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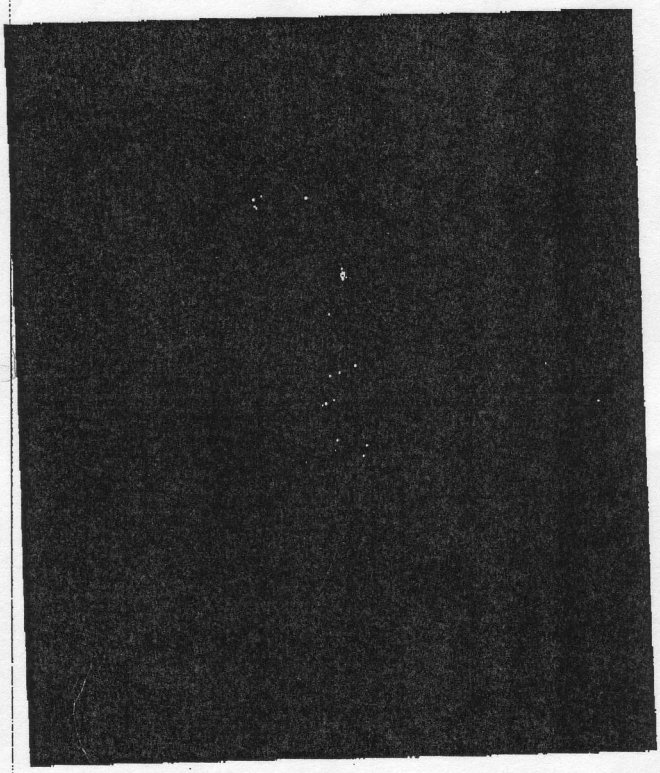
Fax # 607-257-1366	Fax #	

ABBE-3L

REFRACTOMETER



OPERATOR'S MANUAL

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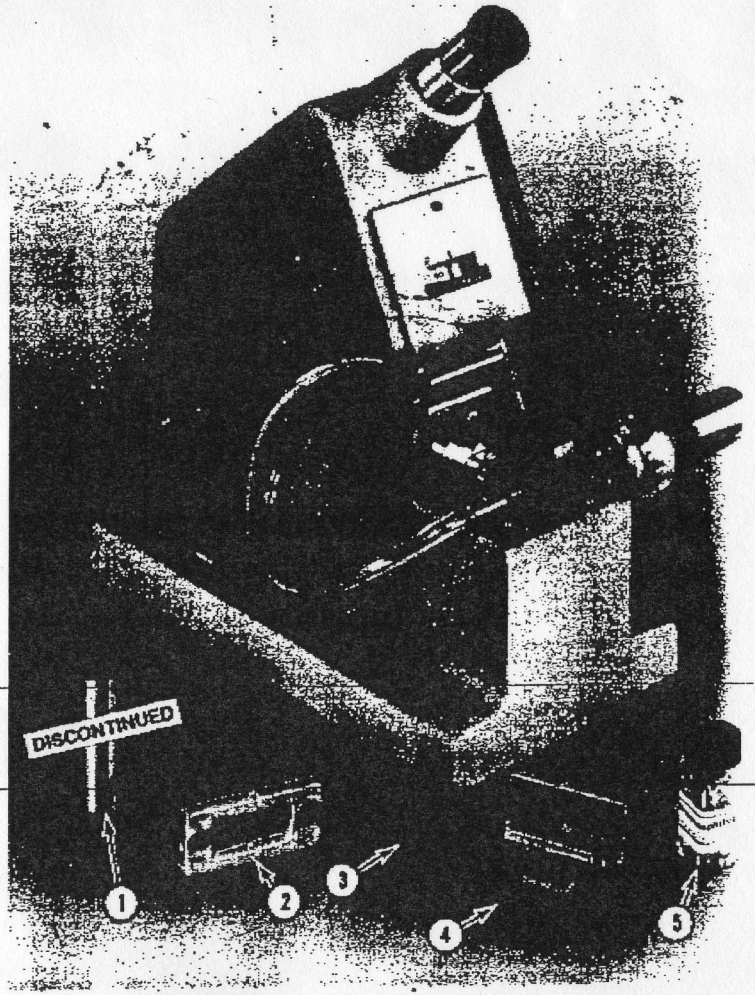


1. Optional 1.3X Eyepiece
2. Compensator Dial Cover
3. Calibration Hex Wrench
4. Calibration Test Piece
5. Contact Liquid

FIGURE 1. The Milton Roy Abbe-3L Refractometer

DESCRIPTION

The Abbe-3L consists of a refracting prism assembly (with illuminator), an internal measurement scale, and a compensating prism system.

