UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Marketing Service
Fruit and Vegetable Division
Processed Products Standardization
and Inspection Branch
Washington, D.C.

FILE CODE
135-A-3

TECHNICAL INSPECTION PROCEDURES

BRIX MEASUREMENT

FOR USE OF USDA PROCESSED FOODS INSPECTORS

APRIL, 1960

ACTION BY: All Processed Food Inspectors

APPROVED BY: F. L. Southerland, Chief of the Branch

FILE UNDER: Chapter X - Laboratory Procedures

THESE INSTRUCTIONS SUPERSEDE:

1) Memorandum A-11 (11-9-49)

2) Memorandum A-76 (9-28-51)

TABLE OF CONTENTS

INSPECTORS' INSTRUCTIONS FOR BRIX MEASUREMENT

-- APRIL 1960 --

I GENERAL

A TERMINOLOGY

The term "Brix" technically means the percent by weight of sugar solids in a pure sucrose solution. In canned fruits, fruit juice, and similar products is commonly used as a convenient term to express the percent by weight of all soluble solids in solutions that are generally not pure sucrose but which contain sweeteners or mixtures of two or more types of sweeteners and small amounts of other substances.

The instruments generally used for Brix measurement are the Brix hydrometer and the refractometer. These instruments are affected not only by the sugars present in a product but also by such substances as fruit acids, pectins, and minerals. Regardless of the composition of the solution, the Brix reading expresses the soluble solids content of such solution in terms of a Brix value corresponding to a pure sucrose solution of the same specific gravity.

B FACTORS AFFECTING BRIX IN CANNED FRUIT AND SIMILAR PRODUCTS

The final Brix measurement of liquid packing media in canned fruit and similar products depends largely on four factors:

(1) The soluble solids of the in-going fresh products.

(2) The Brix of the in-going Liquid medium.

(3) The proportion of fresh product to packing medium, and

(4) The extent to which the finished product (fresh product and liquid medium) has equalized.

II PREPARATION OF SAMPLES

A EQUALIZATION - TERMINOLOGY

In order to properly evaluate Brix readings it is important that the product and any included packing medium have undergone equalization. In the case of canned fruits and vegetables packed in sirup, complete equalization may require several weeks.

However, for the purposes of inspection, it may be assumed that equalization is completed 15 days after packing unless otherwise stated in the particular standard or specification. This, of course, does not mean that the product and packing media have completely equalized during this period but equalization sufficiently complete for inspection and certification purposes.

It is not necessary to delay inspection pending the 15 day equalization period. Using proper equipment and techniques, complete equalization may be accomplished at any time by comminuting the product and packing medium. This procedure is referred to as simulated equalization and will yield comparable results to natural equalization.

In accordance with the foregoing discussion there are two basic categories of products on which Brix is measured; 1) naturally equalized products (either by prolonged storage or by the nature of the product), 2) non-equalized products.

Samples are to be taken from individual containers only. Composite samples are not be used.

B PROCEDURE

1 Equalized Products

a. Mix the sample. Completely liquid produce should be stirred while in their original container.

Liquid packing media of products such as canned fruits is recovered during or after the drain weight operation, while the fruit remains on the sieve. The grading tray, over which the individual container is drained, must be free from water and reasonably free from sirup adhering as a result of inspecting a previous sample. (Pans used for sirup samples that are borderline or in dispute shall, of course, be cleaned and dried each time). Sirup collected in this manner is considered well mixed. Liquid packing media of products such as canned fruits in smaller containers (where the contained volume of sirup is less than or approximately equals the capacity of the glass cylinder) may be poured from the can directly into a glass cylinder when the Brix hydrometer is to be used as the measuring device.

b. Transfer sirup to cylinder and take the Brix spindle reading.

c. Make temperature corrections (if any).

d. If refractometer is used, follow procedure as outlined in 2 c, (3)-(5) of this section.

2 Non-Equalized Products

a. Simulated Equalization is the process of simulating the equalization of soluble solids in the fruit or vegetable ingredient and the packing media. For all practical purposes, this process produces the same results as those obtained by the Brix hydrometer method on the liquid packing media of the same product after complete equalization.

In essence, the entire contents of the canned products are comminuted into a homogeneous liquid state and degree Brix of this slurry is determined refractometrically. The resultant degree Brix is afforded the same significance as that obtained by Brix hydrometer on the liquid packing media of the equalized product.

b. Equipment

(1) Comminutor such as "Waring Blender," "Osterizer," or other similar machine with bowl size adequate to accommodate contents of No. 2 1/2 can size and smaller.

(2) Comminutor, as above, with bowl size adequate to accommodate entire contents of a No. 10 can size.

(3) Refractometer, water cooled, and equipped with thermometer, and suitable light source.

(4) Temperature corrections chart for refractometer Brix scale. (included at end of this instruction).

(5) Soft applicator such as plastic spatula or glass rod tipped with rubber policeman.

(6) Filtering equipment:
(a) funnel
(b) test tube
(c) cover glass
(d) filter paper (such as Whatman #12.
NOTE: Nylon cloth or similar material may be used in lieu of filter paper provided comparable results can be obtained.

c. Procedure

(1) Pour entire contents of container into comminutor bowl. Whole, unpitted fruit should be hand-pitted before comminuting. Take care that all the fruit and liquid is transferred to the bowl insofar as is practicable.

(2) Comminute the sample until homogeneous. This process should take from one to two minutes. Check efficiency of blending by occasionally pouring a sample onto a clean, dry pan and visually examining for lumps of fruit or vegetable flesh. Further mixing is indicated if these lumps are present. The inspector will arrive at correct mixing times with experience. (It is usually not possible to completely liquify marasonino cherries used in fruit cocktail and fruit mixes; however, final results are not adversely affected). Avoid excessive mixing since it shortens the motor-life of the comminutor and over heats the sample. Special comminutor blades (such as the Cenco-Pinto available from Central Scientific Co.) may be used where the product is packed in very small containers and difficulty is encountered with regular comminutor blades. An alternative method for overcoming any small container problem is the use of double-dilution with an equal part by weight of distilled water, comminuting and multiplying the result by 2. Also, a small fruit jar may be adapted with blending knives and used for comminuting small samples.

