BAUMÉ

PRINCIPLE

Commercial corn syrups can be sold on a Baumé basis which can be interpreted in terms of dry substances and/or specific gravity according to appropriate Tables as appended. Since some of these materials are quite viscous at room temperature, the determination is made at 140 °F under controlled conditions. An arbitrary correction of 1.00 °Baumé (°Bé) is added to the observed reading, to reduce the value to that obtained at 100 °F.

SCOPE

This method is designed for application to corn syrup and corn sugar syrups and can be used for high fructose corn syrups. When the procedure is followed carefully, the error will not exceed 0.05 °Bé (Note 1).

SPECIAL APPARATUS

1. Water Bath: Use an insulated bath, equipped with stirrer, heater and thermostat control to maintain a temperature of 140 ± 0.5 °F throughout. The bath should be fitted with a lower shelf about 14 ins. below the water level, and a higher shelf adjusted so that the surface of syrup will extend about 0.5 in. above water after immersing the hydrometer.

2. Hydrometer Cylinders: Flanged, 15 × 2 ins.

3. Stopper Seal: The seal consists of 2 rubber stoppers which fit snugly in the cylinder, and which are separated on a metal rod by about 3 ins. The rod is fixed in the bottom stopper, but does not extend through it. The top stopper is free to move on the rod, but fits sufficiently tight to maintain a predetermined position (see sketch).

4. Standard Hydrometer: Use reference hydrometer, with certificate of correction at 5 points issued by the National Institute of Standards and Technology.

5. Hydrometers: Use hydrometers of the streamlined type, 145 modulus, standardized at 60 °F, with a range of about 12 °Bé graduated to 0.1 °Bé,

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manufactured from Kimble flint glass with a linear coefficient of expansion of 9.2 $\times 10^{-6}$. The overall length of the hydrometer shall be not more than 13 ins. or less than 12 ins. The diameter of the body at the center shall not be more than 0.790 in. or less than 0.770 in. The scale length for each Baumé degree shall be not more than 14 mm or less than 12 mm.

Hydrometer Standardization: Prepare aqueous solutions of calcium nitrate to float the hydrometers at 3 scale points at room temperature (e.g., 40, 43 and 45 °Bé). Maintaining constant temperature, immerse standard hydrometer and test hydrometer (Note 2) in the solution corresponding nearest to the Baumé if the syrup under test. Read the hydrometers, apply the correction (if any) of the standard hydrometer tot he test hydrometer (Note 3). Several readings should be made on both hydrometers and average values should be used.

REGEANTS

Calcium Nitrate, reagent grade

PROCEDURE

Adjust water bath temperature to 140 °F. Pour the syrup into the cylinder within 4 in. of the top, taking care that the sides of the cylinder are free of syrup. Seal the cylinder with the dual stoppers, the bottom stopper being placed within 0.5 in. of the syrup surface and the top stopper closing the cylinder. Place the cylinder in the water bath so that the water extends to within 1 in. of the top. Fill the second cylinder with the syrup in the same manner. Seal this cylinder with a stopper fitted with a thermometer that will immerse in the syrup to a depth of 4 to 5 ins. Place this cylinder in the water bath. Fill a third cylinder with purified water, place the test hydrometer in it, and place in water bath. When the syrup is free of air (Note 4), and at a temperature of 140 °F (Note 5), place the cylinder on the higher shelf. Remove dual stoppers from the cylinder. Remove the test hydrometer by contact with top of the stem, dry quickly with a clean towel, and immerse in the syrup (Note 6).

After about 10 mins., read the hydrometer at intervals of 2 mins., through the cylinder, taking care to avoid parallax (Notes 7 and 8). Read until 2 more readings are identical.

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CALCULATION

Baumé = Obs. °Bé at 140 °F + 1.00 °Bé + Correction (Note 9)

NOTES AND PRECAUTIONS

1. Alternatively, for a precision of ± 0.1 °Bé, fill a clean, dry cylinder with sufficient "as is" sample so that it will be filled after immersion of the hydrometer. Place the filled cylinder in the 140 °F water bath using one of the holes in the top. When the syrup is at temperature and is free of air bubbles, usually 30 mins. to 2 hrs., remove surface skin. Lower a clean, dry hydrometer previously warmed to bath temperature, to within 0.5 °Bé of the anticipated reading. Add a drop of water at the stem meniscus, and allow syrup to stand until equilirium is reached, usually in 5 to 15 mins. Then add another drop of water to form a uniform meniscus and take the reading. Observe the point of upper surface where the syrup contacts the hydrometer stem and arbitrarily add 0.1 °Bé to the scale reading to compensate for the meniscus. Proceed as under Calculations.

