IPPA °SAG method
revision 0,
23.01.2017

This procedure is based on the method described by Cox and Higby, in *Food Inds.,* 16, 441 (1944) and Joseph and Baier, *Food Technol. 3, 18 (1949)* and is a modification of the IFT Method 5-54 (Food Technology, Vol 13, 496 - 500ff (1959).

Equipment:

- Stainless steel pan e.g. Brabantia 30000189 Favourite Stielkasserolle 16 cm ohne Deckel Artikel-Nummer: 342737040
- Cook whisk, e.g. Roesle jug whisk, 27 cm, order no. 95581 is an ideal for stirring and skimming Pectin test jelly batches (2)
- Analysis balance min. 0.001 g
- Laboratory balance min. 0.01 g
- pH meter, readability to 0.01
- Thermostated refractometer (with precision +/- 0.05 - 0.1)
- Pipettor, 0.5 - 5.0 mL or volumetric pipette
- Stopwatch
- Gas or Electric stove (min. 2000W)
    - **The heating device should be adjusted, so that the entire heating time for the jelly is 5-8 minutes**.
    - When an electric stove is used it should be preheated.
    - When using an induction electric stove preheating is reserved.
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- Exchange Ridgelimeter with glass plate
- Wire cutter
- Ridgelimeter glasses (obtainable from IPPA – International Pectin Producers Association) have an inside height from exactly 3.125 inches.
- Masking Tape e.g. Tesa Masking Tape 50 m x 25 mm Article no. 4348
- Climate cabinet, 25 +/- 3 °C
- 1000 mL beaker
- 150 mL screw cap bottle
- 100 mL volumetric flask
- Spatula

Reagents

- Tartaric acid cryst. Exp Ph Eur, BP, JP, NF E334 CAS: 87-69-4, e.g Merck 100802
    - 48.8% solution w/v
    - The tartaric acid solution should be made by dissolving 48.80 g. of tartaric acid crystals in distilled water and making up to a total volume of 100.0 mL in a volumetric flask (A).
- Distilled water / deionized water
- Sugar table grade
    - The sugar table grade should be the finely granulated type, where about 75% is within the band of 35-80 mesh.

Preparation of SAG glasses	
Prepare 3 Ridgelimeter glasses by extending the height of the glasses with masking tape - see remark	Masking tape is used to make sideboards on each glass. The strip should cover the top 10 mm of the glass and must extend approximately 15 mm above the glass. Squeezing the tape against the glass, especially under the flange near the top of the glass, will ensure a tight seal which will not leak hot jelly.
Add 2.0 ml tartraric acid solution (a) to each glass	Use volumetric pipette for pipetting the 2 mL
Preparation of jelly	
Procedure	**Remarks**
Calculate the weight of Pectin to used by dividing 650.0 by the value of an assumed firmness grade (a) for the Pectin. $Pectin(g) = \frac{650}{assumed\ grade}$	a) Jellies produced by this Method should contain 650.0 g of total soluble solids in 1000.0 g of jelly. The ratio of the actual weight of Pectin in a particular jelly to the weight of Pectin in that jelly is defined as the ‘’assumed grade’’ for the Pectin, in that specific jelly
Weigh into a dry 1000 mL beaker the amount of sugar which will be 650.0 minus the weight (to the nearest gram) of Pectin used: (b) $g\ Sugar = 650.00\ g - g\ Pectin\ calculated$	The sugar could also be weighed in two separate containers b) Example: Suppose one assumed a “firmness grade” of 150, then 650 / 150 or 4.33 g would be weight of Pectin to be used and 650 - 4 or 646 would be the grams of sugar to use.
Transfer about 20 - 30 g of the weighed sugar into a dry 150 mL beaker and add the weighed Pectin sample. Mix the Pectin and sugar thoroughly in the small beaker by stirring with a spatula or glass rod.	
Pour 410 mL of distilled water into a stainless steel pan (1) containing a stainless steel cooking whisk (2) for stirring. (The sauce pan and cooking whisk should have been tared previously, on a scale or balance).	
The pectin-sugar mixture is now poured into water all at once. Rinse the beaker with approximately 20 g sugar from the total sugar amount then gentle stirring is started and continued for about 2 minutes.	The object here is to get the sugar-pectin mixture under the surface of the water as quickly as possible. When hot water is used the sugar dissolves too quickly and the pectin tends to stay on the surface and stick to the sides of the pan. Avoid splashing