REFRACTING PRISM ASSEMBLY

The prism assembly consists of an upper and lower prism case, each containing a separate prism. The upper case contains the illuminating prism and the lower case contains the measuring prism. The upper case is opened with the handle on the right-hand side.

In use, the n_D of liquid samples is measured by introducing a thin film of sample between the upper and lower prisms; the n_D of solid samples is measured by placing them in optical contact with the surface of the measuring (lower) prism with a suitable contact liquid.

In both cases, the sample/prism interface generates a "total reflection" borderline which is visually observed through the instrument eyepiece. This total reflection borderline is used to determine the n_D of the sample.

The prism cases are hollow to allow for the optional circulation of constant temperature liquid. A thermometer in the input line provides an accurate indication of the liquid temperature. A short, external jumper carries the liquid to the upper prism case.

Prism Identification Number

The particular series of prism glass used in your Abbe-3L is identified by a number found on the right-hand side of the measuring prism. This number can be seen by opening the upper prism case and holding a light near the lower prism. This number MUST match the scale series number described below and must be given along with the instrument serial number, in all correspondence or parts orders for your instrument.

The lower prism case has a small, hinged shield which prevents stray light from entering the front of the measuring prism. This shield can be swung down for measuring opaque samples.

Prism Illumination

The total reflection borderline, as seen in the instrument eyepiece, is the dividing line between a light and a dark sector. The required illumination (white light) is given by the "Field Lamp" located at the end of the adjustable arm. The lamp is housed inside the rotating lens assembly which also contains a lamp shield and diffuser. The arm assembly can be moved up or down and the lens rotated for optimum illumination of the prism, as seen by maximum definition in the reflection borderline. The field lamp is turned on when the combined power/lamp selector switch on the left panel is in the center position.

EYEPIECE

The eyepiece is used to observe both the total reflection borderline and the instrument's internal measurement scales. It normally provides a 2X magnification. A dual reticle provides precise settings on the reflection borderline and accurate readout of the measurement scale.

MEASUREMENT SCALES

The instrument contains two coincident scales which read from 1.30 to 1.71n_D and from 0-85% total dissolved solids. The scales are visible through the instrument eyepiece when the power/lamp selector switch is depressed to its lower position.

The eyepiece should be focused for the best image of the reticle and scales. The "Total Dissolved Solids" scale is based directly on the 20°C ICUMSA Tables of 1966.

Turning the handwheel on the right-hand side of the instrument moves the scales (and total reflection borderline) across the reticle.

When the scales are set to their extreme low end, a small 3-digit number will be seen. This number (the prism identification number) MUST match that found on the side of the measurement prism.

