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Manual

Refractometer ABBE

Abbe Refractometer

AR3 | AR4 (with Illumination Unit)

Operating Manual

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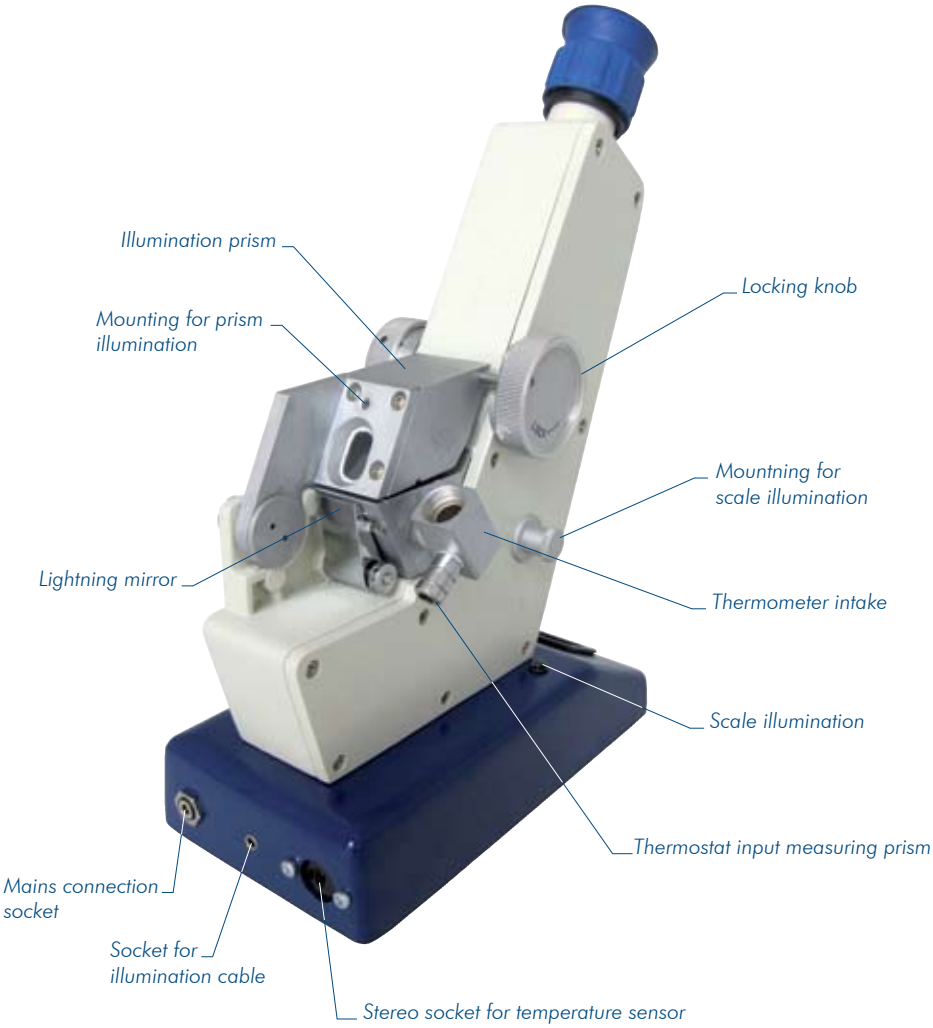
Index

ENGLISH

1. Handling and connection part


Illumination prism
Mounting for prism illumination
Locking knob
Mountning for scale illumination
Lightning mirror
Thermometer intake
Scale illumination
Thermostat input measuring prism
Mains connection socket
Socket for illumination cable
Stereo socket for temperature sensor

2. Applications

The Abbe refractometer measures refractive indexes nD, solid contents in % and mean dispersion values nF-nC of tranparent and translucent liquids or solids. When connected to a thermostat the instrument can measure the refractive indexes from 0–70 °C.

The refractive indexes and the dispersion values belong to the important optical data of substance with which the concentration, purity and optical condition can be tested.

The Abbe refractometer has a wide field of application eg. in the petro-chemistry, oil and lubrication industries and in the pharmaceutical, chemical, food and

It is suitable for use in the following analyses:

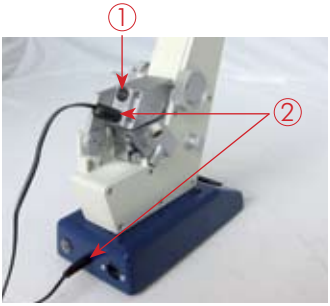
- Determination of concentration
- Determination of mixing ration
- Purity control
- Manufacturing control of products

3. Setting Up

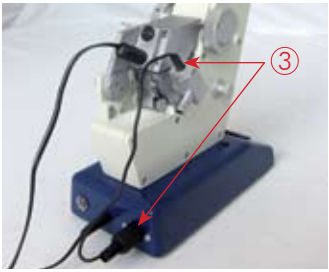
The Abbe refractometer is delivered in styrofoam packing material. Remove the instrument and the attachements from the packing. Mount the illumination and digital thermometer as follows:

Important!

