CALCULATIONS

USED IN

CANE-SUGAR FACTORIES

A PRACTICAL SYSTEM OF CHEMICAL CONTROL FOR THE SUGAR HOUSES OF LOUISIANA, THE TROPICS, AND OTHER CANE-PRODUCING COUNTRIES

BY

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PREFACE TO THE SECOND EDITION

Since the publication of the first edition, thirteen years ago, the cane-sugar industry has developed rapidly, both in furnishing a much larger number of tons of the commercial product and also by the use of more scientific and economical methods of manufacture. This period has been especially noted for the improvements made in the machinery used for crushing the cane, by which the loss of sugar in the bagasses has been greatly reduced, and in the installation of multiple effects, pans, and centrifugals, that are in proportion to the capacity of the mills, thereby securing an evenly balanced and efficient plant. Chemical laboratories have multiplied and the value of chemical control now generally recognized, so that in many instances the entire responsibility of the fabrication is placed upon the technical superintendent. For in such a position there is combined the theoretical chemical knowledge with the practical side of the manufacture, a combination that has added greatly to our present knowledge, and should continue until the making of sugar will be carried on as efficiently as other great modern industries. It is for the benefit of the men holding these positions, their head chemists and assistants, that the second edition has been rewritten and enlarged and it is hoped will be of some help to them in their important work.

While much of the data contained in the present volume will apply to the manufacture of sugar in the Tropics, where the author spent nine seasons, yet by far the greater part deals with the problems connected with the sugar industry in Louisiana. Admitting that the weather conditions are such that the cane never fully ripens and that an early freeze will still further reduce its value for making sugar, will it be possible to compete with other cane-producing countries, where there is a longer grinding season, the cane mature, and the supply of labor adequate? From an economical standpoint, it would appear fundamentally wrong to continue under such circumstances, but if the future may be judged by the past, the question must be answered in the affirmative, for in spite of many disasters from natural causes, and harassed by debates in Congress over the question of Free Sugar, the sugar planters of Louisiana have persisted in their efforts, adapting themselves to each new condition, and now have the satisfaction of producing one of the largest crops in the history of the State.

But in order to prepare for the lower prices that will naturally follow the close of the European War, two things are essential to meet the new conditions—first, to adopt the Two-Factory System, by which only that part of the cane-stalk is ground that will pay a profit when manufactured into sugar, and second, to evolve a simple, economical process of making standard granulated sugar direct from the cane, thereby receiving the full value for the raw product.

IRVING H. MORSE.

NEW ORLEANS, LOUISIANA.

TABLE OF CONTENTS

CHAPTER VIII

CHAPTER IX

CALCULATIONS

USED IN

CANE-SUGAR FACTORIES

CHAPTER I

THE SAMPLING AND ANALYSIS OF THE SUGAR PRODUCTS

THE chemical control of a cane-sugar factory requires the sampling of the following products:

FOR MILL CONTROL.

Crusher Juice.
Residual Juice.
Dilute Juice.
Bagasse.

The underlying principle of sampling is to secure a small part of each product, sufficient for analysis, which will correctly represent the whole. As the cane received at the factory comes from many different localities, its composition is constantly changing, so that the only way to secure a fair sample of the extracted juice is to provide some device for sampling continuously. Buckets with brass gauze covers, placed under the rollers and in the stream of juice, is probably the most satisfactory method for the crusher and residual juice sample, while "drip" samples may be used for the dilute juice. The bagasse should be sampled continuously also, but there are so many difficulties surrounding this operation that in the majority of cases an hourly sample is considered the best. All the samples are collected each hour and taken to the laboratory, where they are preserved with a few drops of formaldehyde and analyzed at intervals of either four or six hours.

For Clarification Control.

Dilute Juice.
Clarified Juice.
Filtered Juice.
Filter Press Mud.
Syrup.

After the juice has been limed and pumped through the heaters into the clarifiers, it is usually well mixed and hourly samples may be taken of the clarified and filtered juices. The filter press mud should be sampled at least once each watch and the syrup hourly or from the storage tanks.

For Pan and Centrifugal Control.

Syrup.
First, Second and Third Massecuites.
First, Second, and Final Molasses.
First, Second, and Third Sugars.

All massecuites are sampled as the pans are discharged into the mixer or crystallizers, and the molasses when the strike is half dried, either at the storage tanks or in the trough leading from the machines. A spoonful of sugar is taken from each package when weighed and analyzed by lots or each 100 sacks.

Cane-sugar products are tested for: Total solids, sucrose, glucose, moisture, ash, acidity.

TOTAL SOLIDS.—The juice extracted from the cane is made up of from 80 to 86 per cent of water and from 14 to 20 per cent of solid matter, most of which is sucrose. There are two methods of determining the total solids in use, first, by means of a special hydrometer, graduated to record the percentage of pure sugar in a solution, and second, by weighing the liquor in a standardized flask and obtaining the required percentage from Specific Gravity Tables. Of these two methods the latter is the most accurate, but requires more time and careful manipulation, so that in the great majority of cane-sugar laboratories the per cent total solids is obtained by means of the Brix hydrometer. All of the instruments must first be standardized, to insure uniformity, and to determine whether each degree registered on the stem represents an equal amount of pure sugar in the solution. This may be done by means of the table given below, calculated from the following formula:

$$\text{Polariscope reading} \times \frac{26.048}{\text{Sp. gr.}} = \text{required total solids.}$$

TABLE I

Total Solids.	Polariscope Reading.
1.0	3.85
2.0	7.74
3.0	11.65
4.0	15.60
5.0	19.57
6.0	23.58
7.0	27.58
8.0	31.69
9.0	35.79
10.0	39.93
11.0	44.11
12.0	48.35
13.0	52.54
14.0	56.82
15.0	61.10
16.0	65.52
17.0	69.83
18.0	74.25
19.0	78.70
20.0	83.07
21.0	87.74
22.0	92.26
23.0	96.94
23.68	100.00

By means of this table, not only the hydrometer is standardized, but the accuracy of the polariscope and the flasks used determined. Take, for example, a hydrometer having a scale of five degrees, from 10 to 15. First, five weighings of granulated sugar and distilled water in the following proportion are made:

For	10°,	50 grams sugar,	450 grams water	
"	11°,	55 "	445 "	
"	12°,	60 "	440 "	
"	13°,	65 "	435 "	
"	14°,	70 "	430 "	

The solutions are thoroughly mixed and placed in cylinders, and a sample polarized. If the polariscope is correct, the flask accurate, and the temperature 17.5 C., the reading will be the same as given in the table. The hydrometer to be tested is then immersed in each of the five solutions and the readings taken. If it is absolutely correct, the reading will correspond with the per cent solution; but if there is a difference, usually the same for each degree, it is added to or subtracted from all subsequent tests. Since all massecuites and molasses samples are diluted to the density of juices before analysis, there are only one or two hydrometers used, and the error in the instruments may be incorporated in the table for temperature correction. If, for instance, the error is .15+, it would indicate that the hydrometer was correct at 20°, and that for 21° there would be added .07 instead of .22, and at 19° the deduction would be .07 instead of an addition of .08. When a hydrometer is broken, a new table for correction is made out, based on a similar standardization with a pure sugar solution.

TABLE II

CORRECTION FOR TEMPERATURE

DEGREE BRIX

Temp. C.	5.0	10.0	15.0	20.0	25.0
10	.26	.29	.33	.36	.39
11	.23	.26	.28	.31	.34
12	.20	.22	.24	.26	.29
13	.18	.19	.21	.22	.24
14	.15	.16	.17	.18	.19
15	.11	.12	.14	.14	.15
16	.07	.08	.09	.10	.10
17	.02	.03	.03	.03	.04
18	.03	.03	.03	.03	.03
19	.06	.08	.08	.09	.09
20	.14	.15	.17	.17	.18
21	.20	.22	.24	.24	.25
22	.26	.29	.31	.31	.32
23	.32	.35	.37	.38	.39
24	.38	.41	.43	.44	.46
25	.44	.47	.49	.51	.53
26	.50	.54	.56	.58	.60
27	.57	.61	.63	.65	.68
28	.64	.68	.72	.76	.78
29	.71	.75	.78	.79	.84
30	.78	.82	.87	.87	.92
31	.85	.90	.94	.95	1.00
32	.93	.98	1.01	1.03	1.08
33	1.01	1.06	1.08	1.12	1.16
34	1.09	1.14	1.16	1.21	1.24
35	1.17	1.22	1.24	1.30	1.32

The use of the Brix hydrometer for the determination of the total solids is not altogether satisfactory, even when the most accuiate instruments are used. When immersed in a solution there is often a difference of .05 in two readings, and it is only by taking the average of several tests that the danger of error is avoided. For this reason, the second method mentioned, in which the specific gravity flask is used, has a real advantage, and if the present practice is modified, will combine both speed and accuracy. A 50-c.c. or 100-c.c. flask is now required and the weighing made on an analytical balance, sensitive to .001 gram. To secure the weight of the solution under such conditions requires considerable time, and when the small sample is considered, there is a possibility of obtaining misleading results. The improvement recommended is to use a 1000-c.c. flask, and a balance, sensitive to 0.1 gram, which will furnish a larger quantity of the sample for analysis, and may be weighed much faster; due to a less delicate balance. A table, showing the degree Brix or total solids, corresponding to the weight, is given below. First a litre flask is standardized by filling with distilled water, with a temperature of 17.5° C., and marking the neck at the point which will just balance 1000 grams. A sugar solution is then filled to the same mark and weighed, and the total solids found in the table. The temperature is also taken, and the correction made as usual. By this method the total solids may be found in fortieths of a degree, whereas the best hydrometers offered by the manufacturers only record to the twentieths.

TABLE III

DEGREE BRIX CORRESPONDING TO SPECIFIC GRAVITY

Wgt. 1000 c.c.	Brix.	Wgt. 1000 c.c.	Brix.	Wgt. 1000 c.c.	Brix.	Wgt. 1000 c.c.	Brix.
1040.0	9.99	1046.0	11.42	1052.0	12.82	1058.0	14.23
1040.2	10.05	1046.2	11.45	1052.2	12.87	1058.2	14.27
1040.4	10.08	1046.4	11.50	1052.4	12.92	1058.4	14.32
1040.6	10.13	1046.6	11.55	1052.6	12.96	1058.6	14.37
1040.8	10.18	1046.8	11.59	1052.8	13.01	1058.8	14.42
1041.0	10.23	1047.0	11.64	1053.0	13.06	1059.0	14.46
1041.2	10.28	1047.2	11.69	1053.2	13.10	1059.2	14.51
1041.4	10.32	1047.4	11.74	1053.4	13.15	1059.4	14.56
1041.6	10.37	1047.6	11.78	1053.6	13.20	1059.6	14.60
1041.8	10.42	1047.8	11.83	1053.8	13.24	1059.8	14.65
1042.0	10.46	1048.0	11.88	1054.0	13.29	1060.0	14.70
1042.2	10.50	1048.2	11.93	1054.2	13.34	1060.2	14.74
1042.4	10.54	1048.4	11.97	1054.4	13.38	1060.4	14.79
1042.6	10.59	1048.6	12.02	1054.6	13.43	1060.6	14.84
1042.8	10.64	1048.8	12.07	1054.8	13.48	1060.8	14.88
1043.0	10.69	1049.0	12.11	1055.0	13.53	1061.0	14.93
1043.2	10.74	1049.2	12.16	1055.2	13.57	1061.2	14.98
1043.4	10.78	1049.4	12.21	1055.4	13.62	1061.4	15.02
1043.6	10.83	1049.6	12.26	1055.6	13.67	1061.6	15.07
1043.8	10.88	1049.8	12.30	1055.8	13.71	1061.8	15.12
1044.0	10.93	1050.0	12.35	1056.0	13.76	1062.0	15.15
1044.2	10.98	1050.2	12.40	1056.2	13.81	1062.2	15.20
1044.4	11.02	1050.4	12.44	1056.4	13.85	1062.4	15.25
1044.6	11.07	1050.6	12.49	1056.6	13.90	1062.6	15.29
1044.8	11.12	1050.8	12.54	1056.8	13.95	1062.8	15.34
1045.0	11.17	1051.0	12.59	1057.0	13.99	1063.0	15.39
1045.2	11.21	1051.2	12.63	1057.2	14.04	1063.2	13.43
1045.4	11.26	1051.4	12.68	1057.4	14.09	1063.4	13.48
1045.6	11.31	1051.6	12.73	1057.6	14.13	1063.6	13.53
1045.8	11.37	1051.8	12.77	1057.8	14.18	1063.8	13.58

TABLE III—(*Continued*)

DEGREE BRIX CORRESPONDING TO SPECIFIC GRAVITY

Wgt. 1000 c.c.	Brix.	Wgt. 1000 c.c.	Brix.	Wgt. 1000 c.c.	Brix.	Wgt. 1000 c.c.	Brix.
1064.0	15.62	1070.0	17.00	1076.0	18.36	1082.0	19.71
1064.2	15.67	1070.2	17.04	1076.2	18.40	1082.2	19.75
1064.4	15.71	1070.4	17.09	1076.4	18.45	1082.4	19.80
1064.6	15.76	1070.6	17.13	1076.6	18.49	1082.6	19.84
1064.8	15.80	1070.8	17.18	1076.8	18.54	1082.8	19.89
1065.0	15.85	1071.0	17.22	1077.0	18.58	1083.0	19.93
1065.2	15.89	1071.2	17.27	1077.2	18.63	1083.2	19.97
1065.4	15.94	1071.4	17.31	1077.4	18.68	1083.4	20.02
1065.6	15.99	1071.6	17.36	1077.6	18.72	1083.6	20.06
1065.8	16.03	1071.8	17.40	1077.8	18.76	1083.8	20.11
1066.0	16.08	1072.0	17.45	1078.0	18.81	1084.0	20.15
1066.2	16.12	1072.2	17.49	1078.2	18.85	1084.2	20.20
1066.4	16.17	1072.4	17.54	1078.4	18.90	1084.4	20.24
1066.6	16.21	1072.6	17.58	1078.6	18.95	1084.6	20.29
1066.8	16.26	1072.8	15.63	1078.8	18.99	1084.8	20.33
1067.0	16.31	1073.0	15.68	1079.0	19.03	1085.0	20.37
1067.2	16.36	1073.2	15.72	1079.2	19.08	1085.2	20.42
1067.4	16.40	1073.4	17.76	1079.4	19.12	1085.4	20.46
1067.6	16.45	1073.6	17.81	1079.6	19.17	1085.6	20.51
1067.8	16.50	1073.8	17.85	1079.8	19.21	1085.8	20.55
1068.0	16.54	1074.0	17.90	1080.0	19.26	1086.0	20.60
1068.2	16.59	1074.2	17.95	1080.2	19.30	1086.2	20.64
1068.4	16.63	1074.4	17.99	1080.4	19.34	1086.4	20.69
1068.6	16.68	1074.6	18.04	1080.6	19.40	1086.6	20.73
1068.8	16.72	1074.8	18.08	1080.8	19.44	1086.8	20.78
1069.0	16.77	1075.0	18.13	1081.0	19.49	1087.0	20.82
1069.2	16.81	1075.2	18.18	1081.2	19.53	1087.2	20.87
1069.4	16.86	1075.4	18.22	1081.4	19.57	1087.4	20.91
1069.6	16.91	1075.6	18.27	1081.6	19.62	1087.6	20.95
1069.8	16.95	1075.8	18.31	1081.8	19.67	1087.8	21.00