(3) Filter if necessary, discarding first few drops. Avoid evaporation.

(4) Apply about two drops of sample to the refractometer prisms.

(5) Take the reading, make temperature correction (if any) and record results.

III SELECTION OF MEASURING INSTRUMENT

A Hydrometer

1 Naturally equalized canned fruit and canned vegetables (such as sweet potatoes in sirup) consisting of separate units in a liquid packing medium (including water and dietetic packs).

2 Canned, chilled and frozen single-strength fruit juices.

3 Frozen fruits. In-going sirups only.

4 Special products (such as pickles, pickle relish, molasses and table sirups) as specified in standards or specifications and instructions.

B Refractometer

1 Non-equalized canned fruits and canned vegetables (such as sweet potatoes in sirup) consisting of separate units in a liquid packing medium, including water and dietetic pack -- after undergoing simulated equalization.

2 Canned fruit products such as purees, pulps, butters, jams, preserves and jellies.

3 Canned and frozen fruit juices other than single-strength.

4 Naturally equalized canned fruit and canned vegetables (such as sweet potatoes in sirup) consisting of separate units in a liquid packing medium, where individual containers contain insufficient liquid medium to measure by hydrometer.

5 Frozen fruits.

6 Special products (such as honey) as specified in standards, specifications or instructions.

MEASUREMENT TECHNIQUE

A BRIX HYDROMETER

1 Description

The Brix hydrometer or spindle is a glass instrument consisting of a hollow bulb which causes the hydrometer to float. Below this bulb is a section filled with shot to cause the instrument to float in an upright position, and above the bulb is a graduated stem from which the readings are taken. The extent to which the stem extends above the surface of the liquid depends upon the specific gravity of the liquid being tested.

The instrument is similar to any specific gravity hydrometer indicating degrees of liquid density. However, the graduations on the stem of this instrument are expressed in degrees Brix and indicate the percentage of soluble solids in terms of sucrose

equivalent. If the Brix hydrometer is immersed in a solution composed entirely of sucrose and water, the reading at proper temperature is exactly the percentage by weight of pure dry sugar (sucrose) in the solution. The degree of Brix is easy to determine and is a convenient measurement of the specific gravity in terms of the Brix scale and reflects the total soluble solids in solution.

The hydrometer most often used in laboratories has a 5 degree range for each spindle with graduations in 1/10 degrees. Thus six or seven hydrometers are necessary to cover the range of sirups normally encountered during inspections. Most laboratories should be equipped with instruments to cover at least the range from 5 degrees to 40 degrees Brix.

2 Standardizing the Hydrometer

Brix hydrometer should be checked periodically for accuracy. Two methods are suggested:

a Comparison of the hydrometer reading of a sample of sirup with the reading of another hydrometer of known accuracy on the same sirup sample; or

b Testing the hydrometer in a specially prepared sucrose solution which contains a known percentage, by weight, of pure, dry sucrose. For all practical purposes a good grade of dry commercial cane or beet sugar will be sufficiently pure for standardization of hydrometers. Observe the following rules:

(1) Select a point approximately midway on the spindle to be tested. For example, a hydrometer in the range of 15 to 20 degrees can be tested in a sirup of 18 degrees.

(2) Prepare a sugar solution of the required density by dissolving a weighed quantity of dry, free-running sugar in a weighed quantity of distilled water. For example, assume it is desired to prepare 1000 grams of 18 degrees sirup. Tar a beaker or suitable receptacle on a gram balance and add exactly 180 grams of dry sugar. Then add sufficient water to bring the weight of the mixture (sugar and water) to exactly 1000 grams. This solution will give a reading of 18 degrees Brix with an accurate hydrometer at the proper temperature. Do not make up to volume in a volumetric flask.

Bear in mind that 18 degrees Brix is 18 percent by weight of sugar solids which is 18 grams per 100 grams of solution and not 18 grams made up to 100 ml.

(3) Mix the sugar and water well. Finally transfer the contents back and forth between two large beakers in order to assure proper mix.

(4) Cool solution down to about 1 degree below the temperature at which the instrument is calibrated.

(5) Transfer sirup to a cylinder and observe temperature at which the instrument was calibrated. If necessary, immerse in a water bath of the proper temperature.

(6) When the sirup in the cylinder has equalized to the proper temperature, immerse the hydrometer and observe the reading. It is well to take a series of readings by removing the hydrometer and cleaning and drying it before each immersion.

(7) If the hydrometer reads within 1/10 of a degree of the proper reading, it can be considered sufficiently accurate for our purposes. If the error is more than 1/10 degree, a proper correction should be recorded for such error and each reading with this hydrometer so adjusted.

(8) If the error in the instrument exceeds 3/10 degree, replace the instrument.

(9) For more precise calibration the instrument should be standardized at more than one check point.

3 Procedure

a Pour the liquid into a standard glass laboratory cylinder (approximately 1 1/4 inches inside diameter, eight to ten inches tall). Completely fill the cylinder, if sufficient liquid is available, and allow to overflow slightly so as to float off any foam or bubbles.

b Slowly lower clean, dry hydrometer into the liquid until it is very near floating position. Release spindle with a slight spinning motion. If it is dropped into the sirup it will sink too far and when it rises, some of the sirup will adhere to the stem. The weight of this adhering sirup will cause the hydrometer to float at a lower position than it should. It is also important to note that air bubbles in the sirup will cause the hydrometer to float at an erroneous level.

c Observe the reading on the stem after allowing the hydrometer to come completely to rest. The hydrometer must not touch the side of the glass cylinder.