FIGURE 3. View of Reflection Borderline

1. Total Reflection Borderline
2. Dual Reticle

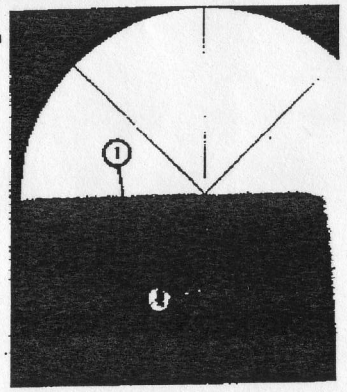
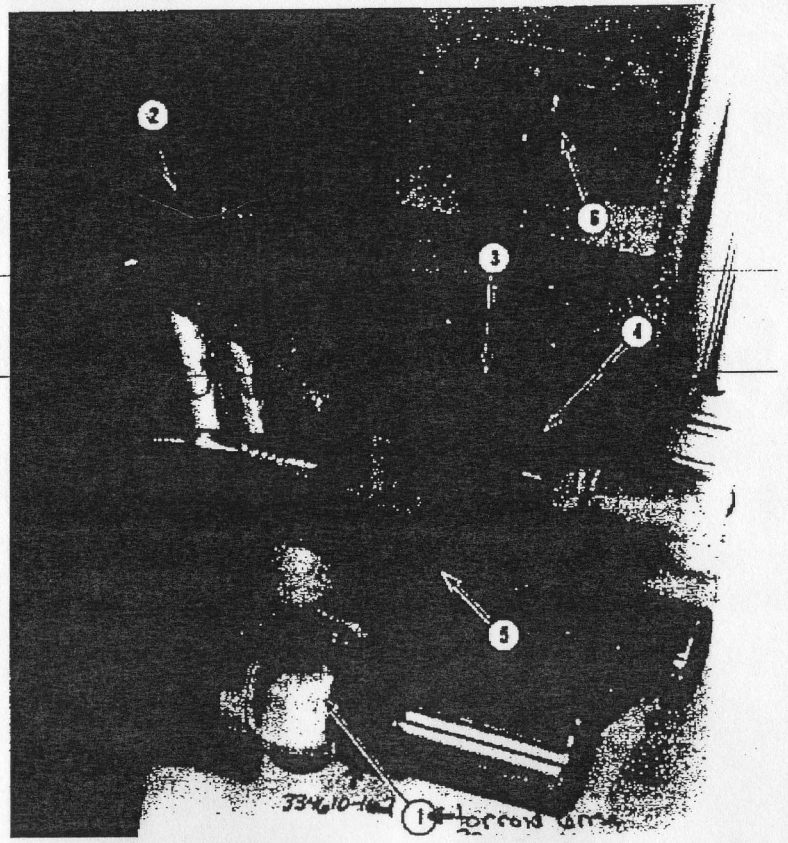
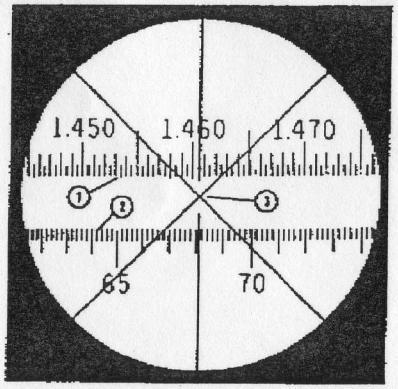


FIGURE 2. Abbe-3L Parts Description

1. Prism Field Lamp
2. Upper Prism Case
3. Measuring Prism
4. Lower Prism Case
5. Hinged Lightshield
6. Compensator Dial
7. Thermometer Assembly
8. Water Inlet Fitting





1. Refractive Index (n_D)Scale
2. Total Dissolved Solids Scale
3. Dual Reticle

FIGURE 4. View of Internal Scales

COMPENSATOR SYSTEM

The compensator corrects for the dispersion inherent in the refractometer optics and the sample, and is adjusted using the large dial on the front of the instrument. When properly set, the reflection borderline seen through the eyepiece will be achromatic in the center (at the cross hair), with a faint red color at one end, and a faint blue color at the other end.

Note that the dial circumference has two sets of markings with a common zero (0) point. If the compensator is in proper working order, the borderline can be achromatized at two positions of rotation with near identical dial settings. The dial numbers themselves are NOT significant in routine n_D or % total solids determinations. They are, however, used in the calculation of dispersion with the tables provided with the instrument.

A removable plastic dial cover prevents the entry of foreign material into the inside of the instrument. Keep the cover in place except when adjusting the Compensator Dial.

OPERATING PROCEDURES

GENERAL

The Abbe-3L provides maximum precision with quick, easy operation. To maintain its performance, keep it clean at all times and pay particular attention to the care of the measuring prism:

1. **Use a non-ionic detergent to clean the prisms after each sample and keep the upper prism closed when not in use. The prism glass is quite soft and easily scratched.**

2. **The sealer around the prisms is an epoxy resin which is resistant to most materials. However, there are a few solvents which are known to attack it and which must not be used with the instrument:**

   a. N,N - Dimethylformamide.

   b. Phenols, cresols, and other tar acids.

   c. Acetic acid solutions.

   d. N,N - Dimethylacetamide.