TABLE III—(*Continued*)

DEGREE BRIX CORRESPONDING TO SPECIFIC GRAVITY

Wgt. 1000 c.c.	Brix.	Wgt. 1000 c.c.	Brix.	Wgt. 1000 c.c.	Brix.	Wgt. 1000 c.c.	Brix.
1088.0	21.04	1091.0	21.70	1094.0	22.37	1097.0	23.02
1088.2	21.08	1091.2	21.74	1094.2	22.41	1097.2	23.07
1088.4	21.13	1091.4	21.79	1094.4	22.45	1097.4	23.11
1088.6	21.17	1091.6	21.83	1094.6	22.50	1097.6	23.15
1088.8	21.22	1091.8	21.88	1094.8	22.55	1097.8	23.19
1089.0	21.26	1092.0	21.92	1095.0	22.59	1098.0	23.24
1089.2	21.31	1092.2	21.97	1095.2	22.63	1098.2	23.28
1089.4	21.35	1092.4	22.01	1095.4	22.67	1098.4	23.33
1089.6	21.40	1092.6	22.05	1095.6	22.72	1098.6	23.37
1089.8	21.44	1092.8	22.10	1095.8	22.79	1098.8	23.42
1090.0	21.49	1093.0	22.14	1096.0	22.81	1099.0	23.46
1090.2	21.53	1093.2	22.19	1096.2	22.85	1099.2	23.51
1090.4	21.57	1093.4	22.23	1096.4	22.90	1099.4	23.55
1090.6	21.61	1093.6	22.28	1096.6	22.94	1099.6	23.60
1090.8	21.66	1093.8	22.32	1096.8	22.98	1099.8	23.64
						1100.0	23.68

SUCROSE IN JUICES AND DILUTED PRODUCTS.—The percentage of sucrose may be found by either weighing out 26.048 grams of the product and making up to 100 c.c. with lead acetate solution and water, or by measuring out 100 c.c. of the solution in a 100–110-c.c. flask, and filling to the second mark with lead acetate and water. While it is doubtful whether any of the tests made, with the exception of pure sugar at 17.5° C., are absolutely correct, on account of the different degrees of dilutions and the volume of the lead acetate precipitate, yet for the purpose of controlling the process of manufacture, they are sufficiently accurate, providing all the analyses are made by one of the two methods given above. In connection with the 100–110-c.c. method, Schmitz' Sucrose Tables are used, by which the per cent of sucrose is found from the polariscope reading. These tables have been rearranged in a more convenient form, the possible readings for each degree Brix from 8 to 23 being given on one page.

SUCROSE IN BAGASSE.—Weigh out 50 grams of the sample into the inner part of a double cooker and add approximately 500 grams of water, that contains either 3 c.c. of lead acetate solution or sufficient carbonate of soda solution to neutralize the acidity present. Digest for one hour, then cool, and weigh. Draw off sufficient liquor and determine the per cent sucrose in a 400 mm. tube, the table on page 29 giving the per cent sucrose corresponding to the polariscope reading. This is multiplied by the weight of the bagasse and water, less the fibre contents, to find the per cent sucrose in the bagasse. If a 200 mm. tube is used, the last figure is multiplied by 2.

Table IV

SCHMITZ' SUCROSE TABLES

8

Degree Brix

Specific Gravity = 1.03187
Polariscope Reading 1.0 = .2776 per cent Sucrose

Polariscope Reading.	Per Cent Sucrose.	Polariscope Reading.	Per Cent Sucrose.	Polariscope Reading.	Per Cent Sucrose.
6	1.665	14	3.886	22	6.107
7	1.943	15	4.164	23	6.385
8	2.221	16	4.442	24	6.662
9	2.498	17	4.719	25	6.940
10	2.776	18	4.997	26	7.218
11	3.054	19	5.274	27	7.495
12	3.331	20	5.552	28	7.773
13	3.609	21	5.830		

Polariscope Reading.	Per Cent Sucrose.
0.1	.028
0.2	.055
0.3	.083
0.4	.111
0.5	.139
0.6	.167
0.7	.194
0.8	.222
0.9	.250

Table IV—(*Continued*)

SCHMITZ' SUCROSE TABLE

9

Degree Brix

Specific Gravity = 1.036.
Polariscope Reading 1.0 = .2766 per cent Sucrose

Polariscope Reading.	Per Cent Sucrose.	Polariscope Reading.	Per Cent Sucrose.	Polariscope Reading.	Per Cent Sucrose.
7	1.936	16	4.426	25	6.915
8	2.213	17	4.702	26	7.192
9	2.489	18	4.979	27	7.468
10	2.766	19	5.255	28	7.745
11	3.043	20	5.532	29	8.021
12	3.319	21	5.809	30	8.298
13	3.594	22	6.086	31	8.574
14	3.892	23	6.362	32	8.852
15	4.149	24	6.638		

Polariscope Reading.	Per Cent Sucrose.
0.1	.028
0.2	.055
0.3	.083
0.4	.111
0.5	.138
0.6	.166
0.7	.194
0.8	.221
0.9	.249

TABLE IV—(*Continued*)

SCHMITZ' SUCROSE TABLE

10

DEGREE BRIX

Specific Gravity = 1.04014
Polariscope Reading 1.0 = .2755 per cent Sucrose

Polariscope Reading.	Per Cent Sucrose.	Polariscope Reading.	Per Cent Sucrose.	Polariscope Reading.	Per Cent Sucrose.
7	1.928	17	4.683	27	7.438
8	2.204	18	4.959	28	7.714
9	2.480	19	5.234	29	7.990
10	2.755	20	5.510	30	8.265
11	3.030	21	5.785	31	8.540
12	3.306	22	6.061	32	8.816
13	3.581	23	6.336	33	9.091
14	3.857	24	6.612	34	9.365
15	4.132	25	6.887	35	9.642
16	4.408	26	7.163	36	9.918

Polariscope Reading.	Per Cent Sucrose.
0.1	.028
0.2	.055
0.3	.083
0.4	.110
0.5	.138
0.6	.165
0.7	.193
0.8	.220
0.9	.248

Table IV—(*Continued*)

SCHMITZ' SUCROSE TABLE

11

Degree Brix

Specific Gravity = 1.04431
Polariscope Reading 1.0 = .2743 per cent Sucrose

Polariscope Reading.	Per Cent Sucrose.	Polariscope Reading.	Per Cent Sucrose.	Polariscope Reading.	Per Cent Sucrose.
8	2.194	19	5.211	30	8.229
9	2.469	20	5.486	31	8.503
10	2.743	21	5.760	32	8.778
11	3.017	22	6.035	33	9.052
12	3.292	23	6.309	34	9.326
13	3.566	24	6.583	35	9.600
14	3.840	25	6.857	36	9.875
15	4.114	26	7.131	37	10.149
16	4.389	27	7.406	38	10.423
17	4.663	28	7.680	39	10.698
18	4.937	29	7.954	40	10.972

Polariscope Reading.	Per Cent Sucrose.
0.1	.027
0.2	.055
0.3	.082
0.4	.110
0.5	.137
0.6	.164
0.7	.192
0.8	.219
0.9	.247

Table IV—(*Continued*)

SCHMITZ' SUCROSE TABLE

12

Degree Brix

Specific Gravity = 1.04852

Polariscope Reading 1.0 = .2731 per cent Sucrose

Polariscope Reading.	Per Cent Sucrose.	Polariscope Reading.	Per Cent Sucrose.	Polariscope Reading.	Per Cent Sucrose.
9	2.458	21	5.735	33	9.012
10	2.731	22	6.008	34	9.285
11	3.004	23	6.281	35	9.558
12	3.277	24	6.554	36	9.831
13	3.550	25	6.827	37	10.104
14	3.823	26	7.100	38	10.378
15	4.096	27	7.374	39	10.651
16	4.370	28	7.646	40	10.924
17	4.643	29	7.920	41	11.197
18	4.916	30	8.193	42	11.470
19	5.189	31	8.466	43	11.743
20	5.462	32	8.739		

Polariscope Reading.	Per Cent Sucrose.
0.1	.027
0.2	.055
0.3	.082
0.4	.109
0.5	.136
0.6	.164
0.7	.191
0.8	.218
0.9	.246

Table IV—(*Continued*)

SCHMITZ' SUCROSE TABLE

13

Degree Brix

Specific Gravity = 1.05276

Polariscope Reading 1.0 = .2722 per cent Sucrose

Polariscope Reading.	Per Cent Sucrose.	Polariscope Reading.	Per Cent Sucrose.	Polariscope Reading.	Per Cent Sucrose.
10	2.722	23	6.260	36	9.799
11	2.994	24	6.533	37	10.071
12	3.266	25	6.804	38	10.344
13	3.539	26	7.077	39	10.616
14	3.811	27	7.349	40	10.888
15	4.038	28	7.622	41	11.160
16	4.355	29	7.893	42	11.432
17	4.627	30	8.166	43	11.705
18	4.900	31	8.438	44	11.977
19	5.173	32	8.710	45	12.249
20	5.444	33	8.982	46	12.521
21	5.716	34	9.253	47	12.793
22	5.988	35	9.527		

Polariscope Reading.	Per Cent Sucrose.
0.1	.027
0.2	.054
0.3	.082
0.4	.109
0.5	.136
0.6	.163
0.7	.190
0.8	.218
0.9	.245

Table IV—(*Continued*)

SCHMITZ' SUCROSE TABLE

14

Degree Brix

Specific Gravity = 1.05703

Polariscope Reading 1.0 = .2711 per cent Sucrose

Polariscope Reading.	Per Cent Sucrose.	Polariscope Reading.	Per Cent Sucrose.	Polariscope Reading.	Per Cent Sucrose.
10	2.711	24	6.506	38	10.302
11	2.982	25	6.777	39	10.572
12	3.253	26	7.049	40	10.843
13	3.524	27	7.320	41	11.114
14	3.795	28	7.591	42	11.385
15	4.066	29	7.862	43	11.656
16	4.338	30	8.133	44	11.927
17	4.609	31	8.404	45	12.198
18	4.880	32	8.675	46	12.470
19	5.151	33	8.946	47	12.741
20	5.422	34	9.217	48	13.012
21	5.693	35	9.488	49	12.283
22	5.964	36	9.760	50	13.554
23	6.235	37	10.031	51	12.825

Polariscope Reading.	Per Cent Sucrose.
0.1	.027
0.2	.054
0.3	.081
0.4	.108
0.5	.135
0.6	.163
0.7	.190
0.8	.216
0.9	.243

Table IV—(*Continued*)

SCHMITZ' SUCROSE TABLE

15

Degree Brix

Specific Gravity = 1.06133

Polariscope Reading 1.0 = .27 per cent Sucrose

Polariscope Reading.	Per Cent Sucrose.	Polariscope Reading.	Per Cent Sucrose.	Polariscope Reading.	Per Cent Sucrose.
11	2.97	26	7.02	41	11.07
12	3.24	27	7.29	42	11.34
13	3.51	28	7.56	43	11.61
14	3.75	29	7.83	44	11.88
15	4.05	30	8.10	45	12.15
16	4.32	31	8.37	46	12.42
17	4.59	32	8.64	47	12.69
18	4.86	33	8.91	48	12.96
19	5.15	34	9.18	49	13.23
20	5.40	35	9.45	50	13.50
21	5.67	36	9.72	51	13.77
22	5.94	37	9.99	52	14.04
23	6.21	38	10.26	53	14.31
24	6.48	39	10.53	54	14.58
25	6.75	40	10.80	55	14.85

Polariscope Reading.	Per Cent Sucrose.
0.1	.027
0.2	.054
0.3	.081
0.4	.108
0.5	.135
0.6	.162
0.7	.189
0.8	.216
0.9	.243

Table IV—(*Continued*)

SCHMITZ' SUCROSE TABLE

16

Degree Brix

Specific Gravity = 1.06566

Polariscope Reading 1.0 = .2688 per cent Sucrose

Polariscope Reading.	Per Cent Sucrose.	Polariscope Reading.	Per Cent Sucrose.	Polariscope Reading.	Per Cent Sucrose.
12	3.225	28	7.526	44	11.827
13	3.494	29	7.795	45	12.096
14	3.763	30	8.064	46	12.365
15	4.032	31	8.333	47	12.634
16	4.301	32	8.602	48	12.902
17	4.570	33	8.870	49	13.171
18	4.838	34	9.139	50	13.440
19	5.107	35	9.408	51	13.709
20	5.376	36	9.677	52	13.967
21	5.645	37	9.946	53	14.236
22	5.914	38	10.214	54	14.505
23	6.182	39	10.483	55	14.774
24	6.451	40	10.752	56	15.042
25	6.720	41	11.020	57	15.311
26	6.889	42	11.290	58	15.580
27	7.256	43	11.558	59	15.849