The eye should be on a level with the surface of the liquid (see illustration). Where the liquid touches the stem, it rises a short distance to form a meniscus. The reading will be inaccurate if taken at the top of the meniscus rather than at the true liquid level. The meniscus layer is usually thin and the graduation marks can be seen through it. However, with very dark colored sirups it may be necessary to make a slight allowance for the meniscus factor.

d Make any appropriate temperature correction. Record the temperature of the sirup and refer to the temperature corrections chart for the Brix hydrometer. The chart is self-explanatory but it should be noted that the correction factor varies according to the specific gravity of the liquid as well as with temperature. The correction factor is taken from the column nearest the degree Brix found upon examination. For example, if the hydrometer indicates a reading of 23.5 degrees Brix, the correction factor is taken from the vertical column headed "25 degrees Brix."

4 Care of the Hydrometer

The Brix hydrometer is a very delicate and fragile instrument. It must be handled with care and respect to avoid unnecessary breakage and is to be thoroughly cleaned and dried immediately after each use. Protect it from breakage when not in use by storing in an adequately cushioned container.

B REFRACTOMETER

1 Description

The refractometer is an instrument that optically measures the density of a liquid. Light is passed through the sample and is deflected in relation to the density of the sample. The instrument is calibrated in terms of refractive index and also usually contains a scale in terms of degrees Brix. A common type of refractometer consists of two prisms between which a portion of the material to be tested is placed; a mirror which reflects light through the prisms and liquid; a telescopic tube with cross-hairs superimposed on the field of vision; a scale calibrated in terms of refractive index, degrees Brix, or both; a compensator with which to correct for the chromatic dispersion of light; and a thermometer in the water circulating system.

Further descriptions of the refractometer vary with the make and model of the individual instrument. The manual of instructions accompanying each refractometer should be studied closely. Many of the small, hand-type refractometers are not sufficiently accurate for laboratory purposes but may be used to good advantage in estimating the soluble solids content of fresh fruit.

2 Standardizing the Refractometer

The refractometer should be checked for accuracy before use. It should be checked daily when in constant use, such as on In-plant inspections.

The method of determining the instrument's accuracy of calibration should be that specified in the manual of instructions accompanying the refractometer. This is generally accomplished through the use of a special prism of known refractive index.

Standardizing the refractometer by the test prism is considered the most accurate method. This method is to be used periodically.

Frequent day-to-day checks may be made with distilled water provided there is very close correlation with the test prism method. The distilled water checks shall supplement less frequent checks with the test prism.

The distilled water check for accuracy shall be made as follows:

(1) Adjust prism temperature as close as possible to standard temperature. (In hot weather it may be necessary to surround the water hoses with ice water, or draw from a resevoir of cooled water).

(2) Clean and dry the prisms carefully.

(3) Apply one or two drops of distilled water to prisms.

(4) Compare observed refractive index and prism temperature with the appropriate refractive index (on the table below) for the same temperature. If the refractometer differs more than plus or minus 0.0002 repeat steps (2) and (3) until a total of three readings is obtained. If the refractive index of the last reading still differs from the table more than plus or minus 0.0002, check the refractometer with the standard test prism. If the reading still differs more than plus or minus 0.0002 recalibrates the refractometer.

CAUTION:

Recalibration of the refractometer should be done by only an experienced inspector.

REFRACTIVE INDEX OF DISTILLED WATER

TEMPERATURE DEGREES F	DEGREES C	ABBE' REFRACTOMETER READING	TEMPERATURE DEGREES F	DEGREES C	ABBE' REFRACTOMETER
59.0	15	1.3334	71.6	22	1.3328
60.8	16	1.3334	73.4	23	1.3327
62.6	17	1.3333	75.2	24	1.3326
64.4	18	1.3332	77.0	25	1.3325
66.2	19	1.3331	78.8	26	1.3324
68.0	20	1.3330	82.4	28	1.3322
69.8	21	1.3329	86.0	30	1.3320

3 Procedure

a Apply one or two drops of the sample (filtered when necessary) to the lower prism. Avoid scratching the soft, refractometer prisms.

b Close and lock the prism chamber.

c Apply the light source and view the shadow through the telescope, keeping the eye in the center of the eyepiece. Align the shadow edge (which should be very sharp) exactly with the intersection of the cross-hairs. An indistinct shadow edge may be caused by:

(1) Insufficient or excessive sample on prisms.

(2) Unfiltered sample of purees and slurries.

(3) Improper carematic dispersion adjustment (indicated by a blue or red tinge in the shadow edge).

(4) Insufficient or excessive light directed on the prisms.

(5) Improper closing of prisms (too rapid closure of prisms or prisms not locked securely.

(6) Light stop (present on some instruments) was controls amount of light transmitted to prisms not fully closed.

d Read the degree Brix from the Brix scale and note the temperature indicated by the thermometer.

e Make any appropriate temperature correction.

Temperature greatly influences the Brix reading and therefore it is imperative that the reading be corrected to the instrument's standard temperature - usually 10 degrees C (68 degrees F). This correction is made in the same manner as the correction adjustment for the Brix hydrometer except that a different chart is consulted. The appropriate chart is supplied at the end of this instruction. Temperature of the prisms should remain as close to standard temperature, usually 20 degrees C (68 degrees F), as is practical by adjustment of the flow of water through the cooling system.

CAUTION: The inclusion of water at any point in the determination will result in erroneous readings. Placing a surplus of sample on the prisms may

cause a portion of the liquid to flow around onto the backside of a prism which will result in an erroneous reading.

These instructions are to be supplemented by the manual of instructions pertaining to the particular refractometer being used.

4. Care of the Refractometer

The instrument must be kept clean and in proper working order at all times.

Clean and dry the prisms with soft, lint free tissues immediately after each reading. The prisms are very soft and scratch easily. Therefore, never touch them with hard objects such as spoons or glass rods. It is well to place a small piece of soft paper or tissue between them when the instrument is not in use.

The refractometer should be protected with a cover when not in use and should be kept in its case during long periods of storage.