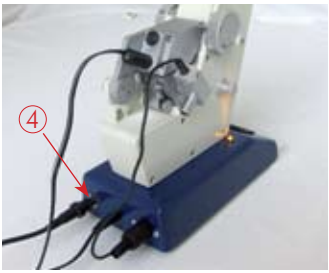
► First screw in the thermometer.



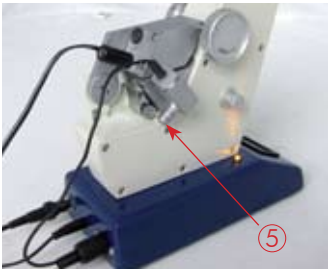
Screw the lighting plate with the knurled screw onto the lightning mount ①. Mount the lightning cable to the corresponding sockets ②.



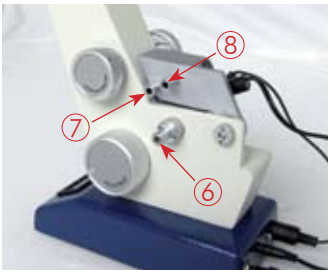
Screw the temperature sensor of the digital thermometer with the sealing ring into the thermometer mount ③ and connect the stereo plug to the stereo socket.
It is necessary to keep the temperature constant for absolute exact measurements because the refractive index of liquids alters with the temperature.
For temperature control of the prisms, flexible piping connections are supplied.



Connect the power cable with the device ④ and then with the power supply.



Connect the thermostat pipe to the connecting nipple ⑤....



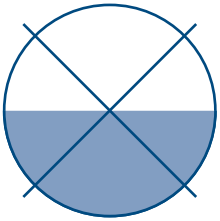
... The lukewarm water flows round the measuring prism, through a small piece of pipe from nipple ⑥ to nipple ⑦, then through the illuminating prism and leaves this through the second nipple ⑧.

4. Calibration

Before taking any measurements, the calibration of the scale must be checked. Two possible ways of doing this are described as follows:

4.1 Calibration with standard solids

After switching the instrument on turn the locking knob clockwise and lift up the illuminating prism. Put a few drops of contact liquid on the measuring prism before placing the polished surface of the standard glass block on the measuring prism. Make sure that there are no air bubbles between the two surfaces.



The standard glass block must be slightly covered by the illuminating prism. This is done so that the direct light is reduced otherwise an over-exposure will occur which would make an exact calibration impossible.

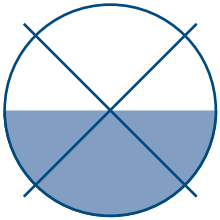
Look through the eyepiece and turn to the left or to the right until it is possible to see the reticle clearly.

Then turn the scale knob to the value marked on the standard glass block.

Then eliminate the colour round the light/ dark line with the compensation knob, the separation line must now lie on the point of intersection of the reticle.

If this is not the case, adjust the position of the light/ dark line by turning the adjustment screw on the front of the refractometer, with a screwdriver, until it lies exactly on the point of intersection of the reticle.

4.2 Calibration with distilled water



The method described above is theorectically the more exact method but the following method is easier to use and, therefore, is used more frequently.

Instead of using contact liquid, a few drops of distilled water are put onto the measuring prism. Otherwise, the above instructions are to be followed with the exception that a refractive index of 1.3330 nD or 0% Brix is to be set on the scale.

By this method of calibration, it is necessary to take into account that the refractive index of distilled water depends a lot on the temperature; therefore, it is necessary to measure the temperature and with the help of table 1 to set the corrected refractive index on the scale. Then, as above, light/dark line can be set on the point of intersection of the reticle.

5. Measuring Liquids

Turn the locking knob to lift up the illumination prism.

Put one or two drops of liquid on the measuring prism, then lower the illumination prism to the former position and lock with the knob.

Look through the eyepiece and sharply define the reticle by turning to the right or left.

By turning the scale adjustment knob move along the measuring range until a light/dark division appears. Eliminate the colour round the devision line with the compensation knob until a black-white division is reached. The dispersion of the light is compensated.

Adjust the light/dark line exactly on the point of intersection of the reticle and then the display will show the refractive index or solid content in %.

6. Measuring Solids

The surface of the object to be measured should have a plane smooth surface.