Polariscope Reading.	Per Cent Sucrose.
0.1	.027
0.2	.054
0.3	.081
0.4	.107
0.5	.134
0.6	.161
0.7	.188
0.8	.215
0.9	.242

Table IV—(*Continued*)

SCHMITZ' SUCROSE TABLE

17

Degree Brix

Specific Gravity = 1.07002

Polariscope Reading 1.0 = .2678 per cent Sucrose

Polariscope Reading.	Per Cent Sucrose.	Polariscope Reading.	Per Cent Sucrose.	Polariscope Reading.	Per Cent Sucrose
14	3.749	31	8.302	48	12.854
15	4.017	32	8.570	49	13.122
16	4.285	33	8.837	50	13.390
17	4.553	34	9.105	51	13.658
18	4.820	35	9.373	52	13.926
19	5.088	36	9.641	53	14.193
20	5.356	37	9.909	54	14.461
21	5.624	38	10.176	55	14.729
22	5.892	39	10.444	56	14.997
23	6.159	40	10.712	57	15.265
24	6.427	41	10.980	58	15.532
25	6.695	42	11.248	59	15.800
26	6.962	43	11.515	60	16.068
27	7.231	44	11.783	61	16.336
28	7.498	45	12.051	62	16.604
29	7.766	46	12.309	63	16.871
30	8.034	47	12.587		

Polariscope Reading.	Per Cent Sucrose.
0.1	.027
0.2	.054
0.3	.803
0.4	.107
0.5	.134
0.6	.161
0.7	.187
0.8	.214
0.9	241

Table IV—(*Continued*)

SCHMITZ' SUCROSE TABLE

18

Degree Brix

Specific Gravity = 1.07441

Polariscope Reading 1.0 = .2766 per cent Sucrose

Polariscope Reading.	Per Cent Sucrose.	Polariscope Reading.	Per Cent Sucrose.	Polariscope Reading.	Per Cent Sucrose.
14	3.734	32	8.534	50	13.335
15	4.000	33	8.801	51	13.602
16	4.267	34	9.068	52	13.868
17	4.534	35	9.335	53	14.135
18	4.801	36	9.601	54	14.402
19	5.067	37	9.868	55	14.668
20	5.334	38	10.135	56	14.935
21	5.601	39	10.401	57	15.202
22	5.867	40	10.668	58	15.469
23	6.134	41	10.935	59	15.735
24	6.401	42	11.201	60	16.002
25	6.667	43	11.468	61	16.270
26	6.934	44	11.734	62	16.535
27	7.201	45	12.002	63	16.802
28	7.468	46	12.268	64	17.069
29	7.734	47	12.535	65	17.335
30	8.001	48	12.801	66	17.624
31	8.268	49	13.068	67	17.869

Polariscope Reading.	Per Cent Sucrose.
0.1	.027
0.2	.053
0.3	.080
0.4	.107
0.5	.133
0.6	.160
0.7	.187
0.8	.213
0.9	.240

Table IV—(*Continued*)

SCHMITZ' SUCROSE TABLE

19

Degree Brix

Speicfic Gravity = 1.07884

Polariscope Reading 1.0 = .2656 per cent Sucrose

Polariscope Reading.	Per Cent Sucrose.	Polariscope Reading.	Per Cent Sucrose.	Polariscope Reading.	Per Cent Sucrose.
20	5.312	36	9.562	52	13.811
21	5.578	37	9.827	53	14.077
22	5.843	38	10.092	54	14.342
23	6.109	39	10.358	55	14.608
24	6.374	40	10.624	56	14.875
25	6.640	41	10.890	57	15.139
26	6.906	42	11.155	58	15.405
27	7.171	43	11.421	59	15.670
28	7.437	44	11.686	60	15.936
29	7.702	45	11.952	61	16.201
30	7.968	46	12.217	62	16.467
31	8.234	47	12.483	63	16.732
32	8.499	48	12.749	64	16.998
33	8.765	49	13.014	65	17.264
34	9.030	50	13.280	66	17.530
35	9.296	51	13.546	67	17.795

Polariscope Reading.	Per Cent Sucrose.
0.1	.026
0.2	.053
0.3	.080
0.4	.106
0.5	.133
0.6	.159
0.7	.186
0.8	.212
0.9	.239

TABLE IV—(*Continued*)

SCHMITZ' SUCROSE TABLE

20

DEGREE BRIX

Specific Gravity = 1.08329

Polariscope Reading 1.0 = .2645 per cent Sucrose

Polariscope Reading.	Per Cent Sucrose.	Polariscope Reading.	Per Cent Sucrose.	Polariscope Reading.	Per Cent Sucrose.
30	7.935	46	12.167	62	16.399
31	8.200	47	12.431	63	16.663
32	8.464	48	12.696	64	16.928
33	8.728	49	12.960	65	17.192
34	8.993	50	13.225	66	17.457
35	9.257	51	13.490	67	17.721
36	9.522	52	13.754	68	17.986
37	9.787	53	14.018	69	18.250
38	10.051	54	14.283	70	18.515
39	10.315	55	14.547	71	18.780
40	10.580	56	13.812	72	19.044
41	10.844	57	15.076	73	19.308
42	11.109	58	15.341	74	19.573
43	11.373	59	15.605	75	19.837
44	11.688	60	15.870		
45	11.902	61	16.134		

Polariscope Reading.	Per Cent Sucrose.
0.1	.026
0.2	.053
0.3	.079
0.4	.106
0.5	.132
0.6	.159
0.7	.185
0.8	.211
0.9	.238

Table IV—(*Continued*)

SCHMITZ' SUCROSE TABLE

21

Degree Brix

Specific Gravity = 1.08778

Polariscope Reading 1.0 = .2633 per cent Sucrose

Polariscope Reading.	Per Cent Sucrose.	Polariscope Reading.	Per Cent Sucrose.	Polariscope Reading.	Per Cent Sucrose.
30	7.899	47	12.375	64	16.851
31	8.162	48	12.638	65	17.114
32	8.425	49	12.902	66	17.378
33	8.689	50	13.165	67	17.641
34	8.952	51	13.428	68	17.904
35	9.215	52	13.691	69	18.168
36	9.479	53	13.955	70	18.431
37	9.742	54	14.218	71	18.694
38	10.005	55	14.481	72	18.957
39	10.269	56	14.745	73	19.221
40	10.532	57	15.008	74	19.484
41	10.795	58	15.271	75	19.747
42	11.058	59	15.535	76	20.011
43	11.322	60	15.798	77	20.274
44	11.585	61	16.061	78	20.537
45	11.848	62	16.324	79	20.800
46	12.112	63	16.588		

Polariscope Reading.	Per Cent Sucrose.
0.1	.026
0.2	.053
0.3	.080
0.4	.105
0.5	.132
0.6	.258
0.7	.184
0.8	.211
0.9	.237

TABLE IV—(*Continued*)

SCHMITZ' SUCROSE TABLE

22

DEGREE BRIX

Specific Gravity = 1.0923

Polaris^ope Reading 1.0 = .2623 per cent Sucrose

Polariscope Reading.	Per Cent Sucrose.	Polariscope Reading.	Per Cent Sucrose.	Polariscope Reading.	Per Cent Sucrose.
30	7.869	48	12.590	66	17.312
31	8.131	49	12.853	67	17.574
32	8.394	50	13.115	68	17.836
33	8.656	51	13.377	69	18.098
34	8.918	52	13.640	70	18.361
35	9.180	53	13.902	71	18.623
36	9.443	54	14.164	72	18.886
37	9.705	55	14.427	73	19.148
38	9.967	56	14.689	74	19.410
39	10.230	57	14.951	75	19.672
40	10.492	58	15.213	76	19.934
41	10.754	59	15.476	77	20.197
42	11.017	60	15.738	78	20.459
53	11.279	61	16.000	79	20.722
44	11.541	62	16.263	80	20.984
45	11.803	63	16.525	81	21.246
46	12.066	64	16.787	82	21.509
47	12.328	65	17.049	83	21.771

Polariscope Reading.	Per Cent Sucrose.
0.1	.026
0.2	.052
0.3	.079
0.4	.105
0.5	.131
0.6	.157
0.7	.184
0.8	.210
0.9	.236

TABLE IV—(*Continued*)
SCHMITZ' SUCROSE TABLE
23
DEGREE BRIX

Specific Gravity = 1.09686

Polariscope Reading 1.0 = .261 per cent Sucrose

Polariscope Reading.	Per Cent Sucrose.	Polariscope Reading.	Per Cent Sucrose.	Polariscope Reading.	Per Cent Sucrose.
30	7.830	50	13.050	70	18.270
31	8.091	51	13.311	71	18.531
32	8.352	52	13.572	72	18.791
33	8.613	53	13.833	73	19.051
34	9.874	54	14.094	74	19.311
35	9.135	55	14.355	75	19.572
36	9.396	56	14.616	76	19.833
37	9.657	57	14.877	77	20.094
38	9.918	58	15.138	78	20.355
39	10.179	59	15.409	79	20.616
40	10.440	60	15.660	80	20.877
41	10.701	61	15.921	81	21.138
42	10.962	62	16.182	82	21.399
43	11.223	63	16.443	83	21.660
44	11.484	64	16.704	84	21.921
45	11.745	65	16.965	85	22.182
46	12.006	66	17.226	86	22.443
47	12.267	67	17.487	87	22.704
48	12.528	68	17.748	88	22.965
49	12.789	69	18.009		

Polariscope Reading.	Per Cent Sucrose.
0.1	.026
0.2	.052
0.3	.078
0.4	.104
0.5	.130
0.6	.157
0.7	.183
0.8	.209
0.9	.235

Table IV—(*Continued*)

SCHMITZ' SUCROSE TABLE

RESIDUAL JUICE

Polariscope Reading.	Degree Brix.					
	2.00	3.00	4.00	5.00	6.00	7.00
4	1.14					
5	1.42					
6	1.70	1.69				
7	1.98	1.98	1.97			
8	....	2.26	2.25	2.24		
9	....	2.54	2.53	2.52		
10	....	2.82	2.81	2.80	2.79	
11	....	....	3.09	3.08	3.07	3.06
12	....	....	3.38	3.36	3.35	3.34
13	....	....	3.66	3.64	3.63	3.61
14	....	....	....	3.92	3.91	3.89
15	....	....	....	4.20	4.19	4.17
16	....	....	....	4.48	4.47	4.45
17	....	....	....	4.77	4.75	4.73
18	....	....	....	....	5.02	5.00
19	....	....	....	....	5.31	5.28
20	....	....	....	....	5.55	5.56
21	....	....	....	....	....	5.84
22	....	....	....	....	....	6.12
23	....	....	....	....	....	6.40

One-tenth Reading.	Per Cent Sucrose.
0.1	0.03
0.2	0.05
0.3	0.08
0.4	0.11
0.5	0.13
0.6	0.16
0.7	0.19
0.8	0.21
0.9	0.24

Table IV—(*Continued*)

SUCROSE TABLE FOR

BAGASSE

Use 200-mm. tube

Polariscope Reading.	Dry Lead.	100/110	Polariscope Reading.	Dry Lead.	100/110
1.0	.259	.285	4.3	1.114	1.225
1.1	.285	.313	4.4	1.140	1.254
1.2	.311	.342	4.5	1.165	1.282
1.3	.337	.370	4.6	1.191	1.311
1.4	.363	.399	4.7	1.217	1.339
1.5	.388	.427	4.8	1.243	1.368
1.6	.414	.456	4.9	1.269	1.396
1.7	.440	.484			
1.8	.466	.513	5.0	1.295	1.425
1.9	.492	.541	5.1	1.321	1.453
			5.2	1.347	1.482
2.0	.518	.570	5.3	1.373	1.510
2.1	.544	.598	5.4	1.399	1.539
2.2	.570	.627	5.5	1.425	1.567
2.3	.596	.655	5.6	1.450	1.596
2.4	.622	.684	5.7	1.476	1.624
2.5	.647	.712	5.8	1.502	1.653
2.6	.673	.741	5.9	1.528	1.681
2.7	.699	.769			
2.8	.725	.798	6.0	1.554	1.710
2.9	.751	.826	6.1	1.580	1.739
			6.2	1.606	1.767
3.0	.777	.855	6.3	1.632	1.795
3.1	.803	.883	6.4	1.657	1.824
3.2	.828	.912	6.5	1.683	1.852
3.3	.855	.940	6.6	1.709	1.881
3.4	.881	.969	6.7	1.735	1.910
3.5	.906	.997	6.8	1.761	1.938
3.6	.932	1.026	6.9	1.787	1.967
3.7	.958	1.054			
3.8	.984	1.083	7.0	1.813	1.995
3.9	1.010	1.111	7.1	1.839	2.023
			7.2	1.865	2.052
4.0	1.036	1.140	7.3	1.891	2.080
4.1	1.062	1.168	7.4	1.917	2.109
4.2	1.088	1.197	7.5	1.942	2.137

Glucose.—The determination of glucose in cane-sugar products is made by titrating a weighed amount, usually 5 grams made up to 100 c.c., against a standard Fehling solution, which is prepared as follows:

Copper Solution: 34.64 grams copper sulphate per litre.

Alkali Solution: 187 grams Rochelle salts and 78 grams sodium hydrate per litre.