	when stirring so pectin is not scattered to upper parts of pan. Just before the pan is put on the heater or stove any traces of pectin-sugar remaining in the small beaker should be transferred to the jelly batch. Can be done by brushing the glass with a small paint brush
The sauce pan is than placed on a stove and heated until the contents come to a full rolling boil, stirring being continued during this period. The remaining sugar is added in 2 portions and heating and stirring continued until the net weight of the jelly batch is 1015.0 g	The sugar should be added in 2 portions because of avoiding a cooling down of the mixture. **The heating device should be adjusted, so that the entire heating time for the jelly is 5 - 8 minutes**. When an electric stove is used it should be preheated. When using an induction electric stove preheating is reserved. The stirrer is to be left in the sauce pan during the cooking and weighting period. If the batch weighs less than 1015 g distilled water is added in slight excess so that additional boiling will be necessary to reduce the net weight to 1015 g. The amount of water used at the start should be adjusted by each operator so that the entire heating time is kept within the 5 to 8 minutes range. For checking the net weight, the sauce pan should be taken from the heater only as often as necessary.
After the 1015 g batch is removed from the balance or the scale, it is allowed to be left undisturbed on the desk-top for one minute.	
The batch is then poured quickly and without interruption into three previously prepared Ridgelimeter glasses, each containing 2.0 mL of tartaric acid solution(A) while stirring with a spatula.	**See comment**
Measurements on the Test Jelly 1. Determination of the Jelly Sag After the jellies have been stored for 20 - 24 hours the tape strips torn off. A tightly stretched wire, clean and wetted (cheese cutter furnished with the Ridgelimeter) is carefully drawn across the top of the glass while the latter is held upright and is turned slowly part way around so that a smooth cut is made to remove the layer of jelly projecting above the top of the glass. The	The Ridgelimeter has to be calibrated Check of the Ridgelimeter Calibration: A ¾ inch brass rod exactly 2.5000 inches in length may be used to check the Ridgelimeter scale and must be used adapt the instrument for using new glass plates. A slight shift in the vernier and/or in the scale or use of a glass plate other than the one originally sent out with the instrument, can result in unreliable readings. It is easy to check the instrument by standing the 2.500

detached top layer is carefully removed and discarded. The jelly is turned out of the glass into an inverted position on a plate glass square furnished with the Ridgelimeter. This is accomplished by holding the glass tilted at about a 45° angle while the point of a spatula is inserted between the top of the jelly and the glass, to start the separation of the jelly from the glass. The jelly should pull away from the glass while the latter is rotated slowly, without further aid from a spatula. The glass is quickly and carefully inverted just above the glass square in such a way that the jelly slides out and stands up right near the center of the glass plate. Do not drop the jelly onto the plate.	inch gauge rod upright on the glass square, under the tip of the micrometer screw. When the tip of the screw is in gentle contact with the gauge rod, the instrument should read exactly 20.0. Both the vertical scale and the vernier, knob can be reset so the instrument does read exactly 20.0 when checked with the 2.500 inch rod as just described. Occasional checking by this method is recommended to insure that the scale settings remain fixed.
A stopwatch is started as soon as the jelly is on the glass plate. If the jelly leans slightly to one side this usually can be corrected by gentle tilting the glass plate away from the direction in which the jelly leans. The plate and the jelly should now be placed carefully on the base of the Ridgelimeter so that the jelly is centered under the micrometer screw, which then should be screwed down near to the surface of the jelly (The Ridgelimeter should be used only on a level desk table.)	
Exactly two minutes after the stopwatch was started, the point of the micrometer is brought just into contact with the top jelly surface. The lowest line on the vertical scale beyond which the lower edge of the circular micrometer head has passed, is the per cent and the number on the micrometer head nearest the vertical scale denotes the tenth of a per cent sag. The Ridgelimeter reading is recorded only to the nearest 0.1.	When Ridgelimeter readings on different glasses from the same jelly batch differ more than 0.6, the batch should be remade.
Determination of Soluble Solids and pH of Jelly Take a portion from one of the three glasses from the center of the gel and measure the soluble solids with a refractometer. Spread the jelly to the refractometer prism. Quickly close the refractometer, firmly, and after about a minute or so, read the temperature of the	**** See appendix**