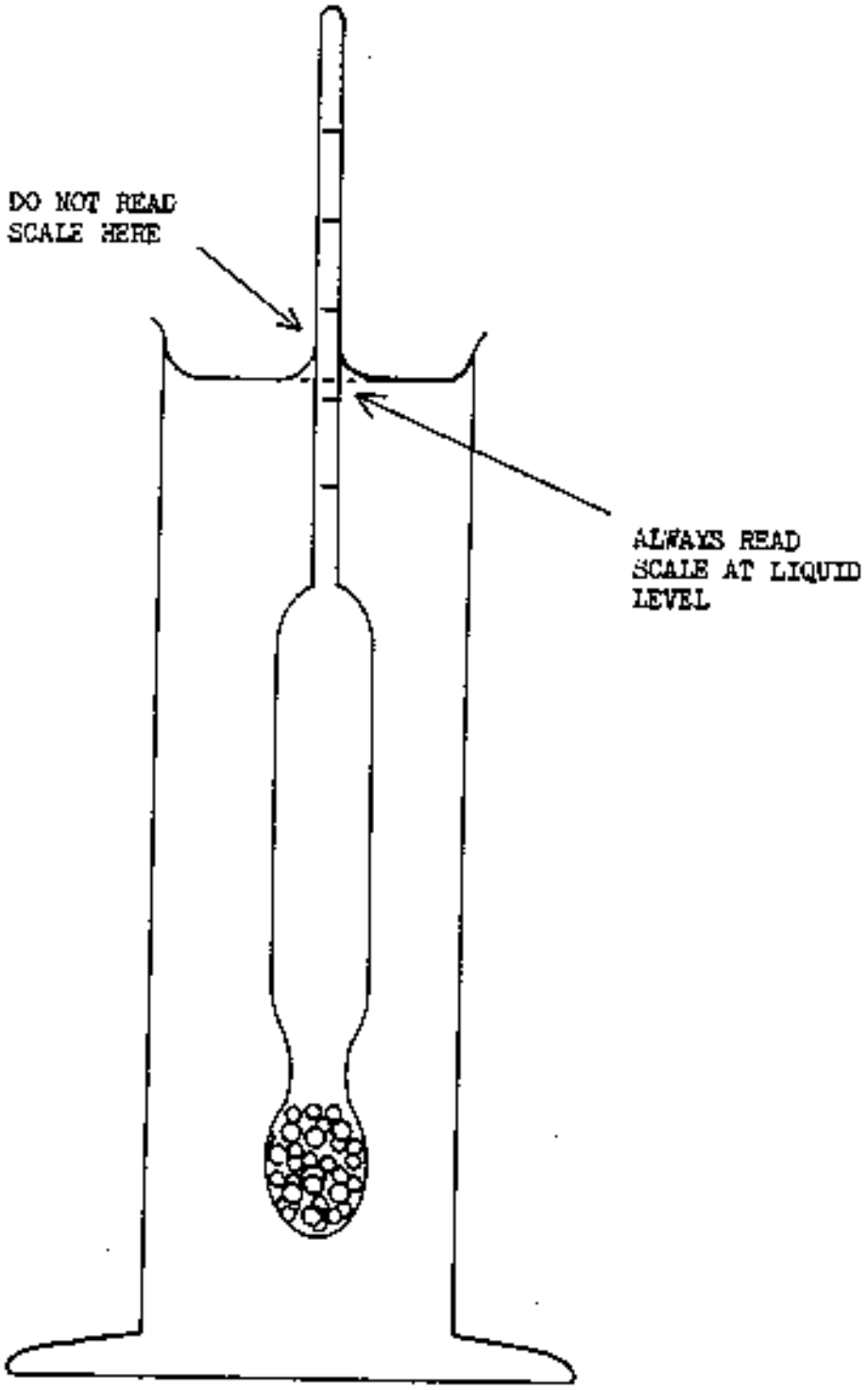
Instruments standardized at 20 degrees C are preferred by the Branch. When sample temperatures are above or below the temperature at which the instrument is calibrated, corrections are made to the standard temperature of the instrument. Temperature corrections charts included in this instruction are for instruments standardized at 20 degrees C only.

V REPORTING RESULTS

Unless otherwise specified, report results of Brix readings to the closest 1/10th degree.

In reporting results, be sure to adjust the readings for any temperature or instrument correction.

Corrections for presence of fruit acids, minerals, and similar ingredients are not to be made unless so specified in standards, specifications or Inspectors' Instructions.