Ten c.c. of each of the solutions are measured into a small porcelain evaporating dish, and brought to a boil over an alcohol lamp, then removed, and approximately the right amount of the sugar solution run from a burette and thoroughly mixed, and again brought to a boil. If the correct amount has been added, there will be a rapid settling of the red precipitate, leaving a clear liquid at the surface, which will give no reaction when tested with ferrocyanide of potassium and acetic acid, on a color plate. Should a brown color appear, it indicates that the copper has not been entirely reduced, and more of the sugar solution is added, always when removed from the flame. The object of this is to prevent overheating, which introduces a yellow color, making the end reaction more difficult to observe. As the normal glucose solution is 5 per cent or a multiple, it is possible to use a table for obtaining the percentage direct from number of cubic centimeters indicated on

Table V

GLUCOSE

NORMAL SOLUTION—5 GRAMS PER 100

Burette Reading.	Per Cent Glucose.	Burette Reading.	Per Cent Glucose.
15.0	6.67	30.0	3.33
15.5	6.44	30.5	3.28
16.0	6.24	31.0	3.22
16.5	6.06	31.5	3.17
17.0	5.88	32.0	3.12
17.5	5.72	32.5	3.08
18.0	5.56	33.0	3.03
18.5	5.40	33.5	2.98
19.0	5.26	34.0	2.94
19.5	5.12	34.5	2.89
20.0	5.00	35.0	2.86
20.5	4.88	35.5	2.81
21.0	4.76	36.0	2.78
21.5	4.65	36.5	2.74
22.0	4.54	37.0	2.70
22.5	4.44	37.5	2.66
23.0	4.35	38.0	2.63
23.5	4.25	38.5	2.59
24.0	4.17	39.0	2.56
24.5	4.08	39.5	2.53
25.0	4.00	40.0	2.50
25.5	3.92	40.5	2.47
26.0	3.85	41.0	2.44
26.5	3.77	41.5	2.40
27.0	3.70	42.0	2.38
27.5	3.64	42.5	2.35
28.0	3.57	43.0	2.32
28.5	3.51	43.5	2.30
29.0	3.45	44.0	2.27
29.5	3.39	44.5	2.24

the burette. In case 10, 20, or 50 grams are used, the reading is found in the table and then divided by 2, 4, or 10, in order to obtain the correct percentage.

MOISTURE.—*Bagasse.* One hundred grams of the sample used for the sucrose determination are dried for four hours at 125° C.

Sugar.—Ten grams are dried to constant weight at from 100° to 103° C.

ASH.—Juices, syrups, sugars, and final molasses are tested for ash by first evaporating the excess moisture, adding a few drops of sulphuric acid, charring in a muffle and finally burning completely. The addition of sulphuric acid is arbitrarily compensated for by deducting 10 per cent from the weight.

ACIDITY.—Ten c.c. of the sample are titrated against a one-tenth solution of sodium hydrate, or sulphuric acid.

TABLE VI
MILL JUICE

TOTAL POUNDS AND POUNDS SOLIDS IN ONE GALLON

Per Cent Solids.	Total Pounds per Gallon.	Pounds Solids per Gallon.	Per Cent Solids.	Total Pounds per Gallon.	Pounds Solids per Gallon.
10.0	8.668	0.867	13.0	8.773	1.140
10.1	8.671	0.876	13.1	8.777	1.149
10.2	8.675	1.885	13.2	8.780	1.158
10.3	8.678	0.893	13.3	8.784	1.168
10.4	8.681	0.903	13.4	8.787	1.177
10.5	8.685	0.912	13.5	8.791	1.186
10.6	8.688	0.921	13.6	8.794	1.195
10.7	8.692	0.930	13.7	8.798	1.205
10.8	8.696	0.939	13.8	8.801	1.214
10.9	8.699	0.948	13.9	8.805	1.224
11.0	8.703	0.957	14.0	8.809	1.233
11.1	8.706	0.966	14.1	8.812	1.242
11.2	8.709	0.975	14.2	8.816	1.251
11.3	8.713	0.984	14.3	8.819	1.261
11.4	8.717	0.994	14.4	8.823	1.270
11.5	8.720	1.003	14.5	8.826	1.279
11.6	8.724	1.012	14.6	8.830	1.289
11.7	8.727	1.021	14.7	8.834	1.298
11.8	8.731	1.030	14.8	8.837	1.307
11.9	8.734	1.039	14.9	8.841	1.316
12.0	8.738	1.048	15.0	8.844	1.326
12.1	8.741	1.057	15.1	8.848	1.336
12.2	8.745	1.066	15.2	8.852	1.345
12.3	8.748	1.076	15.3	8.855	1.354
12.4	8.752	1.085	15.4	8.859	1.364
12.5	8.755	1.094	15.5	8.863	1.373
12.6	8.759	1.103	15.6	8.866	1.383
12.7	8.762	1.112	15.7	8.870	1.392
12.8	8.766	1.122	15.8	8.873	1.402
12.9	8.769	1.131	15.9	8.877	1.411

Table VI—(*Continued*)
MILL JUICE
TOTAL POUNDS AND POUNDS SOLIDS IN ONE GALLON

Per Cent Solids.	Total Pounds per Gallon.	Pounds Solids per Gallon.	Per Cent Solids.	Total Pounds per Gallon.	Pounds Solids per Gallon.
16.0	8.880	1.421	19.0	8.990	1.708
16.1	8.884	1.430	19.1	8.994	1.718
16.2	8.887	1.440	19.2	8.998	1.728
16.3	8.890	1.449	19.3	9.001	1.737
16.4	8.895	1.459	19.4	9.005	1.747
16.5	8.898	1.468	19.5	9.009	1.757
16.6	8.902	1.478	19.6	9.012	1.767
16.7	8.906	1.487	19.7	9.016	1.776
16.8	8.910	1.497	19.8	9.020	1 786
16.9	8.913	1.506	19.9	9.024	1.796
17.0	8.917	1.516	20.0	9.028	1.806
17.1	8.921	1.526	20.1	9.032	1.816
17.2	8.924	1.535	20.2	9.035	1.826
17.3	8.928	1.545	20.3	9.039	1.836
17.4	8.932	1.554	20.4	9.043	1.845
17.5	8.935	1.564	20.5	9.046	1.855
17.6	8.939	1.574	20.6	9.050	1.865
17.7	8.942	1.583	20.7	9.054	1.875
17.8	8.947	1.593	20.8	9.058	1.884
17.9	8.950	1.602	20.9	9.061	1.894
18.0	8.954	1.612	21.0	9.065	1.904
18.1	8.958	1.621	21.1	9.069	1.914
18.2	8.961	1.631	21.2	9.073	1.924
18.3	8.965	1.641	21.3	9.076	1.934
18.4	8.968	1.650	21.4	9.080	1.943
18.5	8.972	1.660	21.5	9.084	1.953
18.6	8.976	1.669	21.6	9.088	1.963
18.7	8.979	1.679	21.7	9.092	1.973
18.8	8.983	1.689	21.8	9.095	1.982
18.9	8.986	1.698	21.9	9.099	1.992

TABLE VI—(*Continued*)

MILL JUICE

TOTAL POUNDS AND POUNDS SOLIDS IN ONE GALLON

Per Cent Solids.	Total Pounds per Gallon.	Pounds Solids per Gallon.	Per Cent Solids.	Total Pounds per Gallon.	Pounds Solids per Gallon.
22.0	9.103	2.002	23.0	9.140	2.102
22.1	9.107	2.012	23.1	9.144	2.112
22.2	9.111	2.022	23.2	9.148	2.122
22.3	9.114	2.032	23.3	9.152	2.132
22.4	9.118	2.042	23.4	9.156	2.142
22.5	9.121	2.053	23.5	9.159	2.152
22.6	9.125	2.063	23.6	9.163	2.162
22.7	9.129	2.073	23.7	9.167	2.172
22.8	9.133	2.083	23.8	9.171	2.182
22.9	9.136	2.093	23.9	9.175	2.192

SYRUP

TOTAL POUNDS AND POUNDS SOLIDS IN ONE GALLON

Per Cent Solids.	Total Pounds per Gallon.	Pounds Solids per Gallon.	Per Cent Solids.	Total Pounds per Gallon.	Pounds Solids per Gallon.
41.0	9.872	4.047	42.5	9.937	4.223
41.1	9.876	4.059	42.6	9.941	4.235
41.2	9.881	4.070	42.7	9.945	4.247
41.3	9.885	4.082	42.8	9.950	4.258
41.4	9.889	4.094	42.9	9.954	4.270
41.5	9.893	4.105			
41.6	9.898	4.117	43.0	9.959	4.282
41.7	9.902	4.129	43.1	9.963	4.294
41.8	9.906	4.141	43.2	9.968	4.306
41.9	9.911	4.152	43.3	9.972	4.318
			43.4	9.977	4.330
42.0	9.915	4.164	43.5	9.981	4.341
42.1	9.919	4.176	43.6	9.985	4.353
42.2	9.924	4.188	43.7	9.990	4.365
42.3	9.928	4.199	43.8	9.994	4.377
42.4	9.933	4.211	43.9	9.998	4.389

Table VI—(*Continued*)

SYRUP

TOTAL POUNDS AND POUNDS SOLIDS IN ONE GALLON

Per Cent Solids.	Total Pounds per Gallon.	Pounds Solids per Gallon.	Per Cent Solids.	Total Pounds per Gallon.	Pounds Solids per Gallon.
44.0	10.003	4.401	47.0	10.137	4.764
44.1	10.007	4.413	47.1	10.141	4.776
44.2	10.012	4.425	47.2	10.146	4.788
44.3	10.016	4.437	47.3	10.150	4.800
44.4	10.021	4.449	47.4	10.155	4.813
44.5	10.025	4.461	47.5	10.159	4.825
44.6	10.029	4.473	47.6	10.164	4.837
44.7	10.033	4.485	47.7	10.168	4.850
44.8	10.043	4.497	47.8	10.173	4.862
44.9	10.047	4.509	47.9	10.177	4.874
45.0	10.047	4.521	48.0	10.182	4.877
45.1	10.052	4.533	48.1	10.186	4.899
45.2	10.056	4.545	48.2	10.191	4.912
45.3	10.061	4.557	48.3	10.195	4.924
45.4	10.065	4.569	48.4	10.200	4.937
45.5	10.069	4.581	48.5	10.204	4.950
45.6	10.074	4.593	48.6	10.209	4.961
45.7	10.078	4.605	48.7	10.213	4.974
45.8	10.083	4.617	48.8	10.218	4.986
45.9	10.087	4.629	48.9	10.222	5.000
46.0	10.092	4.642	49.0	10.227	5.011
46.1	10.096	4.654	49.1	10.231	5.024
46.2	10.101	4.666	49.2	10.236	5.036
46.3	10.105	4.678	49.3	10.240	5.049
46.4	10.110	4.690	49.4	10.245	5.061
46.5	10.114	4.702	49.5	10.249	5.074
46.6	10.119	4.714	49.6	10.254	6.086
46.7	10.123	4.726	49.7	10.258	5.099
47.8	10.128	4.738	49.8	10.263	5.111
46.9	10.132	4.750	49.9	10.267	5.124

TABLE VI—(*Continued*)

SYRUP

TOTAL POUNDS AND POUNDS SOLIDS IN ONE GALLON

Per Cent Solids.	Total Pounds per Gallon.	Pounds Solids per Gallon.	Per Cent Solids.	Total Pounds per Gallon.	Pounds Solids per Gallon.
50.0	10.272	5.136	53.0	10.414	5.519
50.1	10.277	5.149	53.1	10.418	5.532
50.2	10.282	5.161	53.2	10.422	5.545
50.3	10.287	5.174	53.3	10.427	5.558
50.4	10.291	5.186	53.4	10.431	5.571
50.5	10.296	5.199	53.5	10.436	5.584
50.6	10.300	5.211	53.6	10.441	5.597
50.7	10.305	5.224	53.7	10.445	5.610
50.8	10.310	5.237	53.8	10.450	5.623
50.9	10.315	5.249	53.9	10.454	6.636
51.0	10.319	5.263	54.0	10.459	5.648
51.1	10.323	5.275	54.1	10.464	5.661
51.2	10.328	5.288	54.2	10.468	5.674
51.3	10.333	5.301	54.3	10.743	5.687
51.4	10.337	5.314	54.4	; 10.478	5.700
51.5	10.342	5.326	54.5	10.482	5.713
51.6	10.347	5.339	54.6	10.487	5.726
51.7	10.351	5.352	54.7	10.492	5.739
51.8	10.356	5.365	54.8	10.497	5.752
51.9	10.360	5.377	54.9	10.501	5.765
52.0	10.365	5.390	55.0	10.507	5.779
52.1	10.375	5.403	55.1	10.512	5.792
52.2	10.380	5.416	55.2	10.517	5.806
52.3	10.384	5,429	55.3	10.521	5.819
52.4	10.389	5.442	55.4	10.526	5.832
52.5	10.394	5.455	55.5	10.531	5.845
52.6	10.399	5.468	55.6	10.537	5.859
52.7	10.404	4.581	55.7	10.541	5.872
52.8	10.408	5.494	55.8	10.545	5.885
52.9	10.411	5.507	55.9	10.550	5.899

Table VI—(*Continued*)

SYRUP

TOTAL POUNDS AND POUNDS SOLIDS IN ONE GALLON

Per Cent Solids.	Total Pounds per Gallon.	Pounds Solids per Gallon.	Per Cent Solids.	Total Pounds per Gallon.	Pounds Solids per Gallon.
56.0	10.555	5.912	58.5	10.676	6.244
56.1	10.560	5.925	58.6	10.680	6.257
56.2	10.565	5.938	58.7	10.685	6.271
56.3	10.570	5.951	58.8	10.690	6.285
56.4	10.574	5.964	58.9	10.695	6.298
56.5	10.579	5.977			
56.6	10.584	5.990	59.0	10.700	6.313
56.7	10.589	6.003	59.1	10.705	6.327
56.8	10.594	6.010	59.2	10.710	6.340
56.9	10.598	6.020	59.3	10.715	6.354
			59.4	10.720	6.367
57.0	10.603	6.043	59.5	10.725	6.381
57.1	10.608	6.056	59.6	10.730	6.395
57.2	10.613	6.070	59.7	10.735	6.408
57.3	10.618	6.083	59.8	10.740	6.422
57.4	10.622	6.097	59.9	10.745	6.435
57.5	10.627	6.110			
57.6	10.632	6.123	60.0	10.749	6.449
57.7	10.637	6.137	60.1	10.754	6.463
57.8	10.642	6.150	60.2	10.759	6.477
57.9	10.646	6.164	60.3	10.764	6.591
			60.4	10.769	6.505
58.0	10.651	6.177	60.5	10.774	6.519
58.1	10.656	6.190	60.6	10.778	6.533
58.2	10.661	6.203	60.7	10.783	6.547
58.3	10.666	6.216	60.8	10.788	6.561
58.4	10.671	6.230	60.9	10.793	6.576