   The following materials will attack the sealer over a long period of time or at elevated temperatures:

   a. Tetrahydrofuran.

   b. Mixtures of esters, especially methyl acetate and vinyl acetate.

   c. Some lacquer thinners.

   If in doubt about the sample/sealer compatibility, please contact the nearest Milton Roy regional office.

3. **Strong mineral acids and bases will quickly fog the prisms and must not be used.**

INSTRUMENT CALIBRATION

Each instrument is supplied with a calibration test piece used to check and adjust the accuracy of the index scale reading. To calibrate the instrument:

1. **Connect the power cord with external transformer to a standard 115VAC 50/60 Hz outlet and depress the power/lamp switch.**

2. **Open the top prism. Thoroughly clean the measurement prism and the test piece. Use care not to scratch the glass surfaces.**

3. **Apply a small drop of 1-Bromonaphthalene contact liquid to the prism.**

4. **Place the test piece on the contact liquid, polished end toward the illuminator. Move the test piece to completely fill the contact area. Do not allow any excess 1-Bromonaphthalene to "bead" at the edges.**

5. **Depress the power/lamp switch and use the handwheel to set the index scale (visible through the eyepiece) to the value engraved on the test piece. Focus the eyepiece for the best definition of the reticle and scale.**

6. **Release the switch and position the field lamp arm and shield for the best contrast and definition at the reflection borderline.**

   NOTE

   It may help to rotate the lamp lens to the diffused position.

7. **Rotate the Compensator Dial until the achromatic section of the borderline is centered on the vertical reticle mark.**

8. **Use the handwheel and center the reflection borderline exactly on the reticle cross hairs.**

9. **Depress the switch and note the index value. It must coincide with the value engraved on the test piece. Repe measurement several times, c ing the reflection borderline both above and below the cross intersection.**

10. **If the index displayed does not cide with the test piece, insert th bration wrench into the hex screw on the right-hand side the handwheel, and adjust the to the test piece value.**

1. Calibration Screw
2. Handwheel

FIGURE 5. Right Side View

LIQUID SAMPLES

1. **Insure that the prisms are absc clean and refer to the section on "Te ature Control."**

2. **Turn on the instrument. Open t prism case and apply the sample di to the measurement prism with a dr Use care not to touch the prism s with the dropper. If the sample i viscous, use a wooden or plastic cator. NEVER USE GLASS OR M**

APPLICATORS ON THE PRISM FACE. Insure that sufficient sample has been loaded to completely fill the space between prisms. Close the prism case.

NOTE

If bubbles form in the sample, they may sometimes be eliminated by slightly opening and closing the prism case. If this is not effective, reclean the prism surfaces.

3. Adjust the illuminator for the best contrast in the reflection borderline. Using the handwheel, set the borderline on the cross hair intersection, and achromatize it with the Compensator Dial.

4. Depress the contact switch and read the sample value in index of refraction (n_D) or % total solids.

SOLID SAMPLES

To accurately measure the index of a solid sample, it must meet the following requirements:

a. The contacting surface must be flat to a few wavelengths.

b. It must have a sharp right angle edge.

c. The material must be homogeneous.

1. Open the top prism case and insure that the measurement prism is absolutely clean.

2. Using a suitable contact liquid, place the sample on the measurement prism with the sharp edge toward the illuminator and flat side down. NOTE: The 1-Bromonaphthalene is suitable for samples with an index up to 1.64n_D. For samples with a higher index, use methylene iodide.

3. Adjust the illuminator for the best contrast in the reflection borderline. Set the borderline on the cross hair intersection, and achromatize it with the Compensator Dial.

4. Depress the contact switch and read the sample value in index of refraction (n_D).

In general, the temperature coefficient of index change is so small in solid materials that temperature control is not required. However, with some of the newer plastics this may not be true, and if in doubt the temperature coefficient should be checked.

OPAQUE SAMPLES

Refractive index measurements are seldom required on opaque materials, but when it is necessary to obtain such a reading the reflection method must be used which is, at best, not very satisfactory.

When measuring by reflection, the sample is attached to the prism with the usual contact liquid, the light shield on the measuring prism is swung down, and the light from the illuminator is directed toward the shield. The illuminator arm and shield are then adjusted for the most favorable reflection borderline.