Put one drop contact liquid on the measuring prism and lightly press the smooth surface of the sample onto it. There must be no air bubbles.

Open the reflecting mirror and direct light by way of the mirror onto the prism.

Proceed in the same way as for measuring liquids.

The measurements occur now in reflected light, the light/dark fields are exchanged and the contrast becomes less but this has no effect on the measurement results.

Important!

► When measuring solids the refractive index of the contact fluid must be higher than that of the solid to be measured.

When the refractive index of the solid to be measured is higher than 1.65 nD then methyljod with 1.71 nD must be used as a contact fluid.

The surfaces of the prisms must be cleaned immediately after use with alcohol because contact liquids are very corrosive.

The prisms are made of optical glass, therefore, one must be careful not to scratch the surfaces.

7. Calculation of the Dispersion

The *dispersion value* can be calculated from the following equation:

$$nF - nC = A + B \times a$$

The values A and B in table 2 are related to refractive indices. The values in between are to be obtained by interpolation.

The refractive index of the sample must be measured, the values appertaining to A and B are to be taken from table 2.

The value for A is determined as follows:

When measuring the refractive index, the colour on the dividing line is eliminated by using the compensation knob. There is a scale ring on the knob which is divided into 60 – 0 – 60.

There are two positions on the compensation knob where it is possible to eliminate the colour fringe on the dividing line.

Adjust to the two positions and read the corresponding value on the scale ring on the compensation knob. This process should be repeated several times and the values noted on a table so that the mean value can be calculated.

The alpha value can then be determined using the mean value „Z" according to table 3. The values in between can be found by interpolation.

The *Abbe figure* is another important quantity as an identification of an optical medium. It is calculated as follows:

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

Example for calculation the value of dispersion:
Measured refractive index **nD = 1.4827**

Values on the scale of compensation knob:

1st position	2nd position
42.3	42.2
42.2	42.1
42.2	42.3
42.2	42.2

meanvalue Z = 42.2

Calculation:

nD = 1.4827 (measured)
Z = 42.2 (meanvalue)
A = 0.024265 (from table)
B = 0.024670 (from table)
a = - 0.5962 (from table)
B x a = - 0.014708
nF - nC = A + B x a
= 0.009557

$$V = \frac{n_D - 1}{n_F - n_C} = \frac{0.4827}{0.009557} = 50.5$$

8. Special Instructions

- The contrast of the light/dark area is less if the sample is cloudy or coloured. In this case the measurement must be done with reflected light as described for solid samples.
- When a colloid solution is used one must make sure that the colloids are finely and homogenously distributed in the solution otherwise the dividing line will appear to be blurred.

- A highly viscous solution could show a different refractive index on the surface as on the bottom. The solutions should always be well stirred and mixed.
- The solution must cover the larger part of the measuring prism otherwise no clear light/dark division can be obtained. This can, in particular, happen by quickly evaporating liquids that remain a longer time between the measuring and the illuminating prisms.
- To have optimal adhesion of the samples the prism must always be kept clean.
- The instrument must not come in contact with dust, gases, direct sunlight or dampness. It must always be used in an horizontal position otherwise incorrect values will be measured.

9. Technical Data

Measuring range	Refractive index: 1.300 - 1.700 nD dry substance: 0.0 - 95 %Brix
Scale devision	0.0005 nD 0.25 % Brix
Resolution and accuracy	0.0002 nD 0.1 %Brix

10. Tables

Table 1 Refracting Index and Dispersion of destilled water according to the temperature.

°C	nD	nF - nC	°C	nD	nF - nC
10	1.33369	0.00600	26	1.33240	0.00596
11	1.33364	0.00600	27	1.33229	0.00595
12	1.33358	0.00599	28	1.33217	0.00595
13	1.33352	0.00599	29	1.33206	0.00594
14	1.33346	0.00599	30	1.33194	0.00594
15	1.33339	0.00599	31	1.33182	0.00594
16	1.33331	0.00598	32	1.33170	0.00593
17	1.33324	0.00598	33	1.33157	0.00593
18	1.33316	0.00598	34	1.33144	0.00593
19	1.33307	0.00597	35	1.33131	0.00592
20	1.33299	0.00597	36	1.33117	0.00592
21	1.33290	0.00597	37	1.33104	0.00591
22	1.33280	0.00597	38	1.33090	0.00591
23	1.33271	0.00596	39	1.33075	0.00591
24	1.33261	0.00596	40	1.33061	0.00590
25	1.33250	0.00596			

Dispersion table for Abbe-refractometer:
Equation: **nF - nC = A + B x a**

For **Z = 0 .. 30** Plus sign **(+)** for **a**
For **Z = 30 .. 60** Minus sign **(-)** for **a**