prism (the water circulating through the instrument) as well as the % soluble solids so that later corrections can be made for getting the soluble solids at 20 °C by the table of corrections in the appendix of *Methods of Analysis,* 8th Edition, page 880, Assoc. Offic. Agr. Chemists, Wash., D. C. 1955**. (l).The obtained sugar concentration is changed into factor F2 according to table 2.	
When the soluble solids content of these test jellies is as much as 1.0 unit from 65.0% at 20 °C, serious errors must have been entered into the method of making the jellies.	A spread of ± 1.0% soluble solids can mean an error of ± 3 to 4% in jelly grade, a larger error than is involved with ordinary use of the Ridgelimeter. It is necessary, therefore, to get correct soluble solids readings by being careful that samples for testing are always taken quickly from an unexposed jelly surface, and that temperature is given due consideration
The pH can be determined by inserting a pH electrode directly into the one of the jelly glasses. It should be in the range of 2.0-2.4.	If the pH is not within this range the manufacturing of the gel has to be repeated with a modified acid amount: pH > 2.4: prepare 2.25 mL tartaric acid for each Ridgelimeter glass pH < 2.0: prepare 1.75 mL tartaric acid for each Ridgelimeter glass.
Calculation of Jelly Grade of the Pectin Average the three obtained % Sag values and using the table 1 to convert the Ridgelimeter reading to factor F1. Then us the following formula considering the two corrections factor to calculate the °USA-Sag: $°USA - Sag = \frac{650\ x\ F1\ x\ F2}{weighted\ pectin}$ F1 = correction factor of the averaged Sag-readings F2 = correction factor for the soluble solids concentration For an accurate result, the gel properties must be within the following limits: Strength: 19.5 to 27.0 %Sag pH: 2.0-2.4 Soluble solids: 64.5-65.5%	

If outside these limits the jelly should be remade using the obtained values as a guide.	
Report the results with four significant figures	

Comments

It is known that the acid concentration (by titration and pH) as well as the soluble solids can differ from top to bottom in a glass of jelly, even when the acid is added to the batch before it is poured. The differences in acidity are too small to be significant when the pH is below about 3.0.

Pouring the jelly**:** It is best to pour very rapidly and without any interruptions until the glass is filled part way up to the sideboards, then to pour more slowly so that the glass can be filled completely full to the point of overflowing. There is ample evidence to show that 2.0 mL of acid gets suitably mixed in the glass of jelly when rapidly pouring without stirring.

