4	1.30068	87.4	1.46188
12.4	1.04814	37.5	1.16375	62.5	1.30127	87.5	1.46257
12.5	1.04856	37.6	1.16425	62.6	1.30187	87.6	1.46326
12.6	1.04898	37.7	1.16476	62.7	1.30247	87.7	1.46395
12.7	1.04940	37.8	1.16526	62.8	1.30307	87.8	1.46464
12.8	1.04982	37.9	1.16576	62.9	1.30367	87.9	1.46534

12.9	1.05024	38.0	1.16627	63.0	1.30427	88.0	1.46603
13.0	1.05066	38.1	1.16678	63.1	1.30487	88.1	1.46673
13.1	1.05109	38.2	1.16728	63.2	1.30587	88.2	1.46742
13.2	1.05151	38.3	1.16779	63.3	1.30607	88.3	1.46812
13.3	1.05193	38.4	1.16829	63.4	1.30667	88.4	1.46881
13.4	1.05236	38.5	1.16880	63.5	1.30727	88.5	1.46950
13.5	1.05278	38.6	1.16931	63.6	1.30787	88.6	1.47020
13.6	1.05320	38.7	1.16982	63.7	1.30848	88.7	1.47090
13.7	1.05363	38.8	1.17032	63.8	1.30908	88.8	1.47159
13.8	1.05406	38.9	1.17083	63.9	1.30968	88.9	1.47229
13.9	1.05448	39.0	1.17134	64.0	1.31028	89.0	1.47299
14.0	1.05490	39.1	1.17185	64.1	1.31088	89.1	1.47368
14.1	1.05531	39.2	1.17236	64.2	1.31149	89.2	1.47238
14.2	1.05575	39.3	1.17287	64.3	1.31209	89.3	1.47508
14.3	1.05618	39.4	1.17338	64.4	1.31270	89.4	1.47278
14.4	1.05660	39.5	1.17389	64.5	1.31330	89.5	1.47648
14.5	1.05703	39.6	1.17440	64.6	1.31391	89.6	1.47718
14.6	1.05746	39.7	1.17491	64.7	1.31452	89.7	1.17788
14.7	1.05788	39.8	1.17542	64.8	1.31512	89.8	1.47858
14.8	1.05831	39.9	1.17594	64.9	1.31573	89.9	1.47928
14.9	1.05874	40.0	1.17645	65.0	1.31633	90.0	1.47998
15.0	1.05916	40.1	1.17696	65.1	1.31694	90.1	1.48068
15.1	1.05959	40.2	1.17747	65.2	1.31755	90.2	1.48136
15.2	1.06002	40.3	1.17799	65.3	1.31816	90.3	1.48208
15.3	1.06045	40.4	1.17850	65.4	1.31877	90.4	1.48278
15.4	1.06088	40.5	1.17901	65.5	1.31937	90.5	1.48348
15.5	1.06131	40.6	1.17953	65.6	1.31998	90.6	1.48419
15.6	1.06174	40.7	1.18004	65.7	1.32059	90.7	1.48489
15.7	1.06217	40.8	1.18056	65.8	1.32120	90.8	1.48559
15.8	1.06260	40.9	1.18108	65.9	1.32181	90.9	1.48630
15.9	1.06303	41.0	1.18159	66.0	1.32242	91.0	1.48700
16.0	1.06346	41.1	1.18211	66.1	1.32204	91.1	1.48771
16.1	1.06389	41.2	1.18262	66.2	1.32365	91.2	1.48841
16.2	1.06432	41.3	1.18314	66.3	1.32426	91.3	1.48912
16.3	1.06476	41.4	1.18366	66.4	1.32487	91.4	1.48982
16.4	1.06519	41.5	1.18418	66.5	1.32548	91.5	1.49053
16.5	1.06562	41.6	1.18470	66.6	1.32610	91.6	1.49123
16.6	1.06605	41.7	1.18522	66.7	1.32671	91.7	1.49194
16.7	1.06649	41.8	1.18573	66.8	1.32732	91.8	1.49265
16.8	1.06692	41.9	1.18625	66.9	1.32794	91.9	1.49336
16.9	1.06736	42.0	1.18677	67.0	1.32855	92.0	1.49406
17.0	1.06779	42.1	1.18729	67.1	1.32917	92.1	1.49477
17.1	1.06822	42.2	1.18781	67.2	1.32978	92.2	1.49548
17.2	1.06866	42.3	1.18834	67.3	1.33040	92.3	1.49619
17.3	1.06909	42.4	1.18886	67.4	1.33102	92.4	1.49690
17.4	1.06953	42.5	1.18938	67.5	1.33163	92.5	1.49761
17.5	1.06996	42.6	1.18990	67.6	1.33225	92.6	1.49832
17.6	1.07040	42.7	1.19042	67.7	1.33287	92.7	1.40903
17.7	1.07084	42.8	1.19095	67.8	1.33348	92.8	1.49974
17.8	1.07127	42.9	1.19147	67.9	1.33410	92.9	1.50045