2. Cleaning hydrometer and cylinder: Immerse in cleaning solution repeatedly. Rinse repeatedly with purified water until surface drains freely indicating no dirt on the surface. Dry with a clean towel and keep rolled in a clean towel until used.

3. The paper scales in hydrometers used at 140 °F tend to loosen and slip, so that test hydrometers should be checked at frequent intervals.

4. Syrup must be free of air before an accurate reading can be obtained. Results of an experiment with 42 D.E. corn syrup to determine the time required for all the air trapped in the pouring operation to float tot he surface were as follows:

°Baumé	Hours
42	1
43	3.5
44	6
45	24
46	95

BAUMÉ — continued

5. A correct Baumé reading is obtainable only after the temperature of the syrup and hydrometer is at 140 °F. The length of time required varies considerably with the Baumé. The second cylinder of syrup with the thermometer gives an accurate check on temperature.

6. When immersing the hydrometer, it should be slowly sunk into the syrup, without touching the wall of the cylinder, and slightly beyond the point where it floats naturally (not over 1/8 in.) and then allowed to float freely.

7. In reading transparent liquids, the eye should be placed slightly below the plane of the surface of the liquid, and raised slowly until this surface, seen as an ellipse, becomes a straight line. The point at which this line cuts the hydrometer scale is the correct reading.

   In case the syrup is not sufficiently clear to allow the reading to be made as above, it will be necessary too read from above the surface, and to estimate as accurately as possible the point to which the liquid rises on the hydrometer stem. To this reading is added a correction, determined by taking a few readings on the upper and lower meniscus of a clear syrup.

8. Despite precautions to minimize surface evaporation, a small amount of skin will develop during the reading of the hydrometer. This effect is retarded by adding a very small drop of water at the stem meniscus.

9. When the temperature of observation (in this case 140F) differs from that at which the hydrometer was standardized (60 °F), the observed reading is not the true specific gravity. It is a figure which differs from the correct reading by an amount depending upon the difference in temperature and the relative thermal expansion of the hydrometer and of the particular liquid. A table of temperature corrections of considerable precision may be determined, provided subsequent hydrometers are made with glass of the same thermal expansion and of the same physical dimensions as the primary standard, see Table 1.

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CORRECTIONS
Table I
Corrections to be Subtracted

Hydro Meter Reading	Assigned Specific Gravity In Air	Air to Vacuum	Expansion of Glass	Hydro Meter Correction	Total	True Specific Gravity, Vacuum
			60°/60 °F			
0.00	1.0000	0.00000	..	..	0.0000	1.0000
5.00	1.0358	0.00005	..	..	0.0001	1.0357
10.00	1.0742	0.00012	..	..	0.0001	1.0741
15.00	1.1156	0.00019	..	..	0.0002	1.1154
20.00	1.1602	0.00025	..	..	0.0002	1.1600
25.00	1.2086	0.00031	..	..	0.0003	1.2083
30.00	1.2612	0.00037	..	..	0.0003	1.2609
35.00	1.3186	0.00043	..	..	0.0004	1.3182
40.00	1.3815	0.00050	..	..	0.0005	1.3810
45.00	1.4506	0.00056	..	..	0.0006	1.4500
			100°/60 °F			
—0.71	0.9951	—0.00001	0.00021	0.00085	0.00105	0.9940
0.00	1.0000	0.00000	0.00021	0.00090	0.00111	0.9989
5.00	1.0358	0.00005	0.00022	0.00093	0.00120	1.0346
10.00	1.0742	0.00012	0.00023	0.00095	0.00130	1.0729
15.00	1.1156	0.00019	0.00024	0.00100	0.00143	1.1142
20.00	1.1602	0.00025	0.00025	0.00104	0.00154	1.1587
25.00	1.2086	0.00031	0.00026	0.00108	0.00165	1.2069
30.00	1.2612	0.00037	0.00027	0.00113	0.00177	1.2594
35.00	1.3186	0.00043	0.00028	0.00117	0.00188	1.3167
40.00	1.3815	0.00050	0.00030	0.00120	0.00200	1.3795
45.00	1.4506	0.00056	0.00031	0.00124	0.00211	1.4485
			140°/60 °F			
—2.01	0.9864	—0.00002	0.00042	0.00166	0.00206	0.9843
0.00	1.0000	0.00000	0.00042	0.00174	0.00216	0.9978
5.00	1.0358	0.00005	0.00044	0.00184	0.00233	1.0335
10.00	1.0742	0.00012	0.00046	0.00191	0.00249	1.0717
15.00	1.1156	0.00019	0.00047	0.00199	0.00265	1.1129
20.00	1.1602	0.00025	0.00050	0.00206	0.00281	1.1574
25.00	1.2086	0.00031	0.00052	0.00215	0.00298	1.2056
30.00	1.2612	0.00037	0.00055	0.00222	0.00314	1.2581
35.00	1.3186	0.00043	0.00057	0.00230	0.00330	1.3153
40.00	1.3815	0.00050	0.00059	0.00238	0.00347	1.3780
45.00	1.4506	0.00056	0.00061	0.00246	0.00363	1.4470