In the reflection method, the borderline is very indistinct because of the lack of contrast between the two halves of the field. This is inherent in any Abbe type instrument and cannot be avoided. Sometimes the line can be seen only when it is in motion across the field. Then it may help to move the borderline past the cross hairs with a constantly decreasing motion until it can no longer be distinguished. In using this method, take a number of readings, approaching the cross hairs from above and below.

If one is forced to use the reflection method, experimental readings may be made using paraffin oil. With it, the borderline may be set by the usual transmission method and then observed in reflection. This will aid in recognizing the characteristics of a reflection borderline.

TEMPERATURE CONTROL

Various materials differ greatly in their changes of index with change in temperature. The degree of temperature control required depends on the nature of the sample and the desired accuracy of the reading. Most of the vegetable and mineral oil and fats, for example, have temperature coefficients in the order of 0.0004 to 0.0005 n_D per degree centigrade and must have close temperature control for accurate and consistent results.

Correction tables have been prepared for many materials whose refractive index is commonly determined. Readings may be made at any normal ambient temperature

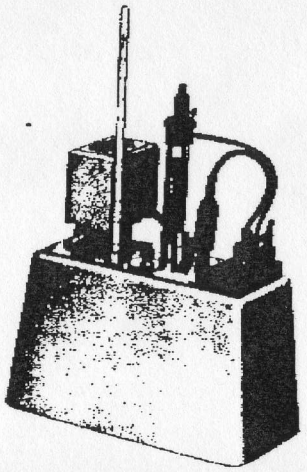
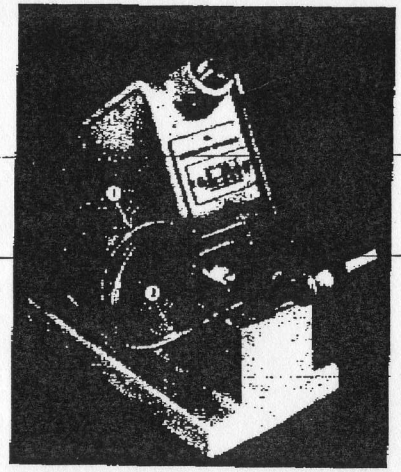


FIGURE 6. Typical External Water Circulator



1. Outlet Hose
2. Jumper Hose

FIGURE 7. Abbe-3L Hose Connections

and the values at a standard temperature computed using the correction factor obtained from the table.

The International Sucrose Tables in this manual are published with correction factors related to the 20°C standard tem-

able, instrument temperature con predetermined value is not neede ever, the room ambient temperatu remain constant for a reasonable time to allow the prism temperatur bilize. NOTE: The sucrose correcti are the only tables furnished by Mil

NOTE

The built-in thermometer (33-45- not agree exactly with the therm supplied with an external water ci This is because the thermometers a different locations. Neither of thes exactly the same as the sample loca greatest accuracy, the user may make a correlation between one thermometers and the actual tem at the sample location as measured l a small, accurately calibrated th placed directly between the closed

WATER BATH CONTROL

For those applications which requi close temperature control, an e water/heater circulator is recomm Models are available which provide only, or a combination of heating When using an external circulator:

1. Follow the instructions supplied v unit.

2. Connect the circulator water out to the connector on the Abbe-3 mometer elbow. Refer to the illu for the jumper hose and outlet h nections. Allow time for the prism bilize at the water temperature.

3. Use caution when operating at e temperatures. The water temp must be raised and lowered slowly vent a possible cracked prism.

4. The Abbe 3-L Refractometer is d for use up to 80°C. If you wish to temperatures over 80°C, contact:

Technical Support
Analytical Products Division
MILTON ROY COMPANY
820 Linden Avenue
Rochester, New York 14625

or telephone:

Continental U.S. 1-800-9

THIN FILM MEASUREMENTS

The Abbe-3L Refractometer can be used to determine both the thickness and refractive index of a thin film coating if it meets the following criteria:

a. A thickness of 0.0001mm to 0.05mm, nominal.

b. The refractive index must be within the range of the instrument.

c. The coating must be flat and uniform in thickness.

d. The coating must have a lower refractive index than the backing.

A sodium vapor lamp must be used for illumination, and a polaroid filter must be placed over the instrument eyepiece.