Appendix

TABLE 1 – USA-SAG grade correction factor F1 for Ridgelimeter Reading

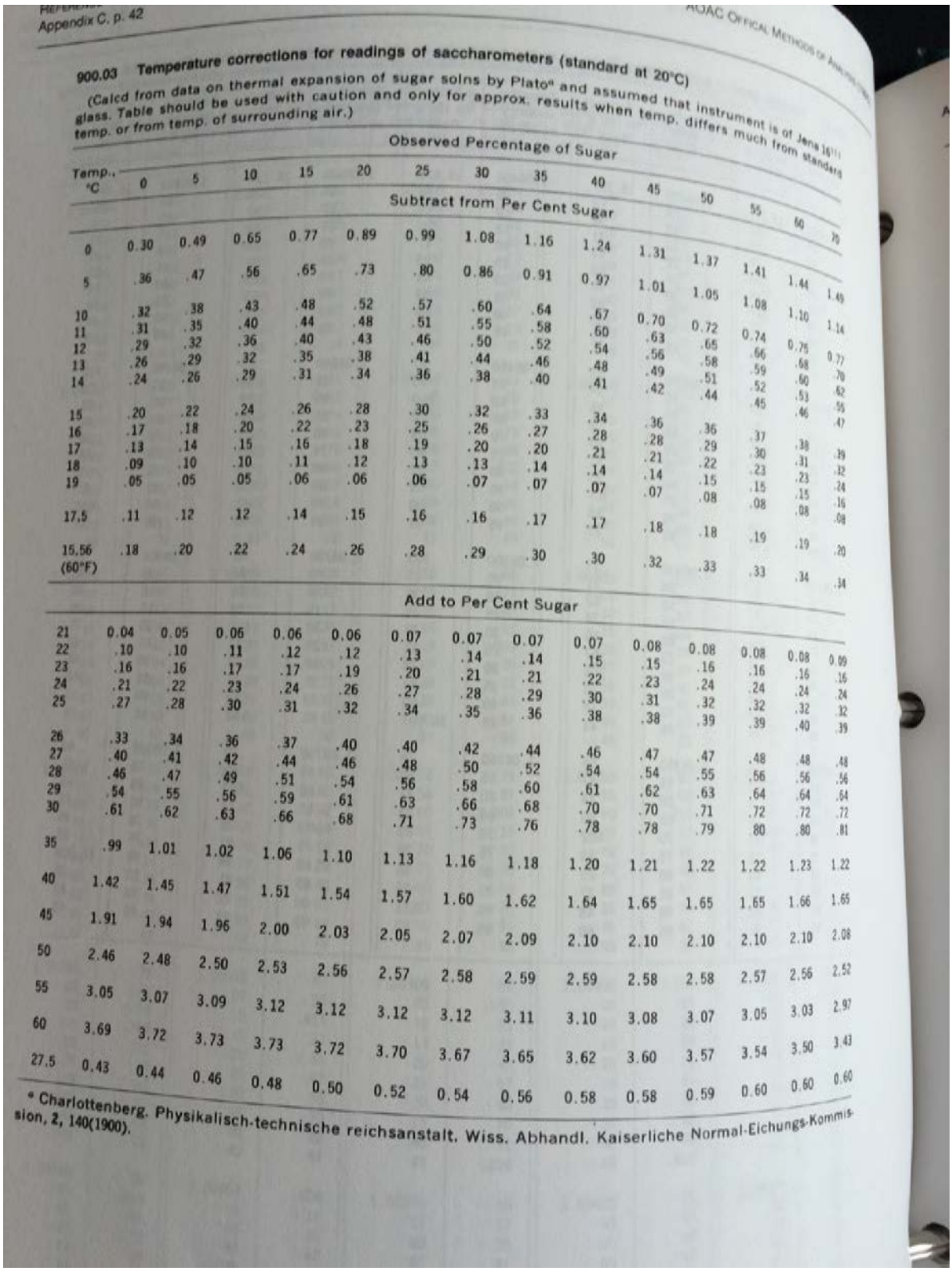
% SAG	Factor	% SAG	Factor	% SAG	Factor
18.1	1.243	22.1	1.062	26.1	0.895
18.2	1.238	22.2	1.058	26.2	0.890
18.3	1.233	22.3	1.053	26.3	0.887
18.4	1.228	22.4	1.048	26.4	0.883
18.5	1.223	22.5	1.044	26.5	0.880
18.6	1.218	22.6	1.040	26.6	0.877
18.7	1.213	22.7	1.035	26.7	0.873
18.8	1.208	22.8	1.031	26.8	0.870
18.9	1.203	22.9	1.026	26.9	0.867
19.0	1.200	23.0	1.022	27.0	0.864
19.1	1.194	23.1	1.017	27.1	0.861
19.2	1.190	23.2	1.013	27.2	0.858
19.3	1.185	23.3	1.008	27.3	0.855
19.4	1.181	23.4	1.004	27.4	0.852
19.5	1.177	23.5	1.000	27.5	0.849
19.6	1.173	23.6	0.995	27.6	0.846
19.7	1.168	23.7	0.991	27.7	0.844
19.8	1.163	23.8	0.987	27.8	0.840
19.9	1.158	23.9	0.982	27.9	0.837
20.0	1.155	24.0	0.977	28.0	0.835
20.1	1.150	24.1	0.973	28.1	0.833

20.2	1.146	24.2	0.969	28.2	0.830
20.3	1.142	24.3	0.964	28.3	0.827
20.4	1.137	24.4	0.960	28.4	0.824
20.5	1.132	24.5	0.956	28.5	0.820
20.6	1.128	24.6	0.952	28.6	0.814
20.7	1.124	24.7	0.948	28.7	0.807
20.8	1.119	24.8	0.944	28.8	0.801
20.9	1.115	24.9	0.940	28.9	0.794
21.0	1.111	25.0	0.936	29.0	0.788
21.1	1.106	25.1	0.932	29.1	0.784
21.2	1.102	25.2	0.928	29.2	0.781
21.3	1.097	25.3	0.924	29.3	0.778
21.4	1.093	25.4	0.920	29.4	0.774
21.5	1.088	25.5	0.917	29.5	0.771
21.6	1.084	25.6	0.913	29.6	0.767
21.7	1.080	25.7	0.909	29.7	0.764
21.8	1.075	25.8	0.905	29.8	0.761
21.9	1.070	25.9	0.902	29.9	0.758
22.0	1.066	26.0	0.898	30.0	0.755