17.9	1.07171	43.0	1.19199	68.0	1.33472	93.0	1.50116
18.0	1.07215	43.1	1.19252	68.1	1.33534	93.1	1.50187
18.1	1.07258	43.2	1.19304	68.2	1.33596	93.2	1.50258
18.2	1.07302	43.3	1.19356	68.3	1.33658	93.3	1.50329
18.3	1.07340	43.4	1.19409	68.4	1.33720	93.4	1.50401
18.4	1.07390	43.5	1.19462	68.5	1.33782	93.5	1.50472
18.5	1.07434	43.6	1.19514	68.6	1.33844	93.6	1.50543
18.6	1.07478	43.7	1.19567	68.7	1.33906	93.7	1.50615
18.7	1.07522	43.8	1.19619	68.8	1.33968	93.8	1.50686
18.8	1.07566	43.9	1.19672	68.9	1.34031	93.9	1.50757
18.9	1.07610	44.0	1.19725	69.0	1.34093	94.0	1.50829
19.0	1.07654	44.1	1.19778	69.1	1.34155	94.1	1.50900
19.1	1.07698	44.2	1.19830	69.2	1.34217	94.2	1.50972
19.2	1.07742	44.3	1.19883	69.3	1.34280	94.3	1.51044
19.3	1.07786	44.4	1.19936	69.4	1.34342	94.4	1.51115
19.4	1.07830	44.5	1.19989	69.5	1.34405	94.5	1.51187
19.5	1.07874	44.6	1.20042	69.6	1.34467	94.6	1.51258
19.6	1.07919	44.7	1.20095	69.7	1.34530	94.7	1.51330
19.7	1.07963	44.8	1.20148	69.8	1.34530	94.8	1.51402
19.8	1.08007	44.9	1.70201	69.9	1.34655	94.9	1.51474
19.9	1.08052	45.0	1.20254	70.0	1.34717	95.0	1.51546
20.0	1.08096	45.1	1.20307	70.1	1.34780	95.1	1.51617
20.1	1.08140	45.2	1.20360	70.2	1.34843	95.2	1.51689
20.2	1.08185	45.3	1.20414	70.3	1.34906	95.3	1.51761
20.3	1.08229	45.4	1.20467	70.4	1.34968	95.4	1.51833
20.4	1.08274	45.5	1.20520	70.5	1.35031	95.5	1.51905
20.5	1.08318	45.6	1.20573	70.6	1.35094	95.6	1.51977
20.6	1.08363	45.7	1.20627	70.7	1.35157	95.7	1.52049
20.7	1.08407	45.8	1.20680	70.8	1.35220	95.8	1.52121
20.8	1.08452	45.9	1.20734	70.9	1.35283	95.9	1.52193
20.9	1.08497	46.0	1.20787	71.0	1.35346	96.0	1.52266
21.0	1.08541	46.1	1.20840	71.1	1.35409	96.1	4.52338
21.1	1.08586	46.2	1.20894	71.2	1.35472	96.2	1.52410
21.2	1.08631	46.3	1.20948	71.3	1.35535	96.3	1.52482
21.3	1.08676	46.4	1.21001	71.4	1.35598	96.4	1.52555
21.4	1.08720	46.5	1.21055	71.5	1.35661	96.5	1.52627
21.5	1.08765	46.6	1.21109	71.6	1.35724	96.6	1.52699
21.6	1.08810	46.7	1.21162	71.7	1.35788	96.7	1.52772
21.7	1.08855	46.8	1.21216	71.8	1.35851	96.8	1.52844
21.8	1.08900	46.9	1.21270	71.9	1.35914	96.9	1.52917
21.9	1.08945	47.0	1.21324	72.0	1.35978	97.0	1.52989
22.0	1.08990	47.1	1.21378	72.1	1.36041	97.1	1.53062
22.1	1.09055	47.2	1.21432	72.2	1.36105	97.2	1.53131
22.2	1.09086	47.3	1.21486	72.3	1.36168	97.3	1.53207
22.3	1.09125	47.4	1.21540	72.4	1.36232	97.4	1.53279
22.4	1.09370	47.5	1.21594	72.5	1.36295	97.5	1.53352
22.5	1.09216	47.6	1.21648	72.6	1.36359	97.6	1.53425
22.6	1.09261	47.7	1.21702	72.7	1.36423	97.7	1.53498
22.7	1.09306	47.8	1.21756	72.8	1.36486	97.8	1.53570
22.8	1.09351	47.9	1.21810	72.9	1.36550	97.9	1.53643

22.9	1.09397	48.0	1.21864	73.0	1.36614	98.0	1.53716
23.0	1.09442	48.1	1.21918	73.1	1.36678	98.1	1.53789
23.1	1.09448	48.2	1.21973	73.2	1.36742	98.2	1.53862
23.2	1.09535	48.3	1.22027	73.3	1.36805	98.3	1.53935
23.3	1.09578	48.4	1.22082	73.4	1.36869	98.4	1.54008
23.4	1.09624	48.5	1.22136	73.5	1.36933	98.5	1.54081
23.5	1.09669	48.6	1.22190	73.6	1.36997	98.6	1.54154
23.6	1.09715	48.7	1.22245	73.7	1.37061	98.7	1.54227
23.7	1.09740	48.8	1.22300	73.8	1.37125	98.8	1.54300
23.8	1.09806	48.9	1.22354	73.9	1.37189	98.9	1.54373
23.9	1.09851	49.0	1.22409	74.0	1.37254	99.0	1.54446
24.0	1.09897	49.1	1.22463	74.1	1.37318	99.1	1.54519
24.1	1.09943	49.2	1.22518	74.2	1.37382	99.2	1.54593
24.2	1.09989	49.3	1.22573	74.3	1.37446	99.3	1.54666
24.3	1.10034	49.4	1.22627	74.4	1.37510	99.4	1.54739
24.4	1.10080	49.5	1.22682	74.5	1.37575	99.5	1.54813
24.5	1.10126	49.6	1.22737	74.6	1.37639	99.6	1.54886
24.6	1.10172	49.7	1.22792	74.7	1.37704	99.7	1.54960
24.7	1.10218	49.8	1.22847	74.8	1.37768	99.8	1.55033
24.8	1.10264	49.9	1.22902	74.9	1.37833	99.9	1.55106
24.9	1.10310	50.0	1.22957	75.0	1.37897	100.0	1.55180
25.0	1.10356						