For further assistance, please contact the nearest Milton Roy regional office.

DETERMINATION OF DISPERSION

The Milton Roy Abbe-3L can be used to determine the following optical parameters:

a. Dispersion

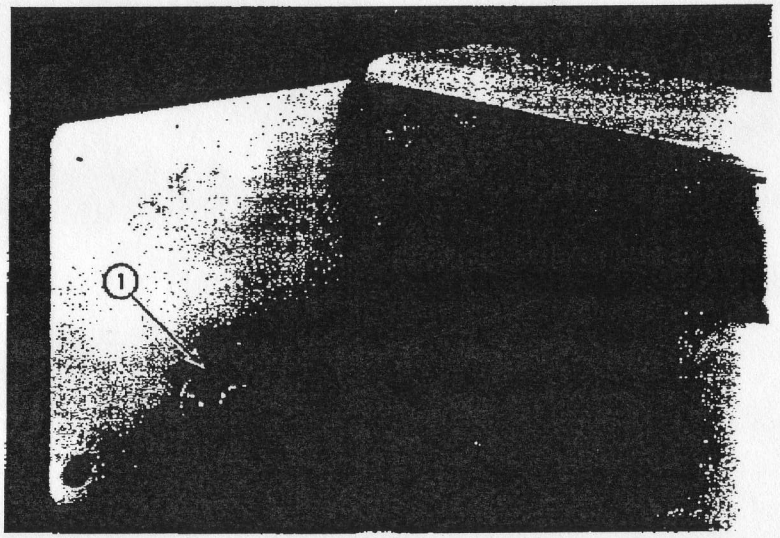
b. υ (Nu Value or Abbe Number)

In these applications, it is essential that the compensator be in good working order, i.e., the two positions of the Compensator Dial which produce an achromatic reflection borderline must occur at identical dial settings on each side of the dial zero mark.

a. Dispersion Measurement - Dispersion is measured as $n_F - n_C$, using the instructions and values given in the "Dispersion Table" furnished with the instrument. NOTE: The series number of the "Dispersion Table" MUST match the series number of the instrument prism and scale.

b. Nu Value - Determined from the equation:

$$\upsilon = \frac{n_D - 1}{n_F - n_C}$$



1. Scale Illuminator Lamp

FIGURE 8. Bottom View

MAINTENANCE

The Abbe-3L is a rugged, trouble-free instrument which needs a minimum of routine maintenance. Customer repairs are limited to lamp and thermometer replacements and prism assembly replacements ONLY. Do not attempt to make any repairs or adjustments on the internal components of the instrument.

If service is required while the instrument is under warranty and it was purchased from a dealer, contact the dealer. If purchased from Milton Roy, contact any Milton Roy Field Service Center.

If service is required when the instrument is out-of-warranty, it may be returned to any Field Service Center, regardless of the purchase location.

LAMP REPLACEMENT

CAUTION

Unplug instrument before replacing lamp.

a. To replace the prism field lamp, pull off the plastic lens assembly from the arm and unlock the old lamp.

b. To replace the scale illumination lamp, open the access door on the bottom of the instrument by removing the two screws in the door corners ONLY.

Replace both lamps with Milton Roy Cat. No. 33-33-46.

PRISM ASSEMBLY REMOVAL & REPLACEMENT

After long use, it may be desirable to have the prism surface repolished by Milton Roy. To remove the prism assembly:

a. Remove the two screws that fasten the lower hinge plate to the lower prism case. Remove the upper prism case and hinge.

b. Remove the four screws holding the nylon insulator to the instrument and remove the lower prism unit.

Spare prism assemblies (of a given series) are available for your Abbe-3L. If a replacement prism is required, BE SURE THE PRISM SERIES NUMBER MATCHES THE SERIES NUMBER ON THE INDEX SCALE.

To reassemble the prism assembly:

a. Apply a thin bead of adhesive/sealant (RTV silicone rubber) along the perimeter of the prism case insulator before fastening the lower prism case to the instrument and tighten the four screws.

b. Attach the hinge and upper prism to the lower case. When securing the hinge screws, press down on the closed upper prism to insure that the two prism cases are in contact and parallel to each other.