Table VI—(*Continued*)

MOLASSES

TOTAL POUNDS AND POUNDS SOLIDS IN ONE GALLON

Per Cent Solids.	Total Pounds per Gallon.	Pounds Solids per Gallon.	Per Cent Solids.	Total Pounds per Gallon.	Pounds Solids per Gallon.
71.0	11.31	8.03	74.0	11.47	8.49
71.1	11.31	8.04	74.1	11.48	8.50
71.2	11.32	8.06	74.2	11.48	8.52
71.3	11.33	8.07	74.3	11.49	8.53
71.4	11.33	8.09	74.4	11.49	8.55
71.5	11.34	8.10	74.5	11.50	8.57
71.6	11.34	8.12	74.6	11.50	8.58
71.7	11.35	8.13	74.7	11.51	8.60
71.8	11.35	8.15	74.8	11.51	8.61
71.9	11.36	8.16	74.9	11.52	8.63
72.0	11.36	8.18	75.0	11.52	8.64
72.1	11.37	8.20	75.1	11.53	8.66
72.2	11.37	8.21	75.2	11.53	8.67
72.3	11.38	8.23	75.3	11.54	8.69
72.4	11.38	8.24	75.4	11.55	8.70
72.5	11.39	8.26	75.5	11.56	8.72
72.6	11.39	8.27	75.6	11.56	8.73
72.7	11.40	8.29	75.7	11.57	8.75
72.8	11.40	8.30	75.8	11.57	8.77
72.9	11.41	8.32	75.9	11.58	8.79
73.0	11.42	8.33	76.0	11.58	8.80
73.1	11.42	8.35	76.1	11.58	8.81
73.2	11.43	8.36	76.2	11.59	8.83
73.3	11.43	8.38	76.3	11.59	8.85
73.4	11.44	8.39	76.4	11.60	8.86
73.5	11.44	8.41	76.5	11.60	8.87
73.6	11.45	8.42	76.6	11.61	8.89
73.7	11.45	8.44	76.7	11.62	8.91
73.8	11.46	8.45	76.8	11.62	8.92
73.9	11.47	8.47	76.9	11.63	8.93

Table VI—(*Continued*)

MOLASSES

TOTAL POUNDS AND POUNDS SOLIDS IN ONE GALLON

Per Cent Solids.	Total Pounds per Gallon.	Pounds Solids per Gallon.	Per Cent Solids.	Total Pounds per Gallon.	Pounds Solids per Gallon.
77.0	11.63	8.95	80.0	11.80	9.43
77.1	11.64	8.97	80.1	11.80	9.45
77.2	11.64	8.99	80.2	11.81	9.47
77.3	11.65	9.00	80.3	11.82	9.48
77.4	11.65	9.02	80.4	11.82	9.49
77.5	11.66	9.04	80.5	11.83	9.51
77.6	11.67	9.05	80.6	11.83	9.53
77.7	11.68	9.06	80.7	11.84	9.55
77.8	11.68	9.08	80.8	11.84	9.57
77.9	11.69	9.09	80.9	11.85	9.59
78.0	11.69	9.10	81.0	11.85	9.60
78.1	11.70	9.12	81.1	11.86	9.61
78.2	11.70	9.14	81.2	11.87	9.63
78.3	11.71	9.16	81.3	11.87	9.65
78.4	11.71	9.17	81.4	11.88	9.67
78.5	11.72	9.19	81.5	11.89	9.69
78.6	11.73	9.21	81.6	11.89	9.70
78.7	11.73	9.22	81.7	11.90	9.72
78.8	11.74	9.24	81.8	11.90	9.74
78.9	11.74	9.26	81.9	11.91	9.76
79.0	11.74	9.27	82.0	11.91	9.77
79.1	11.75	9.29	82.1	11.92	9.79
79.2	11.75	9.31	82.2	11.92	9.81
79.3	11.76	9.33	82.3	11.93	9.82
79.4	11.76	9.34	82.4	11.93	9.84
79.5	11.77	9.35	82.5	11.94	9.86
79.6	11.78	9.37	82.6	11.94	9.87
79.7	11.78	9.38	82.7	11.95	9.89
79.8	11.79	9.40	82.8	11.96	9.90
79.9	11.79	9.41	82.9	11.96	9.91

TABLE VI—(*Continued*)

MOLASSES

TOTAL POUNDS AND POUNDS SOLIDS IN ONE GALLON

Per Cent Solids.	Total Pounds per Gallon.	Pounds Solids per Gallon.	Per Cent Solids.	Total Pounds per Gallon.	Pounds Solids per Gallon.
83.0	11.97	9.93	85.0	12.08	10.27
83.1	11.97	9.95	85.1	12.09	10.28
83.2	11.98	9.97	85.2	12.09	10.30
83.3	11.98	9.98	85.3	12.10	10.32
83.4	11.99	10.00	85.4	12.11	10.34
83.5	12.00	10.02	85.5	12.11	10.35
83.6	12.00	10.03	85.6	12.12	10.37
83.7	12.01	10.05	85.7	12.12	10.39
83.8	12.01	10.07	85.8	12.13	10.40
83.9	12.02	10.08	85.9	12.13	10.42
84.0	12.02	10.10	86.0	12.14	10.42
84.1	12.03	10.12	86.1	12.15	10.46
84.2	12.04	10.13	86.2	12.15	10.47
84.3	12.05	10.15	86.3	12.16	10.49
84.4	12.05	10.17	86.4	12.16	10.50
84.5	12.05	10.18	86.5	12.17	10.52
84.6	12.06	10.20	86.6	12.17	10.54
84.7	12.06	10.22	86.7	12.18	10.56
84.8	12.07	10.23	86.8	12.19	10.58
84.9	12.08	10.25	86.9	12.19	10.60

Table VI—(*Continued*)

MOLASSES

TOTAL POUNDS AND POUNDS SOLIDS IN ONE GALLON AND IN ONE CUBIC FOOT

Per Cent Solids.	Total Pounds per Gallon.	Total Pounds Solids per Gallon.	Total Pounds per Cubic Foot.	Pounds Solids per Cubic Foot.
87.0	12.20	10.61	91.49	79.60
87.1	12.21	10.63	91.53	79.72
87.2	12.21	10.65	91.58	79.85
87.3	12.22	10.66	91.62	79.98
87.4	12.22	10.68	91.66	80.11
87.5	12.23	10.70	91.70	80.24
87.6	12.24	10.72	91.75	80.37
87.7	12.24	10.74	91.79	80.50
87.8	12.25	10.75	91.83	80.63
87.9	12.25	10.77	91.87	80.76
88.0	12.26	10.79	91.92	80.89
88.1	12.26	10.81	91.96	81.02
88.2	12.27	10.82	92.00	81.15
88.3	12.27	10.84	92.05	81.28
88.4	12.28	10.86	92.10	81.41
88.5	12.28	10.87	92.14	81.54
88.6	12.29	10.89	92.18	81.67
88.7	12.29	10.91	92.22	81.80
88.8	12.30	10.93	92.27	81.93
88.9	12.30	10.94	92.32	82.06
89.0	12.31	10.96	92.36	82.20
89.1	12.32	10.98	92.40	82.33
89.2	12.32	11.00	92.45	82.46
89.3	12.33	11.01	92.49	82.59
89.4	12.33	11.03	92.54	82.72
89.5	12.34	11.05	92.58	82.85
89.6	12.35	11.07	92.63	82.98
89.7	12.35	11.09	92.67	83.11
89.8	12.36	11.10	92.71	83.24
89.9	12.36	11.12	92.76	83.37

TABLE VI—(*Continued*)

MOLASSES

TOTAL LBS., ETC., IN ONE GALLON AND IN ONE CUBIC FOOT

Per Cent Solids.	Total Pounds per Gallon.	Total Pounds Solids per Gallon.	Total Pounds per Cubic Foot.	Pounds Solids per Cubic Foot.
90.0	12.37	11.14	92.80	83.52
90.1	12.38	11.16	92.85	83.65
90.2	12.38	11.18	92.89	83.78
90.3	12.39	11.19	92.94	83.91
90.4	12.39	11.21	92.98	84.04
90.5	12.40	11.23	93.03	84.17
90.6	12.41	11.25	93.07	84.30
90.7	12.41	11.27	93.11	84.43
90.8	12.42	11.28	93.16	84.56
90.9	12.43	11.30	93.20	84.69

MASSECUITE

TOTAL POUNDS AND POUNDS SOLIDS IN ONE CUBIC FOOT

Per Cent Solids.	Total Pounds per Cubic Foot.	Pounds Solids per Cubic Foot.	Per Cent Solids.	Total Pounds per Cubic Foot.	Pounds Solids per Cubic Foot.
91.0	93.25	84.86	92.5	93.92	86.88
91.1	93.29	84.98	92.6	93.97	87.01
91.2	93.34	85.12	92.7	94.00	87.15
91.3	93.38	85.25	92.8	94.06	87.28
91.4	93.43	85.39	92.9	94.10	87.42
91.5	93.47	85.52	93.0	94.15	87.56
91.6	93.53	85.66	93.1	94.19	87.69
91.7	93.58	85.79	93.2	94.24	87.83
91.8	93.64	85.93	93.3	94.28	87.97
91.9	93.68	86.06	93.4	94.33	88.11
92.0	93.72	86.22	93.5	94.37	88.25
92.1	93.76	86.34	93.6	94.42	88.39
92.2	93.79	86.47	93.7	94.46	88.52
92.3	93.82	86.60	93.8	94.51	88.65
92.4	93.89	86.75	93.9	94.55	88.79

Table VI—(*Continued*)

MASSECUITE

TOTAL POUNDS AND POUNDS SOLIDS IN ONE CUBIC FOOT

Per Cent Solids.	Total Pounds per Cubic Foot.	Pounds Solids per Cubic Foot.	Per Cent Solids.	Total Pounds per Cubic Foot.	Pounds Solids per Cubic Foot.
94.0	94.60	88.92	95.5	95.28	90.99
94.1	94.64	89.05	95.6	95.32	91.13
94.2	94.69	89.18	95.7	95.37	91.27
94.3	94.73	89.32	95.8	95.42	91.40
94.4	94.78	89.45	95.9	95.46	91.54
94.5	94.83	89.58			
94.6	94.87	89.72	96.0	95.51	91.69
94.7	94.92	89.85	96.1	95.56	91.83
94.8	94.96	89.99	96.2	95.60	91.97
94.9	95.00	90.13	96.3	95.65	92.11
			96.4	95.69	92.25
95.0	95.05	90.30	96.5	95.74	92.39
95.1	95.10	90.43	96.6	95.79	92.53
95.2	95.14	90.58	96.7	95.83	92.67
95.3	95.19	90.71	96.8	95.88	92.81
95.4	95.23	90.85	96.9	95.92	92.95

CHAPTER II

THE FORMULA FOR AVAILABLE SUGAR

THE most important calculation made in the chemical control of a cane-sugar factory is that of determining the amount of available sugar contained in a measured or weighed quantity of material in process of manufacture. It is customary to divide the season into periods, either by weeks or twice a month, and at these times calculate how much sugar may be expected from the juices, syrups, massecuites, etc., on hand. The weight is obtained, directly, or indirectly from the volume, an analysis made for the density or total solids, the per cent of sucrose, and the purity calculated. Using the previous results as a basis, and assuming that the polarization of the sugar and the purity of the molasses will remain the same, the weight of the available sugar under these conditions is calculated. It has been found by experience that the yield is in proportion to the percentage of non-sugars contained, these bodies having the faculty of restraining from crystallization a definite amount of sucrose, all other conditions being the same. For example, the purity of Louisiana final molasses has been found to be approximately 25 per cent, which shows that the solid matter contains 25 per cent of sucrose and 75 per cent of non-sugars, or three parts of non-sugar restrain from crystallization one part of sucrose. With this information, it is possible to predict from an analysis of juice, syrup, or massecuite, how much sugar will be obtained when manufactured and also the quantity and purity of molasses. Take, for example, a massecuite having a purity of 80:

Total solids	100
Sucrose	80
Non-sugars	20

If the non-sugars present restrain one-third of its weight of the sugar present, then the available sugar may be found by taking one-third of 20 and subtracting the result from 80.

$$20 \div 3 = 6.67;$$

$$80 - 6.67 = 73.33.$$

The recovery of sugar from a massecuite having 80 purity and with the final molasses at 25 purity will be 73.33 per cent of the total solids present.

But this simple calculation may only be used when the sugar obtained is absolutely pure, and will not apply the sugars polarizing less than 100. For it is evident that a part of the non-sugars in the massecuite are not removed from the crystals in the centrifugals, and the weight of the molasses is reduced in proportion. It is therefore necessary when the amount of raw sugar is required, to take into consideration the composition of the sugar itself. Claassen gives three formulæ, the first using the total solids of the massecuite, sugars, and molasses, the second the polarization or per cent sucrose, and the third, the total solids and purity. The first two may only be used when the molasses has been undiluted, a condition that renders them practically useless in ordinary sugar-house work. The terms that enter into the formulæ are indicated by the following letters:

Let x = per cent of available sugar;
X' = weight of available sugar;
M = weight of massecuite;

a = Brix or total solids of massecuite;
b = Brix or total solids of sugar;
c = Brix or total solids of molasses;

d = per cent sucrose of massecuite;
e = per cent sucrose of sugar (polarization);
f = per cent sucrose of molasses;

g = purity of massecuite;
h = purity of sugar;
i = purity of molasses.