DO NOT READ
SCALE HERE
ALWAYS READ
SCALE AT LIQUID
LEVEL

R1

TABLE A -- REFRACTIVE INDEX, DEGREES BRIX, SPECIFIC GRAVITY
AND DEGREES BAUME' OF SUGAR (SUCROSE) SOLUTIONS

REFRACTIVE INDEX AT 20 DEGREES C.	DEGREES BRIX	SPECIFIC GRAVITY 20 DEGREES/ 20 DEGREES C.	DEGREES BAUME' MOD. 145	REFRACTIVE INDEX AT 20 DEGREES C.	DEGREES BRIX	SPECIFIC GRAVITY 20 DEGREES/ 20 DEGREES C.	DEGREES BAUME' MOD. 145
1.3330	0.0	1.00000	0.00	1.3423	6.4	1.02530	3.57
1.3333	0.2	1.00078	0.11	1.3426	6.6	1.02611	.69
1.3336	0.4	1.00156	0.22	1.3429	6.8	1.02692	3.80
1.3339	0.6	1.00233	0.34	1.3432	7.0	1.02773	3.91
1.3341	0.8	1.00312	0.45	1.3435	7.2	1.02854	4.02
1.3344	1.0	1.00390	0.56	1.3438	7.4	1.02936	4.13
1.3347	1.2	1.00468	0.67	1.3441	7.6	1.03017	4.24
1.3350	1.4	1.00546	0.79	1.3444	7.8	1.03098	4.35
1.3353	1.6	1.00624	0.90	1.3447	8.0	1.03180	4.46
1.3356	1.8	1.00702	1.01	1.3450	8.2	1.03262	4.58
1.3359	2.0	1.00780	1.12	1.3454	8.4	1.03344	4.69
1.3362	2.2	1.00859	1.23	1.3457	8.6	1.03426	4.80
1.3365	2.4	1.00937	1.34	1.3460	8.8	1.03508	4.91
1.3368	2.6	1.01016	1.46	1.3463	9.0	1.03590	5.02
1.3370	2.8	1.01094	1.57	1.3466	9.2	1.03672	5.13
1.3373	3.0	1.01173	1.68	1.3469	9.4	1.03755	5.24
1.3376	3.2	1.01252	1.79	1.3472	9.6	1.03837	5.35
1.3379	3.4	1.01331	1.90	1.3475	9.8	1.03920	5.46
1.3382	3.6	1.01410	2.02	1.3478	10.0	1.04003	5.57
1.3385	3.8	1.01490	2.13	1.3481	10.2	1.04086	5.68
1.3388	4.0	1.01569	2.24	1.3484	10.4	1.04169	5.80
1.3391	4.2	1.01649	2.35	1.3487	10.6	1.04252	5.91
1.3394	4.4	1.01728	2.46	1.3490	10.8	1.04335	6.02
1.3397	4.6	1.01808	2.57	1.3493	11.0	1.04418	6.13
1.3400	4.8	1.01888	2.68	1.3497	11.2	1.04502	6.24
1.3402	5.0	1.01968	2.79	1.3500	11.4	1.04585	6.35
1.3405	5.2	1.02048	2.91	1.3503	11.6	1.04669	6.46
1.3408	5.4	1.02128	3.02	1.3506	11.8	1.04753	6.57
1.3411	5.6	1.02208	3.13	1.3509	12.0	1.04837	6.68
1.3414	5.8	1.02289	3.24	1.3512	12.2	1.04921	6.79
1.3417	6.0	1.02369	3.35	1.3515	12.4	1.05005	6.90
1.3420	6.2	1.02450	3.46	1.3518	12.6	1.05090	7.02

TABLE A -- REFRACTIVE INDEX, DEGREES BRIX, SPECIFIC GRAVITY
AND DEGREES BAUME' OF SUGAR (SUCROSE) SOLUTIONS

REFRACTIVE INDEX AT 20 DEGREES C.	DEGREES BRIX	SPECIFIC GRAVITY 20 DEGREES/ 20 DEGREES C.	DEGREES BAUME' MOD. 145	REFRACTIVE INDEX AT 20 DEGREES C.	DEGREES BRIX	SPECIFIC GRAVITY 20 DEGREES/ 20 DEGREES C.	DEGREES BAUME' MOD. 145
1.3522	12.8	1.05174	7.13	1.3661	21.4	1.08923	11.87
1.3525	13.0	1.05259	7.24	1.3665	21.6	1.09013	11.98
1.3528	13.2	1.05343	7.35	1.3668	21.8	1.09103	12.09
1.3531	13.4	1.05428	7.46	1.3672	22.0	1.09194	12.20
1.3534	13.6	1.05513	7.57	1.3675	22.2	1.09284	12.31
1.3537	13.8	1.05598	7.68	1.3678	22.4	1.09375	12.42
1.3541	14.0	1.05683	7.79	1.3682	22.6	1.09465	12.52
1.3544	14.2	1.05769	7.90	1.3685	22.8	1.09556	12.63
1.3547	14.4	1.05854	8.01	1.3688	23.0	1.09647	12.74
1.3550	14.6	1.05940	8.12	1.3692	23.2	1.09738	12.85
1.3553	14.8	1.06025	8.23	1.3695	23.4	1.09829	12.96
1.3556	15.0	1.06111	8.34	1.3699	23.6	1.09921	13.07
1.3560	15.2	1.06197	8.45	1.3707	23.8	1.10012	13.18
1.3563	15.4	1.06283	8.56	1.3706	24.0	1.10104	13.29
1.3566	15.6	1.06369	8.67	1.3709	24.2	1.10195	13.40
1.3569	15.8	1.06455	8.78	1.3712	24.4	1.10287	13.51
1.3573	16.0	1.06542	8.89	1.3716	24.6	1.10370	13.62
1.3576	16.2	1.06629	9.00	1.3719	24.8	1.10471	13.69
1.3579	16.4	1.06715	9.11	1.3723	25.0	1.10564	13.80
1.3582	16.6	1.06802	9.22	1.3726	25.2	1.10656	13.95
1.3586	16.8	1.06889	9.35	1.3729	25.4	1.10748	14.06
1.3589	17.0	1.06976	9.45	1.3733	25.6	1.10841	14.17
1.3592	17.2	1.07063	9.56	1.3736	25.8	1.10934	14.28
1.3595	17.4	1.07151	9.67	1.3740	26.0	1.11027	14.39
1.3598	17.6	1.07238	9.78	1.3743	26.2	1.11120	14.49
1.3602	17.8	1.07325	9.89	1.3747	26.4	1.11213	14.60
1.3605	18.0	1.07413	10.00	1.3750	26.6	1.11306	14.71
1.3608	18.2	1.07501	10.11	1.3753	26.8	1.11400	14.82
1.3612	18.4	1.07589	10.22	1.3757	27.0	1.11493	14.93
1.3615	18.6	1.07677	10.33	1.3761	27.2	1.11587	15.04
1.3618	18.8	1.07765	10.44	1.3764	27.4	1.11681	15.15
1.3621	19.0	1.07853	10.55	1.3768	27.6	1.11775	15.26
1.3625	19.2	1.07942	10.66	1.3771	27.8	1.11869	15.37
1.3628	19.4	1.08030	10.77	1.3775	28.0	1.11963	15.48
1.3631	19.6	1.08119	10.88	1.3778	28.2	1.12058	15.59
1.3635	19.8	1.08208	10.99	1.3782	28.4	1.12152	15.69
1.3638	20.0	1.08297	11.10	1.3785	28.6	1.12247	15.80
1.3641	20.2	1.08386	11.21	1.3789	28.8	1.12342	15.91
1.3645	20.4	1.08475	11.32	1.3792	29.0	1.12436	16.02
1.3648	20.6	1.08565	11.43	1.3796	29.2	1.12532	15.13
1.3651	20.8	1.08654	11.54	1.3800	29.4	1.12627	16.14
1.3655	21.0	1.08744	11.65	1.3803	29.6	1.12722	16.15
1.3658	21.2	1.08834	11.76	1.3807	29.8	1.12817	16.16