MERCURY SEPARATION

Separation of the mercury column thermometer can be caused by mech shock and is the most common sou error in thermometer readings. C inspection should be made before detect any separation in the capill mercury droplets on the bore walls. M can be reunited without harm thermometer using the following me

1. Unscrew the thermometer ass from the instrument and unscr guard tube.

2. Dip the thermometer bulb into a si freezing mixture until the me contracts into the bulb. Remo thermometer and allow it to warm at room temperature. The colum usually appear reunited. This p should be tried several times.

3. Mercury may sometimes be reuni gently warming the bulb over a l flame. The mercury column is gra forced into the upper expansion ch

If the thermometer is held in a vertical position to cool, the mercury will recede as a reunited column. CARE MUST BE TAKEN TO PREVENT THE MERCURY FROM COMPLETELY FILLING THE EXPANSION CHAMBER.

INTERNATIONAL SUCROSE TABLES

The "Total Dissolved Solids" scale, visible in the instrument eyepiece along with the index scale, is based directly on the International Sucrose Tables as agreed upon by the Fourteenth Session of the International Commission for Uniform methods of Sugar Analysis (ICUMSA), held in Copenhagen in 1966.

These tables are based on the index values of pure sucrose solutions. When substances other than sucrose are in the solution, the refractometer reads the combined index as "% total dissolved solids" and not as % sucrose.

The instrument scale is based on the 20°C tables. This manual contains the 20°C tables, along with correction factors for other temperatures.

NOTE

Abbe-3L's manufactured prior to August 1980 were calibrated to the 1936 ICUMSA Scale. These instruments will read 1.5033 on the n_D scale when the "Total Dissolved Solids" scale is at 85%. Instruments with 1966 ICUMSA Scales will read 1.50406 at the 85% setting.

A Correction Thermometer, Cat. No. 33-45-21, is available as a replacement for the standard instrument thermometer. It quickly indicates the correction required when the instrument is used at temperatures other than 20°C. The maximum error - found only at the extremes of the temperature range and % solids scale - is only 0.2%.

International Scale (1968) of Refractive Indices of Sucrose Solutions at 20°C

Index	Per cent	Index	Per cent	Index	Per cent	Index	Per cent
1.3330	0	1.3723	25	1.4200	50	1.4778	75
1.3344	1	1.3740	26	1.4221	51	1.4803	76
1.3359	2	1.3758	27	1.4243	52	1.4829	77
1.3373	3	1.3775	28	1.4264	53	1.4855	78
1.3388	4	1.3793	29	1.4286	54	1.4881	79
1.3403	5	1.3811	30	1.4308	55	1.4907	80
1.3418	6	1.3829	31	1.4329	56	1.4933	81
1.3433	7	1.3847	32	1.4351	57	1.4960	82
1.3448	8	1.3866	33	1.4374	58	1.4987	83
1.3463	9	1.3884	34	1.4396	59	1.5013	84
1.3478	10	1.3903	35	1.4419	60	1.5041	85
1.3494	11	1.3922	36	1.4441	61		
1.3509	12	1.3941	37	1.4464	62		
1.3525	13	1.3960	38	1.4487	63		
1.3541	14	1.3979	39	1.4511	64		
1.3557	15	1.3998	40	1.4534	65		
1.3573	16	1.4018	41	1.4558	66		
1.3589	17	1.4037	42	1.4582	67		
1.3605	18	1.4057	43	1.4605	68		
1.3621	19	1.4077	44	1.4630	69		
1.3638	20	1.4097	45	1.4654	70		
1.3655	21	1.4118	46	1.4678	71		
1.3672	22	1.4138	47	1.4703	72		
1.3689	23	1.4159	48	1.4728	73		
1.3706	24	1.4179	49	1.4753	74		

International Temperature Correction Table for the Normal Model of Refractometer Above and Below 20°C.