First formula:

$$x = \frac{100(a-c)}{(b-c)}.$$

Second formula:

$$x = \frac{100(d-f)}{(e-f)}.$$

Third formula:

$$x = \frac{100a(g-i)}{b(h-i)}.$$

The percentage obtained by any of the formulæ multiplied by the WEIGHT of the massecuite or any sugar solution will give the weight of sugar to be expected when the massecuite or sugar solution is manufactured. Prof. J. T. Crowley changed the third formula so that the weight of available sugar is obtained directly, but from the SOLIDS instead of the weight.

$$X' = \frac{aM(g-i)}{b(h-i)}.$$

The PER CENT of available sugar may also be obtained on the solids by always making $aM = 100$.

$$x = \frac{100(g-i)}{b(h-i)}.$$

This last formula has the advantage of reducing the number of calculations by one, as the weight of solids in one gallon or cubic foot may be found in Chapter I. By reducing the divisor, $b(h-i)$, to one figure, corresponding to the purities of the molasses that are usually obtained in the manufacture, two more calculations may be saved, without interfering with the accuracy of the work. For it has been found in the making of raw sugars that the output is very uniform, and it is possible from the polarization to predict very closely the total solids and the purity of the sample. By analyzing different grades of sugars, and noting the decrease in the two percentages as sugars of lower polarization are tested, it becomes possible to construct a table, based on the experimental data, which will be sufficiently accurate for the work intended, viz., a short method of obtaining the available sugar from sugar-house products. Such a table is given below, showing the total solids and purities of sugars polarizing from 80 to 100 degrees.

Table VII

COMMERCIAL SUGARS

Total Solids.	Polarization.	Purity.	Total Solids.	Polarization.	Purity.
100	100	100	98.0	89.5	91.33
100	99.5	99.50	97.9	89.0	90.91
99.9	99.0	99.10	97.8	88.5	90.49
99.8	98.5	98.70	97.7	88.0	90.07
99.7	98.0	98.30	97.6	87.5	89.65
99.6	97.5	97.89	97.5	87.0	89.23
99.5	97.0	97.49	97.4	86.5	88.81
99.4	96.5	97.08	97.3	86.0	88.38
99.3	96.0	96.68	97.2	85.5	87.96
99.2	95.5	96.27	97.1	85.0	87.54
99.1	95.0	95.86	97.0	84.5	87.11
99.0	94.5	95.45	96.9	84.0	86.68
98.9	94.0	95.04	96.8	83.5	86.26
98.8	93.5	94.63	96.7	83.0	85.83
98.7	93.0	94.09	96.6	82.5	85.40
98.6	92.5	93.81	96.5	82.0	84.97
98.5	92.0	93.40	96.4	81.5	84.54
98.4	91.5	92.99	96.3	81.0	84.01
98.3	91.0	92.57	96.2	80.5	83.67
98.2	90.5	92.15	96.1	80.0	83.24
98.1	90.0	91.74			

The method used in obtaining the divisor in one figure, called for convenience a FACTOR, may be shown by an example.

Find the per cent of available sugar from a massecuite having a purity of 80. The purity of the molasses to be 60 and the polarization of the sugar 96.

The total solids and purity of the sugar are found in the table to be 99.3 and 96. Substituting the figures in the formula,

$$x=\frac{100(80-60)}{99.3(96.68-60)}=\frac{2000}{36.42}=54.90.$$

But, as the process of multiplication is a simpler one than division to the majority, the divisor is changed into a multiplier by dividing it into unity.

$$\frac{1}{.3642}=2.745.$$

The example would then read:

$$(80-60)2.745=54.90,$$

and the formula for available sugar, on the weight of the solid matter in any sugar solution.

(Purity of massecuite − purity of molasses) factor.

Table VIII

FACTORS FOR AVAILABLE SUGAR

Purity Molasses.	Polarization of Sugar.			
	100	99.5	99.0	98.5
93.0	14.30	15.40	16.40	17.60
92.8	13.90	14.95	15.90	17.00
92.6	13.50	14.50	15.40	16.45
92.4	13.15	14.10	14.95	15.95
92.2	12.80	13.70	14.50	15.45
92.0	12.50	13.35	14.10	15.00
91.8	12.20	13.00	13.70	14.45
91.6	11.90	12.65	13.35	14.15
91.4	11.65	12.30	13.05	13.75
91.2	11.35	12.05	12.65	13.40
91.0	11.10	11.75	12.35	13.05
90.8	10.85	11.50	12.05	12.70
90.6	10.65	11.25	11.75	12.40
90.4	10.40	11.00	11.50	12.10
90.2	10.20	10.70	11.25	11.80
90.0	10.00	10.55	11.00	11.55
89.8	9.80	10.30	10.75	11.25
89.6	9.60	10.10	10.55	11.00
89.4	9.45	10.00	10.30	10.80
89.2	9.25	9.90	10.10	10.55
89.0	9.10	9.70	9.90	10.35
88.8	8.95	9.50	9.70	10.15
88.6	8.75	9.35	9.55	9.95
88.4	8.60	9.15	9.35	9.75
88.2	8.45	9.00	9.20	9.55
88.0	8.35	8.85	9.00	9.35
87.8	8.20	8.70	8.85	9.20
87 6	8.05	8.55	8.70	9.05
87.4	7.95	8.40	8.55	8.85
87.2	7.80	8.25	8.40	8.70

TABLE VIII—(*Continued*)

FACTORS FOR AVAILABLE SUGAR

Purity Molasses.	Polarization of Sugar.			
	100	99.5	99.0	98.5
87.0	7.70	8.15	8.25	8.55
86.8	7.60	8.00	8.15	8.40
86.6	7.45	7.85	8.00	8.30
86.4	7.35	7.75	7.90	8.15
86.2	7.25	7.65	7.75	8.00
86.0	7.15	7.50	7.65	7.90
85.8	7.05	7.40	7.50	7.80
85.6	6.95	7.30	7.40	7.65
85.4	6.85	7.20	7.30	7.55
85.2	6.75	7.10	7.20	7.45
85.0	6.65	7.00	7.05	7.32
84.0	6.25	6.45	6.63	6.80
83.0	5.88	6.06	6.21	6.36
82.0	5.55	5.71	5.85	6.00
81.0	5.26	5.40	5.53	5.65
80.0	5.00	5.13	5.23	5.35
79.0	4.76	4.88	4.97	5.08
78.0	4.59	4.65	4.78	4.83
77.0	4.35	4.44	4.52	4.60
76.0	4.16	4.26	4.33	4.40
75.0	4.000	4.080	4.145	4.210
74.0	3.845	3.920	3.980	4.040
73.0	3.705	3.775	3.830	3.880
72.0	3.570	3.635	3.685	3.740
71.0	3.445	3.510	3.555	3.605
70.0	3.335	3.390	3.435	3.475
69.0	3.225	3.280	3.320	3.360
68.0	3.125	3.175	3.210	3.250
67.0	3.030	3.075	3.110	3.150
66.0	2.940	2.985	3.020	3.085

Table VIII—(*Continued*)

FACTORS FOR AVAILABLE SUGAR

Purity Molasses.	Polarization of Sugar.			
	100	99.5	99.0	98.5
65.0	2.855	2.900	2.930	2.960
64.0	2.775	2.815	2.845	2.875
63.0	2.705	2.740	2.765	2.795
62.0	2.630	2.665	2.695	2.720
61.0	2.565	2.595	2.620	2.645
60.0	2.500	2.530	2.555	2.580
59.0	2.440	2.470	2.490	2.515
58.0	2.380	2.410	2.430	2.450
57.0	2.325	2.355	2.375	2.395
56.0	2.275	2.300	2.315	2.335
55.0	2.220	2.245	2.265	2.285
54.0	2.175	2.200	2.215	2.235
53.0	2.130	2.150	2.165	2.185
52.0	2.085	2.100	2.120	2.130
51.0	2.040	2.060	2.075	2.090
50.0	2.000	2.010	2.035	2.050
49.0	1.960	1.980	1.995	2.010
48.0	1.925	1.940	1.955	1.970
47.0	1.885	1.905	1.915	1.930
46.0	1.850	1.870	1.880	1.895
45.0	1.820	1.835	1.845	1.860
44.0	1.785	1.800	1.815	1.825
43.0	1.755	1.770	1.780	1.790
42.0	1.725	1.740	1.750	1.760
41.0	1.695	1.710	1.720	1.730
40.0	1.665	1.680	1.685	1.700

TABLE VIII—(*Continued*)

FACTORS FOR AVAILABLE SUGAR

Purity Molasses.	Polarization of Sugar.				
	97.0	96.5	96.0	95.5	95.0
75.0	4.470	4.555	4.645	4.740	5.840
74.0	4.270	4.360	4.441	4.525	4.615
73.0	4.105	4.175	4.253	4.335	4.415
72.0	3.940	4.010	4.080	4.160	4.230
71.0	3.795	3.855	3.921	3.990	4.055
70.0	3.655	3.715	3.775	3.835	3.910
69.0	3.530	3.585	3.638	3.695	3.755
68.0	3.410	3.460	3.509	3.565	3.620
67.0	3.295	3.345	3.392	3.445	3.495
66.0	3.190	3.235	3.282	3.330	3.375
65.0	3.095	3.135	3.177	3.225	3.265
64.0	3.000	3.040	3.081	3.125	3.165
63.0	2.915	2.950	2.990	3.030	3.070
62.0	2.830	2.870	2.904	2.942	2.980
61.0	2.755	2.790	2.822	2.860	2.895
60.0	2.680	2.715	2.745	2.775	2.810
59.0	2.610	2.640	2.673	2.702	2.735
58.0	2.545	2.575	2.603	2.635	2.665
57.0	2.485	2.510	2.538	2.570	2.600
56.0	2.425	2.450	2.475	2.505	2.535
55.0	2.365	2.395	2.414	2.445	2.475
54.0	2.310	2.335	2.359	2.385	2.410
53.0	2.260	2.285	2.305	2.330	2.355
52.0	2.210	2.235	2.254	2.280	2.300
51.0	2.160	2.185	2.204	2.230	2.250
50.0	2.115	2.135	2.157	2.180	2.200
49.0	2.075	2.095	2.112	2.135	2.155
48.0	2.030	2.050	2.069	2.090	2.110
47.0	1.990	2.010	2.027	2.045	2.065
46.0	1.950	1.970	1.990	1.005	2.025

Table VIII—(*Continued*)

FACTORS FOR AVAILABLE SUGAR

Purity Molasses.	Polarization of Sugar.				
	97.0	96.5	96.0	95.5	95.0
45.0	1.950	1.970	1.949	1.970	1.985
44.0	1.880	1.895	1.912	1.930	1.945
43.0	1.845	1.860	1.874	1.895	1.910
42.0	1.810	1.825	1.842	1.860	1.875
41.0	1.780	1.795	1.809	1.825	1.840
40.0	1.750	1.765	1.777	1.795	1.810
39.0	1.720	1.730	1.747	1.760	1.775
38.0	1.690	1.705	1.718	1.730	1.745
37.0	1.660	1.675	1.687	1.700	1.715
36.0	1.635	1.645	1.659	1.675	1.685
35.0	1.610	1.620	1.632	1.645	1.660
34.0	1.585	1.595	1.606	1.620	1.630
33.0	1.560	1.570	1.582	1.595	1.605
32.0	1.535	1.545	1.557	1.570	1.580
31.0	1.510	1.525	1.533	1.545	1.555
30.0	1.490	1.500	1.510	1.520	1.530
29.0	1.470	1.480	1.488	1.500	1.510
28.0	1.445	1.455	1.466	1.475	1.485
27.0	1.425	1.435	1.445	1.455	1.465
26.0	1.410	1.420	1.425	1.435	1.445
25.0	1.385	1.395	1.405	1.415	1.425
24.0	1.365	1.375	1.385	1.395	1.405

Table VIII—(*Continued*)

FACTORS FOR AVAILABLE SUGAR

Purity Molasses.	Polarization of Sugar.				
	92.0	90.0	88.0	86.0	84.0
60.0	3.040	3.210	3.404	3.620	3.865
59.0	2.950	3.115	3.294	3.495	3.735
58.0	2.870	3.020	3.192	3.380	3.595
57.0	2.790	2.935	3.094	3.274	3.475
56.0	2.715	2.850	2.003	3.175	3.360
55.0	2.645	2.775	2.919	3.080	3.255
54.0	2.575	2.700	2.838	2.990	3.160
53.0	2.515	2.630	2.761	2.905	3.065
52.0	2.455	2.560	2.689	2.825	2.975
51.0	2.395	2.500	2.620	2.750	2.890
50.0	2.340	2.440	2.554	2.680	2.815
49.0	2.285	2.385	2.492	2.610	2.740
48.0	2.235	2.330	2.433	2.545	2.670
47.0	2.190	2.280	2.379	2.485	2.600
46.0	2.140	2.230	2.322	2.425	2.535
45.0	2.100	2.180	2.271	2.370	2.475
44.0	2.055	2.135	2.222	2.315	2.420
43.0	2.015	2.090	2.174	2.265	2.365
42.0	1.975	2.050	2.129	2.215	2.310
41.0	1.935	2.010	2.086	2.170	2.260
40.0	1.900	1.970	2.044	2.125	2.210
39.0	1.865	1.935	2.000	2.080	2.165
38.0	1.835	1.895	1.965	2.040	2.120
37.0	1.800	1.860	1.928	2.000	2.075
36.0	1.770	1.830	1.892	1.960	2.035
35.0	1.740	1.795	1.858	1.890	1.960
34.0	1.710	1.765	1.825	1.890	1.960
33.0	1.680	1.735	1.793	1.855	1.920
32.0	1.655	1.710	1.763	1.820	1.890
31.0	1.630	1.680	1.733	1.790	1.855

TABLE VIII—(*Continued*)

FACTORS FOR AVAILABLE SUGAR

Purity Molasses.	Polarization of Sugar.				
	92.0	90.0	88.0	86.0	84.0
30.0	1.595	1.650	1.702	1.760	1.820
29.0	1.575	1.625	1.675	1.730	1.790
28.0	1.555	1.600	1.648	1.700	1.760
27.0	1.530	1.575	1.623	1.675	1.730
26.0	1.505	1.550	1.597	1.650	1.700
25.0	1.485	1.525	1.573	1.620	1.675
24.0	1.465	1.505	1.549	1.600	1.645
23.0	1.440	1.480	1.526	1.570	1.610
22.0	1.420	1.470	1.503	1.550	1.600
21.0	1.400	1.440	1.482	1.535	1.570
20.0	1.385	1.420	1.462	1.505	1.550
19.0	1.365	1.400	1.440	1.480	1.525
18.0	1.345	1.380	1.420	1.460	1.500

There are occasions when it is desirable to know the weight of the massecuite dried. This may be found from the weight of the sugar and the analysis of the massecuite, sugar, and molasses.

$$M=\frac{bx'(h-i)}{a(g-i)}.$$

The purity of the massecuite may be found from the weight of the massecuite and sugar, and the analysis of the sugar and molasses.

$$g=\frac{bx'(h-i)+Mai}{Ma}.$$

The purity of the molasses is found from the weight and analysis of the massecuite and sugar.

$$i = \frac{Mag - hx'b}{Ma - x'b}.$$

H. C. Prensen Geerligs, in "Methods of Chemical Control," develops a formula for available sugar from the raw cane juice.

$$x = \left(1.4 - \frac{.40}{\text{purity of juice}}\right) \text{weight sucrose extracted.}$$

This formula is especially valuable in comparing the results of several runs in the same factory or that of several factories, since the percentage of sugar obtained is absolutely independent of the kind of mill or the skill used in manufacture. When this formula is applied to the juices from several factories, the one that has obtained the best yield is the one that equals or is higher than the calculated amount, since the yield is in proportion to the purity of the juice. While the amount of sugar obtained from juices having 90 purity are much higher than from 70 or 80, yet the work of the factory having juices with a lower purity may be superior from a manufacturing standpoint. A table is also given by Geerligs, in which the available sugar is calculated for juices having a purity of 77 to 93. In order to include the somewhat less mature juices of Louisiana, this table has been enlarged, beginning at 68 and continuing by .2 to 93 purity.