BAUMÉ — continued

COMMERCIAL BAUMÉ — DRY SUBSTANCE[2]

Table 2

145 Modules **Bé = Bé 140 °F/60 °F + 1.00°**

Dextrose Equivalent	30.0	42.0	55.0
Ash	0.28%	0.28%	0.30%
Baumé	% Dry Substance		
—1.0	0.02	0.02	0.02
0.0	1.76	1.77	1.78
1.0	3.50	3.52	3.53
2.0	5.24	5.27	5.29
3.0	6.98	7.02	7.06
4.0	8.72	8.77	8.82
5.0	10.47	10.53	10.59
6.0	12.22	12.29	12.36
7.0	13.97	14.05	14.14
8.0	15.73	15.82	15.91
9.0	17.48	17.58	17.69
10.0	19.24	19.35	19.48
11.0	21.00	21.13	21.26
12.0	22.76	22.90	23.05
13.0	24.52	24.68	24.84
14.0	26.29	26.46	26.64
15.0	28.06	28.24	28.44
16.0	29.83	30.03	30.24
17.0	31.61	31.82	32.05
18.0	33.39	33.61	33.86
19.0	35.17	35.41	35.68
20.0	36.95	37.21	37.50
21.0	38.73	39.01	39.32
22.0	40.52	40.82	41.15
23.0	42.32	42.63	42.98
24.0	44.12	44.45	44.82
25.0	45.92	46.27	46.66

BAUMÉ — continued

COMMERCIAL BAUMÉ — DRY SUBSTANCE[2]

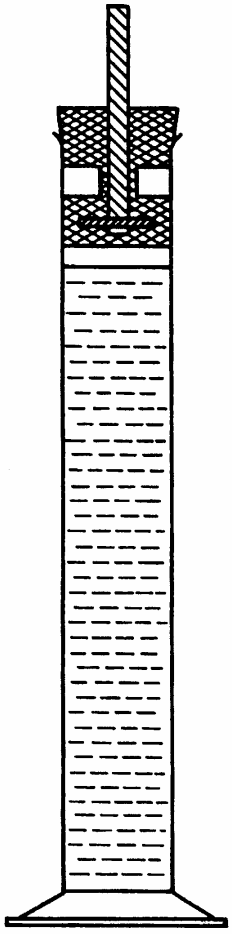
Table 2 — continued

145 Modules **Bé = Bé 140 °F/60 °F + 1.00°**

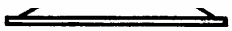
Dextrose Equivalent	30.0	42.0	55.0
Ash	0.28%	0.28%	0.30%
Baumé	% Dry Substance		
—26.0	47.73	48.10	48.51
27.0	49.54	49.93	50.37
28.0	51.36	51.77	52.23
29.0	53.19	53.62	54.09
30.0	55.02	55.47	55.97
31.0	56.85	57.33	57.85
32.0	58.69	59.19	59.73
33.0	60.53	61.06	61.63
34.0	61.39	62.94	63.53
35.0	64.25	64.83	65.44
36.0	66.11	66.72	67.36
37.0	67.99	68.62	69.30
38.0	69.88	70.54	71.24
39.0	71.77	72.46	73.19
40.0	73.66	74.39	75.16
41.0	75.58	76.34	77.14
42.0	77.51	78.30	79.13
43.0	79.45	80.27	81.14
44.0	81.36	84.25	83.17
45.0	83.36	84.25	85.20
46.0	85.34	86.26	81.26
47.0	87.33	88.29	89.34

a) Fauser, Cleland, Evans, Fetzer, Ind. Eng. Chem., Anal. Ed., *15*, 193 (1943)

BAUMÉ — Apparatus



Stopper Seal and Cylinder



Stopper Seal and Cylinder