Table 2

nD	A	B
1.30000	0.02496	0.02901
1.31000	0.02490	0.02889
1.32000	0.02485	0.02876
1.33000	0.02480	0.02861
1.34000	0.02476	0.02845
1.35000	0.02471	0.02828
1.36000	0.02466	0.02810
1.37000	0.02462	0.02790

Table 3

Z	a	Z
0	0.000	60
1	0.999	59
2	0.995	58
3	0.988	57
4	0.978	56
5	0.966	55
6	0.951	54
7	0.934	53

nD	A	B
1.38000	0.02458	0.02768
1.39000	0.02454	0.02746
1.40000	0.02450	0.02722
1.41000	0.02446	0.02696
1.42000	0.02443	0.02670
1.43000	0.02440	0.02641
1.44000	0.02437	0.02612
1.45000	0.02434	0.02580
1.46000	0.02431	0.02547
1.47000	0.02429	0.02513
1.48000	0.02427	0.02477
1.49000	0.02425	0.02440
1.50000	0.02423	0.02400
1.51000	0.02422	0.02359
1.52000	0.02421	0.02316
1.53000	0.02420	0.02272
1.54000	0.02419	0.02225
1.55000	0.02419	0.02176
1.56000	0.02419	0.02126
1.57000	0.02420	0.02073
1.58000	0.02421	0.02017
1.59000	0.02422	0.01959
1.60000	0.02424	0.01899
1.61000	0.02427	0.01835
1.62000	0.02430	0.01769
1.63000	0.02434	0.01699
1.64000	0.02438	0.01626
1.65000	0.02443	0.01549
1.66000	0.02450	0.01467
1.67000	0.02457	0.01381
1.68000	0.02466	0.01288
1.69000	0.02476	0.01189
1.70000	0.02489	0.01083

Z	a	Z
8	0.914	52
9	0.891	51
10	0.866	50
11	0.839	49
12	0.809	48
13	0.777	47
14	0.743	46
15	0.707	45
16	0.669	44
17	0.629	43
18	0.588	42
19	0.545	41
20	0.500	40
21	0.454	39
22	0.407	38
23	0.358	37
24	0.309	36
25	0.259	35
26	0.208	34
27	0.156	33
28	0.104	32
29	0.052	31
30	0.000	30

11. Troubleshooting

Pale picture, little contrast	Mirror turned down ▶ Turn up the mirror Illumination prism is not parallel to the measuring prism ▶ Loose the illumination prism, adjust and fix it Applied too little sample ▶ Increase the sample quantity Defective surface of the measuring prism ▶ Replace the measuring prism
Thermometer does not fit to the mount	Faulty thermometer thread ▶ Change the thermometer Faulty thermometer ▶ Change the thermometer
Illumination does not work	Faulty LED ▶ Send for repair Faulty transformer ▶ Send for repair

12. Flow-through cell

The instrument can be equipped with a flow-through cell. There is a flow-through cell with a funnel AR15 or a flow-through cell for a pump AR16 available. The sample passes the prism continuously with both flow-through cells. With the flow-through cell AR16 a pump must be used. The procedure for connecting the flow-through cell is the same for both models.

13. Warranty Conditions

A. KRUESS Optronic warrants that the instruments of the Abbe refractometer family will be free from defects in materials and workmanship after the date of delivery for a time period of 24 months.
During this warranty period A. KRUESS Optronic will repair or replace products which fall under the warranty conditions. For warranty repairs or service the instrument must be returned to A. KRUESS Optronic. In the case of warranty repairs A. KRUESS Optronic will bear the delivery costs. For all other deliveries the customer will bear the delivery costs. A. KRUESS Optronic warrants that the hardware which A. KRUESS Optronic has determined for use with this instrument will operate free from defects when applied according our manufacturer's instructions.

A. KRUESS Optronic does not warrant error-free and uninterrupted operation of the instrument or that this user manual is free of error. A. KRUESS Optronic will not be liable for consequential damages.

Limited Warranty:
The preceding warranty does not apply to errors and defects caused by improper handling, software not supplied by A. KRUESS Optronic, modification, abuse or by operation outside of the stated environment or by unauthorized maintenance.

Further claims are excluded and will not be accepted. A. KRUESS Optronic explicitly does not warrant the applicability or the economic use for certain applications.

A. KRUESS Optronic reserves the right to change this user manual and the technical specifications of the described instrument at any time.

This Abbe refractometer is only then ready for shipment when it is appropriately packed in the complete original packaging. If necessary, please order a replacement packaging from your supplier.

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