TABLE IX

PERCENTAGE OF AVAILABLE SUGAR FROM JUICE

Purity Juice.	0.0	0.2	0.4	0.6	0.8
68	81.20	81.35	81.50	81.70	81.85
69	82.05	82.20	82.35	82.55	82.70
70	82.85	83.00	83.20	83.35	83.50
71	83.70	83.85	84.00	84.15	84.30
72	84.45	84.60	84.75	84.90	85.05
73	85.21	85.35	85.50	85.65	85.80
74	85.95	86.10	86.25	86.40	86.50
75	86.65	86.80	86.95	87.10	87.25
76	87.35	87.50	87.65	87.80	87.95
77	88.05	88.20	88.30	88.45	88.60
78	88.70	88.85	89.00	89.10	89.25
79	89.35	89.50	89.60	89.75	89.85
80	90.00	90.10	90.25	90.35	90.50
81	90.60	90.75	90.85	91.00	91.10
82	91.20	91.35	91.45	91.60	91.70
83	91.80	91.95	92.05	92.15	92.30
84	92.40	92.50	92.60	92.75	92.85
85	92.95	93.05	93.20	93.30	93.40
86	93.50	93.60	93.70	93.80	93.95
87	94.05	94.15	94.25	94.35	94.40
88	94.55	94.65	94.75	94.85	94.95
89	95.05	95.15	95.25	95.35	95.45
90	95.50	95.65	95.75	95.85	95.95
91	96.00	96.10	96.20	96.30	96.40
92	96.50	96.60	96.70	96.80	96.90
93	97.00	97.10	97.20	97.30	97.35

CHAPTER III

MILL CONTROL

For the complete control of the mill work the following data are necessary:

Weight of cane ground;
Weight of saturation water;
Weight of dilute juice;
Brix of crusher juice;
Brix and sucrose of dilute juice;
Brix and sucrose of residual juice;
Sucrose in bagasse;
Moisture in bagasse.

Probably the best method of presenting the calculations used in the chemical control of cane-sugar factories is by means of a series of blank forms, so arranged that the sucrose in the cane ground is accounted for, either in the bagasse, the sugar and molasses or the stock on hand. Space is provided for daily entries, for periods of seven or sixteen days, depending on the interval between the run reports, and at the bottom three lines for the totals and averages for the run, the same figures to date for the previous run and the sum of these two, which will give the totals and averages to the date of the last run. This system makes it possible for the chemist to check up his report before presenting it to the management, and to feel certain that the figures are absolutely correct. Following each form will be given the necessary explanation for its proper use, and the formulæ and calculations used to obtain the different percentages. Forms 1 and 2 will be given complete to show the appearance each would present when the reports are made out once weekly or twice each month, but only the headings of the different columns will be shown in the remaining forms.

MILL RECORD

Run No. *Form* 1.

Date.	Cane Ground.		Mill Time.		Per Cent Lost Time.		Rate of Grinding.	
	Day.	To Date.	Day.	To Date.	Day.	To Date.	Per Hour.	Per Day.
Sunday								
Monday								
Tuesday								
Wed.								
Thurs.								
Friday								
Saturday								
For run								
Previous								
To date								

Cane Ground:

Total cane weighed—to date;
Cane on yard;
Total cane ground—to date;
Total cane ground—to date, day previous.
Cane ground for day.

Mill Time:

Number of hours and minutes the mill is in operation, each day.

Lost Time:

Number of hours and minutes the mill did not grind, each day.

Per Cent Lost Time:

Per day—Lost time divided by 24.

To date—Total lost time divided by total available time.

Rate of Grinding:

Per hour—Weight of cane divided by mill time.

Per day—Rate per hour multiplied by 24.

When two or more sets of mills or tandems are used, an average is made of the mill time, providing the length of the rollers is the same; if not, it is necessary to multiply the length of the first roller by the mill time of each mill, add the results and divide by the combined length of the rollers. This calculation may be made in the following manner:

	Length of Roller.	Mill Time.	Results.
Tandem A....	5′	22 : 00	110
Tandem B....	6′	20 : 00	120
Tandem C....	4′	17 : 30	70
Totals.....	15′	20 : 00	300

300 ÷ 15 = 20:00

JUICE EXTRACTED

Run No. *Form 2*

Date.	First Quarter.		Second Quarter.		Third Quarter.		Fourth Quarter.		Total Weight.
	Tanks.	Weight.	Tanks.	Weight.	Tanks.	Weight.	Tanks.	Weight.	
Dec. 16.									
Dec. 17.									
Dec. 18.									
Dec. 19.									
Dec. 20.									
Dec. 21.									
Dec. 22.									
Dec. 23.									
Dec. 24.									
Dec. 25.									
Dec. 26.									
Dec. 27.									
Dec. 28.									
Dec. 29.									
Dec. 30.									
Dec. 31.									
For Run									
Previous									
To Date.									

DILUTE JUICE

Run No.

Date.	Analysis.						Weight.
	Brix.	Sucrose.	Glucose	Non-sugar.	Ratio.	Purity.	

Brix-Sucrose-Glucose:
Obtained by analyses.

Non-sugars:
Brix − (Sucrose + Glucose).

Glucose Ratio:
$$\frac{100 \text{ Glucose}}{\text{Sucrose}}.$$

Purity:
$$\frac{100 \text{ Sucrose}}{\text{Brix}}.$$

Weight:
Obtained from Form 2.

Weight Solids:
Weight of Juice × Per cent Brix.

Weight Sucrose:
Weight of Juice × Per cent Sucrose

Weight Glucose:
Weight of Juice × Per cent Glucose.

Available Sugar:
Multiply weight of sucrose by percentage of available sugar found in Table IX, corresponding to the purity of the juice and divide by the polarization.

DILUTE JUICE

Form 3.

Weight. Solid.	Weight Sucrose.	Weight Glucose.	Avail-able Sugar.	Factory Results.		To Date.	
				Weight.	Bags.	Weight.	Bags.

Factory Results.—After first run, calculate the relation between the available sugar obtained from the sucrose in the juice and the actual yield of sugar, and use this percentage in the next run. In the third run use the average of the first two, the object being to furnish a correct estimation of the sugar to be expected from the juice each day. The weight may also be reduced to bags.

NORMAL JUICE

Run No. *Form* 4.

Date.	Analysis.						Weight.	
	Brix.	Sucrose.	Glucose.	Non-sugars.	Ratio.	Purity.	Juice.	Solids.

Brix:

Either .99×Brix first mill juice, or .98×Brix of crusher juice.

Sucrose:

Purity dilute juice×Brix of normal juice.

Glucose:

Per cent sucrose in normal juice×ratio of dilute juice.

Non-sugars:

Brix−(sucrose+glucose).

Ratio:

Same as for dilute juice.

Purity:

Same as for dilute juice.

Weight:

Weight of solids in dilute juice÷per cent solids in normal juice.

Example:

Dilute Juice.—Analysis.

Brix.............	11.50
Sucrose...........	8.97
Glucose...........	1.15
Non-sugars........	1.38
G. Ratio..........	12.82
Purity............	78.00

Gallons.—570,000.

Weight.—750,000×8.72 lbs. = 6,540,000 lbs.

Weight of Solids.—6,540,000×11.50 = 752,100 lbs.

Normal Juice.

Brix 1st mill 15.00.
Brix normal juice 15.00×.99 = 14.85.
Sucrose.—14.85×78.00 = 11.58.
Glucose.—11.58×12.82 = 1.48.
Non-Sugars.—14.85 − (11.58 + 1.48) = 1.79.
Weight.—752,100 ÷ 14.85 = 5,064,646.

MILL EXTRACTION

Run No.

Date.	Weight.					
	Cane.	Dilute Juice.	Normal Juice.	Dilution.	Bagasse Dilution.	Saturation.

Cane Weight.—From Form 1.

Dilute Juice Weight.—From Form 3.

Normal Juice Weight.—From Form 4.

Dilution.—Dilute juice − normal juice.

Bagasse Dilution and Saturation:

The water added to the cane between the mills should equal the sum of the dilution water in the dilute juice and the dilution water in the bagasse. Experience has shown that there is a difference, due in many cases to an evaporation which takes place during the time the cane passes through the rollers. For this reason the water of saturation is often calculated from the dilution, a factor being used based on actual work, and no account being taken of the weight of the water added. This method is admissible, providing, at the end of each run, the amount of water of dilution found in the bagasse is determined and compared with the assumed amount. If it is found that the water in the bagasse equals the *water of saturation*

MILL EXTRACTION

Form 5.

Per Cent Extraction.			Per cent Bagasse Dilution.	Per cent Saturation.	$\frac{B-B'}{B}$.
Total.	Water.	Net.			

—*water of dilution*, then the factor used is correct, but if the water in the bagasse is more or less, then the factor must be changed so that the two different methods of calculating may bring the same results. As the weight of the saturation water is used in obtaining the weight of the bagasse itself. it will be necessary to start with a factor and obtain the weight of the water of dilution in the bagasse by the following calculation:

A = weight juice in bagasse = weight bagasse − weight fibre;

B = Brix of juice in bagasse = $\frac{\text{weight solids in bagasse}}{\text{weight juice in bagasse}}$;

C = per cent bagasse dilution = $\frac{\text{Brix normal juice} - \text{Brix juice in bagasse}}{\text{Brix normal juice}}$;

D = weight water of dilution in bagasse = per cent bagasse dilution × wgt. juice in bagasse.

BAGASSE

Run No.

Date.	Weight.				
	Cane.	Saturation Water.	Cane and Water.	Dilute Juice.	Bagasse.

Bagasse:

Cane + saturation water − dilute juice.

Brix or Per Cent Solids:

Per cent sucrose in bagasse ÷ purity of residual juice.

Per Cent Sucrose:

Obtained by analysis.

Per Cent Moisture:

Obtained by analysis.

Per Cent Fibre:

Obtained by analysis or by formula 100 − (solids + moisture).

RESIDUAL JUICE

Run No. *Form 7.*

Date.	Analysis.			For Averaging.		
	Brix.	Sucrose.	Purity.	Tons.	Solids.	Sucrose.

It is assumed that the juice which remains in the bagasse will have the same purity as that of the residual juice, but with a higher per cent of solids. Advantage is taken of this fact to de-

BAGASSE

Form 6.

Percentage.					Weight.				
Brix.	Sucrose.	Moisture.	Fibre.	Purity	Solids.	Sucrose.	Moisture.	Fibre.	In Cane.

Purity:

Assumed to be the same as that of the residual juice.

Weight of Solids:

Bagasse × per cent solids.

Weight of Sucrose:

Bagasse × per cent sucrose.

Weight of Moisture:

Bagasse × per cent moisture.

Weight of Fibre:

Bagasse × per cent fibre.

Fibre in Cane:

Weight of fibre in bagasse ÷ weight of cane.

termine approximately the percentage of admixture which takes place when the water of saturation is applied to the bagasse between the mills. It is evident that if perfect admixture took place, the two densities would be the same, while if no water was added the per cent solids would be approximately the same as that of the normal juice. Either the solids or sucrose may be used in the following calculation:

Let a = Brix of normal juice;
b = Brix of residual juice;
c = Brix of juice in bagasse.

$$D = \frac{a-b}{a};$$

$$E = \frac{a-c}{a}.$$

Then,

$$\frac{100E}{D} = \text{percentage of admixture.}$$

Example:

Brix of normal juice.............	20.00
Brix of residual juice..............	8.00
Brix of juice in bagasse..........	12.00

$$D = \frac{20-8}{20} = 60;$$

$$E = \frac{20-12}{20} = 40;$$

$$\frac{100 \times 40}{60} = 66.67$$

In order that the analysis of the residual juice will correspond with that of the normal and dilute juices, it is necessary that correct averages be made in direct proportion to the cane ground. This is done by multiplying the per cent Brix and per cent sucrose by the weight of cane ground each day, and at the end of the run add the results and divide by the total tonnage, thus obtaining the average analysis for the run.

SUCROSE ACCOUNT

Run No. *Form* 8.

Date.	Weight of Sucrose.			Per Cent from Cane.			Per Cent from Sucrose in Cane.	
	Juice.	Bagas.	Cane.	Juice.	Bagas.	Cane.	Juice.	Bagas.

The weight of the sucrose in the juice and bagasse is found in Forms 3 and 6. When added together the sum will be the weight of the sucrose in the cane. The percentages are found by dividing the weight of sucrose in the juice and bagasse by the weight of the cane and the sucrose in the cane.