TABLE 2 – USA SAG grade correction factor F2 for Soluble solids

Refractometer solids	Factor (F2)
64.0	1.034
64.1	1.031
64.2	1.028
64.3	1.024
64.4	1.021
64.5	1.018
64.6	1.015
64.7	1.012
64.8	1.008
64.9	1.004
65.0	1.000
65.1	0.997
65.2	0.993
65.3	0.990
65.4	0.987
65.5	0.984
65.6	0.980
65.7	0.975
65.8	0.970
65.9	0.967
66.0	0.964
66.1	0.960
66.2	0.957

Appendix (AOAC Official methods of Analysis (1995))



900.03 Temperature corrections for readings of saccharometers (standard at 20°C)

(Calcd from data on thermal expansion of sugar solns by Plato[a] and assumed that instrument is of Jena 16111 glass. Table should be used with caution and only for approx. results when temp. differs much from standard temp. or from temp. of surrounding air.)

Temp., °C	Observed Percentage of Sugar													
	0	5	10	15	20	25	30	35	40	45	50	55	60	70
	Subtract from Per Cent Sugar													
0	0.30	0.49	0.65	0.77	0.89	0.99	1.08	1.16	1.24	1.31	1.37	1.41	1.44	1.49
5	.36	.47	.56	.65	.73	.80	0.86	0.91	0.97	1.01	1.05	1.08	1.10	1.14
10	.32	.38	.43	.48	.52	.57	.60	.64	.67	0.70	0.72	0.74	0.75	0.77
11	.31	.35	.40	.44	.48	.51	.55	.58	.60	.63	.65	.66	.68	.70
12	.29	.32	.36	.40	.43	.46	.50	.52	.54	.56	.58	.59	.60	.62
13	.26	.29	.32	.35	.38	.41	.44	.46	.48	.49	.51	.52	.53	.55
14	.24	.26	.29	.31	.34	.36	.38	.40	.41	.42	.44	.45	.46	.47
15	.20	.22	.24	.26	.28	.30	.32	.33	.34	.36	.36	.37	.38	.39
16	.17	.18	.20	.22	.23	.25	.26	.27	.28	.28	.29	.30	.31	.32
17	.13	.14	.15	.16	.18	.19	.20	.20	.21	.21	.22	.23	.23	.24
18	.09	.10	.10	.11	.12	.13	.13	.14	.14	.14	.15	.15	.15	.16
19	.05	.05	.05	.06	.06	.06	.07	.07	.07	.07	.08	.08	.08	.08
17.5	.11	.12	.12	.14	.15	.16	.16	.17	.17	.18	.18	.19	.19	.20
15.56 (60°F)	.18	.20	.22	.24	.26	.28	.29	.30	.30	.32	.33	.33	.34	.34
	Add to Per Cent Sugar													
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	0.09
22	.10	.10	.11	.12	.12	.13	.14	.14	.15	.15	.16	.16	.16	.16
23	.16	.16	.17	.17	.19	.20	.21	.21	.22	.23	.24	.24	.24	.24
24	.21	.22	.23	.24	.26	.27	.28	.29	.30	.31	.32	.32	.32	.32
25	.27	.28	.30	.31	.32	.34	.35	.36	.38	.38	.39	.39	.40	.39
26	.33	.34	.36	.37	.40	.40	.42	.44	.46	.47	.47	.48	.48	.48
27	.40	.41	.42	.44	.46	.48	.50	.52	.54	.54	.55	.56	.56	.56
28	.46	.47	.49	.51	.54	.56	.58	.60	.61	.62	.63	.64	.64	.64
29	.54	.55	.56	.59	.61	.63	.66	.68	.70	.70	.71	.72	.72	.72
30	.61	.62	.63	.66	.68	.71	.73	.76	.78	.78	.79	80	.80	.81
35	.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	2.07	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
27.5	0.43	0.44	0.46	0.48	0.50	0.52	0.54	0.56	0.58	0.58	0.59	0.60	0.60	0.60

[a] Charlottenberg. Physikalisch-technische reichsanstalt. Wiss. Abhandl. Kaiserliche Normal-Eichungs-Kommission, 2, 140(1900).

Values to be added to percent sugar read my refractometer calibrated to 20°C (interpolate to get the value for

	Measured percentage of sugar	
Temperature (°C)	**60%**	**70%**
21	**0,08**	**0,09**
22	**0,16**	**0,16**
23	**0,24**	**0,24**
24	**0,32**	**0,32**
25	**0,40**	**0,39**
26	**0,48**	**0,49**
27	**0,56**	**0,56**
28	**0,64**	**0,64**