Temp. °C.	Per cent Sucrose													
	0	5	10	15	20	25	30	35	40	45	50	55	60	65
	Subtract from the per cent Sucrose													
10	0.50	0.54	0.58	0.61	0.64	0.66	0.68	0.70	0.72	0.73	0.74	0.75	0.76	0.7
11	0.46	0.49	0.53	0.55	0.58	0.60	0.62	0.64	0.65	0.66	0.67	0.68	0.69	0.7
12	0.42	0.45	0.48	0.50	0.52	0.54	0.56	0.57	0.58	0.59	0.60	0.61	0.61	0.6
13	0.37	0.40	0.42	0.44	0.46	0.48	0.49	0.50	0.51	0.52	0.53	0.54	0.54	0.5
14	0.33	0.35	0.37	0.39	0.40	0.41	0.42	0.43	0.44	0.45	0.45	0.46	0.46	0.4
15	0.27	0.29	0.31	0.33	0.34	0.34	0.35	0.36	0.37	0.37	0.38	0.39	0.39	0.4
16	0.22	0.24	0.25	0.26	0.27	0.28	0.28	0.29	0.30	0.30	0.30	0.31	0.31	0.3
17	0.17	0.18	0.19	0.20	0.21	0.21	0.21	0.22	0.22	0.23	0.23	0.23	0.23	0.2
18	0.12	0.13	0.13	0.14	0.14	0.14	0.14	0.15	0.15	0.16	0.15	0.16	0.16	0.1
19	0.06	0.06	0.06	0.07	0.07	0.07	0.07	0.08	0.08	0.08	0.08	0.08	0.08	0.0
	Add to the per cent Sucrose													
21	0.06	0.07	0.07	0.07	0.07	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.0
22	0.13	0.13	0.14	0.14	0.15	0.15	0.15	0.15	0.15	0.16	0.16	0.16	0.16	0.1
23	0.19	0.20	0.21	0.22	0.22	0.23	0.23	0.23	0.23	0.24	0.24	0.24	0.24	0.2
24	0.26	0.27	0.28	0.29	0.30	0.30	0.31	0.31	0.31	0.31	0.32	0.32	0.32	0.3
25	0.33	0.35	0.36	0.37	0.38	0.38	0.39	0.40	0.40	0.40	0.40	0.40	0.40	0.4
26	0.40	0.42	0.43	0.44	0.45	0.46	0.47	0.48	0.48	0.48	0.48	0.48	0.48	0.4
27	0.48	0.50	0.52	0.53	0.54	0.55	0.55	0.56	0.56	0.56	0.56	0.56	0.56	0.5
28	0.56	0.57	0.60	0.61	0.62	0.63	0.63	0.64	0.64	0.64	0.64	0.64	0.64	0.6
29	0.64	0.66	0.68	0.69	0.71	0.72	0.72	0.73	0.73	0.73	0.73	0.73	0.73	0.7
30	0.72	0.74	0.77	0.78	0.79	0.80	0.80	0.81	0.81	0.81	0.81	0.81	0.81	0.8

ACCESSORIES AND REPLACEMENT PARTS LIST

CATALOG NO.	DESCRIPTION
33-46-10	Abbe-3L Refractometer, complete, for 115V, 50/60 Hz operation only; with index range from 1.30 to 1.71n_D, includes glass test piece, thermometer, bottle of 1-Bromonaphthalene contact liquid, calibration wrench, dust cover, operator's manual, and dispersion tables
334610-201	Plastic Dust Cover
33-45-21	Thermometer direct reading in "total solids" corrections, "0" ring and mounted bushing
33-45-27	Thermometer assembly, 0-100°C, in 1° divisions
33-45-24	Thermometer, 0-100°C, in 1° divisions, "0" ring and mounted bushing
33-46-11	Replacement Prism Set, for 33-46-10. Please mention series number of prism and serial number of instrument when ordering.
33-46-68	Standard Eyepiece, 2X, as supplied with standard instrument
33-45-81	7 ml bottle Bromonaphthalene, for use as contact liquid for test pieces and other solid samples with indices less than 1.64n_D
33-45-85	Test Piece, Nominal Index of 1.5125n_D, as supplied with each 33-46-10
33-33-46	GE316 Lamp, used for sample and scale illumination
334610-233	Compensator Dial Cover, Magnetic
334556-275	Calibration Wrench, 5/64"

BIBLIOGRAPHY

For a detailed discussion of refractometry, refer to "Physical Methods of Organic Analysis," Vol. 1, Part 2, Chapter 18, by A. Weissberger.