R3

TABLE A -- REFRACTIVE INDEX, DEGREES BRIX, SPECIFIC GRAVITY
AND DEGREES BAUME' OF SUGAR (SUCROSE) SOLUTIONS

REFRACTIVE INDEX AT 20 DEGREES C.	DEGREES BRIX	SPECIFIC GRAVITY 20 DEGREES/ 20 DEGREES C.	DEGREES BAUME' MOD. 145	REFRACTIVE INDEX AT 20 DEGREES C.	DEGREES BRIX	SPECIFIC GRAVITY 20 DEGREES/ 20 DEGREES C.	DEGREES BAUME' MOD. 145
1.3810	30.0	1.12913	16.57	1.3970	38.6	1.17158	21.21
1.3814	30.2	1.13009	16.67	1.3974	38.8	1.17260	21.32
1.3818	30.4	1.13105	16.78	1.3978	39.0	1.17362	21.43
1.3821	30.6	1.13201	16.89	1.3982	39.2	1.17464	21.54
1.3825	30.8	1.13297	17.00	1.3986	39.4	1.17566	21.64
1.3829	31.0	1.13394	17.11	1.3989	39.6	1.17669	21.75
1.3832	31.2	1.3490	17.22	1.3993	39.8	1.17772	21.86
1.3836	31.4	1.13587	17.33	1.3997	40.0	1.17874	21.97
1.3839	31.6	1.13683	17.43	1.4001	40.2	1.17977	22.07
1.3843	31.8	1.13780	17.54	1.4005	40.4	1.18080	22.18
1.3847	32.0	1.13877	17.65	1.4008	40.6	1.18183	22.29
1.3850	32.2	1.13974	17.76	1.4012	40.8	1.18287	22.39
1.3854	32.4	1.14072	17.87	1.4016	41.0	1.18390	22.50
1.3858	32.6	1.14169	17.98	1.4020	41.2	1.18494	22.61
1.3861	32.8	1.14267	18.08	1.4024	41.4	1.18598	22.72
1.3865	33.0	1.14364	18.19	1.4028	41.6	1.18702	22.82
1.3869	33.2	1.14462	18.30	1.4032	41.8	1.18806	22.93
1.3872	33.4	1.14560	18.41	1.4036	42.0	1.18910	23.04
1.3876	33.6	1.14658	18.52	1.4040	42.2	1.19014	23.14
1.3879	33.8	1.14757	18.63	1.4044	42.4	1.19119	23.25
1.3883	34.0	1.14855	18.73	1.4048	42.6	1.19224	23.36
1.3887	34.2	1.14954	18.84	1.4052	42.8	1.19329	23.46
1.3891	34.4	1.15052	18.95	1.4056	43.0	1.19434	23.57
1.3894	34.6	1.15151	19.06	1.4060	43.2	1.19539	23.68
1.3898	34.8	1.15250	19.17	1.4064	43.4	1.19644	23.78
1.3902	35.0	1.15350	19.28	1.4068	43.6	1.19749	23.89
1.3906	35.2	1.15449	19.38	1.4072	43.8	1.19855	24.00
1.3909	35.4	1.15548	19.49	1.4076	44.0	1.19961	24.10
1.3913	35.6	1.15648	19.60	1.4080	44.2	1.20066	24.21
1.3916	35.8	1.15747	19.71	1.4084	44.4	1.20172	24.32
1.3920	36.0	1.15847	19.81	1.4088	44.6	1.20279	24.42
1.3924	36.2	1.15947	19.92	1.4092	44.8	1.20385	24.53
1.3928	36.4	1.16047	20.03	1.4096	45.0	1.20491	24.63
1.3931	36.6	1.16148	20.14	1.4100	45.2	1.20598	24.74
1.3935	36.8	1.16248	20.25	1.4104	45.4	1.20705	24.85
1.3939	37.0	1.16349	20.35	1.4109	45.6	1.20812	24.95
1.3943	37.2	1.16449	20.46	1.4113	45.8	1.20919	25.06
1.3947	37.4	1.16550	20.57	1.4117	46.0	1.21026	25.17
1.3950	37.6	1.16652	20.68	1.4121	46.2	1.21133	25.27
1.3954	37.8	1.16752	20.78	1.4125	46.4	1.21241	25.38
1.3958	38.0	1.16853	20.89	1.4129	46.6	1.21349	25.48
1.3962	38.2	1.16955	21.00	1.4133	46.8	1.21456	25.59
1.3966	38.4	1.17056	21.11	1.4137	47.0	1.21564	25.70

R4

TABLE A – REFRACTIVE INDEX, DEGREES BRIX, SPECIFIC GRAVITY AND DEGREES BAUME' OF SUGAR (SUCROSE) SOLUTIONS

REFRACTIVE INDEX AT 20 DEGREES C.	DEGREES BRIX	SPECIFIC GRAVITY 20 DEGREES/ 20 DEGREES C.	DEGREES BAUME' MOD. 145	REFRACTIVE INDEX AT 20 DEGREES C.	DEGREES BRIX	SPECIFIC GRAVITY 20 DEGREES/ 20 DEGREES C.	DEGREES BAUME' MOD. 145
1.4141	47.2	1.21673	25.80	1.4348	56.8	1.27041	30.83
1.4145	47.4	1.21781	25.91	1.4352	57.0	1.27156	30.94
1.4150	47.6	1.21889	26.01	1.4356	57.2	1.27272	31.04
1.4154	47.8	1.21998	26.12	1.4361	57.4	1.27388	31.15
1.4158	48.0	1.22106	26.23	1.4365	57.6	1.27504	31.25
1.4162	48.2	1.22215	26.33	1.4370	57.8	1.27620	31.35
1.4166	48.4	1.22324	26.44	1.4374	58.0	1.27736	31.46
1.4171	48.6	1.22434	26.54	1.4379	58.2	1.27853	31.56
1.4175	48.8	1.22543	26.65	1.4383	58.4	1.27969	31.66
1.4179	49.0	1.22652	26.75	1.4388	58.6	1.28086	31.76
1.4183	49.2	1.22762	26.86	1.4392	58.8	1.28203	31.87
1.4187	49.4	1.22872	26.96	1.4397	59.0	1.28320	31.97
1.4192	49.6	1.22982	27.07	1.4401	59.2	1.28437	32.07
1.4196	49.8	1.23092	27.18	1.4406	59.4	1.28555	32.18
1.4201	50.0	1.23202	27.28	1.4410	59.6	1.28672	32.28
1.4205	50.2	1.23313	27.39	1.4415	59.8	1.28789	32.38
1.4209	50.4	1.23423	27.49	1.4419	60.0	1.28908	32.49
1.4214	50.6	1.23534	27.60	1.4424	60.2	1.29025	32.59
1.4218	50.8	1.23645	27.70	1.4428	60.4	1.29143	32.69
1.4222	51.0	1.23756	27.81	1.4433	60.6	1.29262	32.79
1.4226	51.2	1.23867	27.91	1.4437	60.8	1.29380	32.90
1.4230	51.4	1.23978	28.02	1.4442	61.0	1.29498	33.00
1.4235	51.6	1.24089	28.12	1.4447	61.2	1.29618	33.10
1.4239	51.8	1.24201	28.23	1.4451	61.4	1.29736	33.20
1.4243	52.0	1.24313	28.33	1.4456	61.6	1.29855	33.31
1.4248	52.2	1.24425	28.44	1.4460	61.8	1.29975	33.41
1.4252	52.4	1.24537	28.54	1.4465	62.0	1.30093	33.51
1.4256	52.6	1.24649	28.65	1.3370	62.2	1.30212	33.61
1.4260	52.8	1.24761	28.75	1.4474	62.4	1.30334	33.72
1.4265	53.0	1.24874	28.86	1.4479	62.6	1.30453	33.82
1.4269	53.2	1.24987	28.96	1.4483	62.8	1.30537	33.92
1.4273	53.4	1.25099	29.06	1.4488	63.0	1.30694	34.02
1.4278	53.6	1.25212	29.17	1.4493	63.2	1.30815	34.12
1.4282	53.8	1.25325	29.27	1.4497	63.4	1.30936	34.23
1.4286	54.0	1.25439	29.38	1.4502	63.6	1.31055	34.33
1.4291	54.2	1.25552	29.48	1.4507	63.8	1.31177	34.43
1.4295	54.4	1.25666	29.59	1.4511	64.0	1.31297	34.53
1.4299	54.6	1.25780	29.69	1.4516	64.2	1.31418	34.63
1.4304	54.8	1.25893	29.80	1.4521	64.4	1.31540	34.74
1.4308	55.0	1.26007	29.90	1.45525	64.6	1.31661	34.84
1.4312	55.2	1.26122	30.00	1.4530	64.8	1.31784	34.94
1.4317	55.4	1.26236	30.11	1.4535	65.0	1.31905	35.04
1.4321	55.6	1.26350	30.21	1.4539	65.2	1.32028	35.14
1.4326	55.8	1.26465	30.32	1.4544	65.4	1.32150	35.24
1.4330	56.0	1.26580	30.42	1.4549	65.6	1.32271	35.34
1.4334	56.2	1.26695	30.52	1.4553	65.8	1.32393	35.45
1.4339	56.4	1.26810	30.63	1.4558	66.0	1.32516	35.55
1.4343	56.6	1.26925	30.73	1.4563	66.2	1.32638	35.65

R5

TABLE A – REFRACTIVE INDEX, DEGREES BRIX, SPECIFIC GRAVITY AND DEGREES BAUME' OF SUGAR (SUCROSE) SOLUTIONS

REFRACTIVE INDEX AT 20 DEGREES C.	DEGREES BRIX	SPECIFIC GRAVITY 20 DEGREES/ 20 DEGREES C.	DEGREES BAUME' MOD. 145	REFRACTIVE INDEX AT 20 DEGREES C.	DEGREES BRIX	SPECIFIC GRAVITY 20 DEGREES/ 20 DEGREES C.	DEGREES BAUME' MOD. 145
1.4568	66.4	1.32759	35.75	1.4798	75.8	1.38705	40.43
1.4572	66.6	1.32884	35.85	1.4803	76.0	1.38835	40.53
1.4577	66.8	1.33007	35.95	2.4808	76.2	1.38967	40.62
1.4582	67.0	1.33129	36.05	1.4814	76.4	1.39097	40.72
1.4587	67.2	1.33254	36.15	1.4819	76.6	1.39228	40.82
1.4591	67.4	1.33377	36.25	1.4824	76.8	1.39358	40.92
1.4596	67.6	1.33500	36.35	1.4829	77.0	1.39489	41.01
1.4601	67.8	1.33625	36.45	1.4834	77.2	1.39619	41.11
1.40606	68.0	1.33748	36.55	1.4839	77.4	1.39750	41.21
1.4611	68.2	1.33872	36.66	1.4844	77.6	1.39882	41.31
1.4615	68.4	1.33997	36.76	1.4849	77.8	1.40014	41.40
1.4620	68.6	1.34121	36.86	1.4854	78.0	1.40146	41.50
1.4625	68.8	1.34245	36.96	1.4860	78.2	1.40277	41.60
1.4630	69.0	1.34371	37.06	1.4865	78.4	1.40409	41.70
1.4635	69.2	1.34495	37.16	1.4870	78.6	1.40541	41.79
1.4640	69.4	1.34621	37.26	1.4875	78.8	1.40674	41.89
1.4644	69.6	1.34746	37.36	1.4880	79.0	1.40806	41.99
1.4649	69.8	1.34871	37.46	1.4886	79.2	1.40938	42.08
1.4654	70.0	1.34997	37.56	1.4891	79.4	1.41072	42.18
1.4659	70.2	1.35123	37.66	1.4896	79.6	1.41204	42.28
1.4664	70.4	1.35248	37.76	1.4901	79.8	1.41337	42.37
1.4669	70.6	1.35375	37.86	1.4906	80.0	1.41471	42.47
1.4674	70.8	1.35501	37.96				
1.4679	71.0	1.35627	38.06				
1.4684	71.2	1.35754	38.16				
1.4688	71.4	1.35881	38.26				
1.4693	71.6	1.36008	38.35				
1.4698	71.8	1.36135	38.45				
1.4703	72.0	1.36261	38.55				
1.4708	72.2	1.36389	38.65				
1.4713	72.4	1.36516	38.75				
1.4718	72.6	1.36643	38.85				
1.4723	72.8	1.36771	38.95				
1.4728	73.0	1.36900	39.05				
1.4733	73.2	1.37028	39.15				
1.4738	73.4	1.37156	39.25				
1.4743	73.6	1.37285	39.35				
1.4748	73.8	1.37411	39.44				
1.4753	74.0	1.37541	39.54				
1.4758	74.2	1.37669	39.64				
1.4763	74.4	1.37798	39.74				
1.4768	74.6	1.37928	39.84				
1.4773	74.8	1.38057	39.94				
1.4778	75.0	1.38187	40.03				
1.4783	75.2	1.38316	40.13				
1.4788	75.4	1.38445	40.23				
1.4793	75.6	1.38575	40.33				

TABLE B -- TEMPERATURE CORRECTIONS -- BRIX HYDROMETER
(Standardized at 20 Degrees C.)
Based on Table 110 Bureau of Standards Circular C-0440 - Nearest 1/10th Degree

	Degrees Brix														
Temp. Degrees C.	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70
	-- Subtract From Observed Reading --														
0	0.3	0.5	0.7	0.8	0.9	1.0	1.1	1.2	1.2	1.3	1.4	1.4	1.4	1.5	1.5
5	.4	.5	.6	.7	.7	.8	.9	.9	1.0	1.0	1.1	1.1	1.1	1.1	1.1
10	.3	.4	.4	.5	.5	.6	.6	.6	.7	.7	.7	.7	.8	.8	.8
11	.3	.4	.4	.4	.5	.5	.6	.6	.6	.6	.7	.7	.7	.7	.7
12	.3	.3	.4	.4	.4	.5	.5	.5	.5	.6	.6	.6	.6.	.6	.6
13	.3	.3	.3	.4	.4	.4	.4	.5	.5.	.5	.5	.5	.5	.5	.6
14	.2	.3	.3.	.3	.3	.4	.4	.4	.4	.4.	4	5.	.5	.5	.5
15	.2	.2	.2	.3	.3	.3	.3	.3.	.3	.4	.4	.4	.4	.4	.4
16	.2	.2	.2	.2	.2	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3
17	.1	.1	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
18	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.2	.2	.2	.2	.2
19	.1	.1	.1	.1	.1	.1.	.1	.1	.1	.1	.1	.1	.1	.1	.1
	-- Add to Observed Reading --														
21	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
22	.1	.1	.1	.1	.1	.1	.1	.1	.2	.2	.2	.2	.2	.2	.2
23	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
24	.2	.2	.2	.2	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3
25	.3	.3	.3	.3	.3	.3.4	.4	.4	.4	.4	.4	.4	.4	.4	.4
26	.3	.3	.4	.4	.4	.4	.4	.4	.5	.5	.5	.5	.5	.5	.5
27	.4	.4	.4	.4	.5	.5	.5	.5	.5	.5	.6	.6	.6	.6	.6
28	.5	.5	.5	.5	.5	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6
29	.5	.6	.6	.6	.6	.6	.7	.7	.7	.7	.7	.7	.7	.7	.7
30	.6	.6	.6	.7	.7	.7	.7	.8	.8	.8	.8	.8	.8	.8	.8
43	1.0	1.0	1.0	1.1	1.1	1.1	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
44	1.4	1.5	1.5	1.5	1.5	1.6	1.6	1.6	1.6	1.7	1.7	1.7	1.7	1.7	1.7
45	1.9	1.9	2.0	2.0	2.0	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1
50	2.5	2.5	2.5	2.5	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.5	2.5
55	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.0	3.0	3.0

R6 and R7

TABLE C -- TEMPERATURE CORRECTIONS -- REFRACTOMETER
(For Refractometers Standardized at 20 Degrees C.)

Degrees Brix															
Temp. Degrees C.	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70
-- Subtract From Brix Reading --															
10	0.5	0.5	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8
11	.5	.5	.5	.6	.6	.6	.6	.7	.7	.7	.7	.7	.7	.7	.7
12	.4	.5	.5	.5	.5	.5	.6	.6	.6	.6	.6	.6	.6	.6	.6
13	.4	.4	.4	.4	.5	.5	.5	.5	.5	.5	.5	.5	.5	.6	.6
14	.3	.4	.4	4.	.4	.4	.4	.4	.4	.5	.5	.5	.5	.5	.5
15	.3	.3	.3	.3	.3	.3	.4	.4	.4	.4	.4	.4	.4	.4	.4
16	.2	.2	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3
17	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
18	.1	.1	.1	.1	.1	.1	.1	.2	.2	.2	.2	.2	.2	.2	.2
19	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
-- Add to Degrees Brix Reading --															
21	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
22	.1	.1	.1	.1	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
23	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
24	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3
25	.3	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4
26	.4	.4	.4.	.4	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5
27	.5	.5	.5	.5	.5	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6
28	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6
29	.6	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7
30	.7	.7	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8

International Temperature Correction Table, 1936. Nearest 1/10th Degree.