CHAPTER IV

CALCULATIONS USED IN THE MANUFACTURING PROCESSES

THE control of the clarification is carried on, in so far as the laboratory is concerned, by comparing the glucose ratio and purity obtained from the analysis of the dilute, sulphured, clarified, and filtered juices and the syrup. The addition of lime and sulphur to the cold juice, the subsequent heating and settling, should not change the relation between the sucrose and glucose, and as a consequence the glucose ratio should always remain the same. But there is always a possibility of the relationship being changed by the action of an excess of lime, which will destroy a part of the glucose, or of acids, which inverts the sucrose and changes it to glucose, or fermentation, which attacks both the sucrose and glucose, changing them into carbonic acid gas and a gummy residue. Fermentation occurs less frequently than the other two chemical changes, so that it is generally accepted that an increase in the ratio indicates inversion, while the reduction shows the action of an excess of lime. Since both may occur at different periods in the process of clarification, it is necessary to compare the ratio of the dilute and sulphured, then the sulphured and clarified and the clarified with the filtered and the syrup.

SULPHURED JUICE

Run No. (FILTERED, CLARIFIED AND SYRUP) *Forms* 9–10–11–12.

Date.	Analysis.						For Averaging.		
	Brix.	Sucrose.	Glucose.	Non-sugars.	Ratio.	Purity.	Weight Solids.	Sucrose.	Glucose.

The daily average of the sulphured, clarified, and filtered juices and the syrup are entered in Form 10, the Brix, sucrose and glucose multiplied by the weight of the cane ground, and the ratio and purity entered on Forms 13 and 14.

RESULTS OF CLARIFICATION

Run No. GLUCOSE RATIO—PURITY *Forms* 13–14.

Date.	*a* Dilute.	*b* Sulphured.	*c* Clarified.	*d* Filtered.	*e* Syrup.	Increase or Decrease.			
						a b	*b c*	*c d*	*c e*

Inversion.—

Let X = weight of sucrose lost by inversion;
M = weight of sugar solution before treatment;
R = glucose ratio of sugar solution before treatment;
R' = glucose ratio of sugar solution after treatment.

Then

$$X = M\left(\frac{R'-R}{R'+105.26}\right).$$

Destruction of Glucose:

Let N = weight of sucrose in solution before treatment;
X' = weight of glucose destroyed.

Then,

$$X' = N(R-R').$$

For convenience the juices are lettered and separate columns provided for the amount of increase or decrease daily. In the same manner the effect of the clarification on the purity is watched.

The purity of the clarified and filtered juice should always be the same, as the two juices are identical, one being drawn off or decanted, while the other is forced through presses. It is usual to add a small quantity of lime to the scums, which may redissolve some of the precipitate, and thus reduce the purity of the filtered juice. Lime also combines with the glucose so that the analysis of the juice will show a lower purity and glucose ratio than the clarified juice. The purity of the syrup may be higher than the proportional average of the clarified and filtered juices due to the settling out in the storage tanks of the impurities formed during concentration in the effects.

FILTER PRESSES

Run No. *Form* 15.

Date.	Percentages.		Weights.					
	Sucrose.	Moisture.	Total.	Precip.	Juice.	Solids.	Suc.	Glu.

Total Weight of Cake.—Weigh the contents of a single frame once each week and multiply by the number of frames in a press and then by the number dumped.

Per Cent Sucrose in Cake.—By analysis.

Weight of Sucrose in Cake.—Weight of cake × per cent sucrose.

Weight of Juice in Cake:

$$\frac{\text{Per cent sucrose in cake}}{\text{Per cent sucrose in filter press juice}} \times \text{Weight of cake.}$$

Weight of Precipitate.—Total weight − weight of juice.

Weight of Solids in Cake:

$$\frac{\text{Weight of sucrose}}{\text{purity of filter press juice}}.$$

Weight of Glucose in Cake.—Weight of sucrose ×glucose ratio of filtered juice.

Weight of Moisture in Cake.—Total weight − (precipitate + solids).

The percentage of the precipitate and moisture is found by dividing the weights given above by the weight of the cake. The most efficient filter press work is the one showing the largest amount of precipitate per ton of cane, combined with the lowest percentage of sucrose.

EVAPORATION

Run No. *Form* 16.

Date.	Brix.		Per Cent Evap.	Weight.		Per Hr.	Per Sq. Ft. H.S. per Hr.
	Dilute Juice.	Syrup.		Dilute Juice.	Water Evap.		

Brix Dilute Juice.—See Form 3.

Brix Syrup.—See Form 10.

Per Cent Evaporation:

$$\frac{\text{Brix of syrup} - \text{Brix dilute juice}}{\text{Brix of syrup}}.$$

Weight of Dilute Juice.—See Form 3.

Weight of Water Evaporated.—Per cent evaporated × weight of dilute juice.

Water Evaporated per Hour:

$$\frac{\text{Weight of water evaporated}}{\text{hours operating}}$$

Per Square Feet of Heating Surface per Hour:

$$\frac{\text{Water evaporated per hour}}{\text{Sq. ft. heating surface}}.$$

The economy in steam consumption obtained by evaporating the largest amount of the water in the juice by means of the multiple effect and reducing the work of the pans, is shown in the following table:

RELATIVE WORK OF EFFECTS AND PANS

Original Density of Juice...... 7.7 Bé.
Brix of Massecuite...........92.0

Bé. Syrup from Effects.	Percentage of Evaporation.	
	By Effects.	By Pans.
20	72.4	27.6
22	76.6	23.4
24	80.0	20.0
26	83.0	17.0
28	85.6	14.4
30	87.7	12.3
32	89.5	10.5
34	91.3	8.7

By boiling the syrup to 34° Bé. in the effects the evaporation in the pan is reduced to one-third, when compared with syrup received at 20° Bé.

PAN WORK

FIRST AND SECOND MASSECUITES

Run No.

Date.	Number.		Analysis.			For Averaging.		
	Strike.	Crystal	Brix.	Sucrose	Purity.	Wgt.	Solids.	Sucrose

Per Cent Sugar Recovered:

$$\left(\frac{\text{Purity of massecuite} - \text{purity of molasses}}{\text{purity of massecuite}}\right)\text{factor.}$$

This formula gives the amount of available sugar from the sucrose in the massecuite.

Formula for Mixtures:

Let a = purity of first solution;
b = purity of second solution;
c = weight of solids in first solution;
d = weight of solids in second solution;
x = purity of mixture.

Then

$$x = \frac{ac+bd}{c+d},$$

$$a = \frac{x(c+d)-bd}{c},$$

$$b = \frac{x(c+d)-ac}{d},$$

PAN WORK

FIRST AND SECOND MOLASSES

Form 17.

Analysis.			For Averaging.			Pola. Sugar.	Per Cent Sugar Recovered.
Brix.	Sucrose	Purity.	Weight.	Solids.	Sucrose.		

$$c = \frac{d(x-b)}{a-x},$$

$$d = \frac{c(a-x)}{x-b}.$$

The fifth form is used to determine how much molasses may be taken into the pans to produce a massecuite of a required purity.

Example:

Purity of syrup....................	80
Tons solids.......................	20
Purity of molasses.................	55
Required purity....................	75

Then

$$\frac{20(80-75)}{75-55} = 5 \text{ tons.}$$

Proof:

$$20 \times 80 = 1600$$
$$5 \times 55 = 275$$
$$25 \qquad 1875$$
$$1875 \div 25 = 75$$

The same result may also be found by another formula, the percentage obtained being multiplied by the total weight of the mixture.

$$\frac{\text{Purity of syrup} - \text{purity of mixture}}{\text{Purity of syrup} - \text{purity of molasses}}.$$

Using the same figures, we have,

$$\frac{80-75}{80-55} = 20\%.$$

Multiplying 20 per cent by the total weight of the mixture, the weight of the solids in the molasses is found.

$$25 \text{ tons} \times 20\% = 5.$$

This formula is especially well suited for controlling the work of the pans, since it is possible to arrive at an average weight of a strike and also the weight of the solids. For convenience, the total weight of the solids is reduced to the number of inches in the storage tank, which will furnish sufficient syrup and molasses of different densities to complete the strike. First the tanks are measured and the gallons per inch determined and a table made which will show the gallons present for each inch, when measured from the top. The gallons per inch are then divided into the number of gallons which will make a ton of solids, and the result multiplied by the tons necessary to complete a strike. The following table gives the number of gallons of syrup and molasses which will make one ton of solids at 140° F.:

Degree Bé.	Gallons.	Degree Bé.	Gallons.
20	513	31	309
21	487	32	297
22	463	33	286
23	441	34	275
24	421	35	265
25	382	36	254
26	365	37	246
27	351	38	237
28	336	39	228
29	322	40	221
30	309		

To illustrate the use of the table, assume that the storage tanks have a capacity of 100 gallons of syrup and molasses per inch and the average weight of the solids in a strike to be 40 tons. If the syrup weighed 20° Bé. at 140° F., it would take 5.13 inches to give a ton of solids, and 4.87 inches if the degree Baumé was 21. To obtain 40 tons of solids the number of inches used would be the product of 5.13 inches×40 tons, or 205.2 inches for syrup at 20° Bé. and 4.87×40, or 194.8 inches at 21 inches, thus replacing the tons solids in the formula by inches of the syrup or molasses used. The table under these conditions has been calculated, and is given below.

Degrees Baumé.	No. Inches per Strike.	Degrees Baumé.	No. Inches per Strike.	Degrees Baumé.	No. Inches per Strike.
20	205.2	27	146.0	34	110.0
21	194.8	28	140.4	35	106.0
22	185.2	29	134.4	36	101.6
23	176.4	30	128.8	37	98.4
24	168.4	31	123.6	38	94.8
25	160.4	32	118.8	39	91.2
26	152.8	33	114.4	40	88.4

It is now possible to determine the number of inches of molasses necessary to take into the pans to produce a massecuite of any purity.

Purity of syrup.............. 80 Bé. 28
Purity of molasses........... 50 Bé. 37
Desired purity of *MC*....... 71

First Problem.—To find the number of inches of molasses to form a mixture having a purity of 71.

$$\frac{80-71}{80-50}=30\%.$$

The number of inches in a strike containing 40 tons of solids when the molasses has a density of 37° Bé. is 98.4.

$$98.4\times 30=29.52''.$$

Second Problem.—To find the number of inches of syrup used in the strike.

The total strike would require 98.4 and the molasses 29.52 inches, the syrup would require 68.84 inches. But this is at a density of 38° Bé., and the syrup has a density of 27° Bé. However, in the table all the numbers given are in proportion, so that the same would be true of the inches as well. The number of inches for a strike at 27 is 140.4, therefore,

$$98.4 : 140.4 :: 68.84 : X,$$

$$X = 90.1.$$

By taking 90.1 inches of syrup and 29.52 inches of molasses, the strike will have 40 tons of solid matter and a purity of 71.

THIRD MASSECUITE

Run No.

Date.	Number.		Analysis.			Inches. Out.	Cubic Feet.
	Strike.	Crystal.	Brix.	Sucrose.	Purity.		

The sugar, 88 polarization, is estimated by means of the available sugar formula, the purity of the final molasses being assumed but based on previous results.

Wgt. solids (purity of massecuite − purity of molasses) factor.

COMMERCIAL SUGAR

Run No.

Date.	Analysis.				Lot No,
	Polariza.	Glucose.	Moisture.	Ash.	

FINAL MOLASSES

Run No.

Date.	Analysis.							Gallons.
	Brix.	Sucrose.	Glucose.	Non-sugars	Ratio.	Purity.	Ash.	

THIRD MASSECUITE

Form 18.

Date.	Weight.	Weight Solids.	Weight Sucrose.	Estimated.	
				88 Sugar.	Final Molasses.

The gallons of molasses are obtained by subtracting the solids in the sugar from the solids in the massecuite and dividing by the solids in one gallon, found in Table VI.

COMMERCIAL SUGAR

Form 19.

No. Packages.	Weight.				
	Total,	Sucrose.	Glucose.	Moisture.	Ash.

FINAL MOLASSES

Form 20.

Weight.	Weight.			
	Solids.	Sucrose.	Glucose.	Ash.

CHAPTER V

STOCK ON HAND CALCULATIONS

At the end of the run all of the data are posted in the preceding forms and the averages found, both for the run and to date. The products in process of manufacture are then measured, a representative sample of each analyzed, and the weight found from the specific gravity, and also the weight of the solids and sucrose. These figures are entered in one of the three forms given below, depending on the kind of sugar manufactured, one for factories selling "Yellow Clarified" and first molasses, another for 96 test sugar and exhausted molasses and another for factories making three grades of sugar and an exhausted molasses. Each form contains four parts; the first, for calculating the available sugar and molasses in the stock on hand; the second, for adding the sugar weighed to the sugar in process of manufacture; the third, for adding the molasses shipped, on hand, and in stock, and the fourth, for combining the total sugar and total molasses, and obtaining the purity of the total product.

STOCK ON HAND

Part I. *Form* 21.

Y. C. SUGAR AND FIRST MOLASSES

Products.	Analysis. Brix.	Analysis. Sucrose.	Analysis. Purity.	Gallons. Cu. ft.	Weight.	Solids.	Sucrose.
JUICES:							
Dilute..........	.....	.....	.....	.....	.....	.....	.....
Clarified........	.....	.....	.....	.....	.....	.....	.....
Filtered........	.....	.....	.....	.....	.....	.....	.....
SYRUP:							
In effects........	.....	.....	.....	.....	.....	.....	.....
In tanks........	.....	.....	.....	.....	.....	.....	.....
FIRST MASSECUITE:							
In pans........	.....	.....	.....	.....	.....	.....	.....
In mixers........	.....	.....	.....	.....	.....	.....	.....
In crystals.......	.....	.....	.....	.....	.....	.....	.....
Total product......	.....	.....	.....	.....	.....	.....	.....
Available sugar....	99.9	99.0	99.1	.....	.....	.....	.....
First molasses......	.....	.....	.....	.....	.....	.....	.....

Total Product.

Total weight = the sum of the weight of the juice, syrup, and first massecuite.

Wgt. solids = The sum of the solids of the juice, syrup, and first massecuite;

Wgt. sucrose = the sum of the sucrose of the juice, syrup, and first massecuite.

Brix = weight of solids × 100 ÷ total weight;

Sucrose = weight of sucrose × 100 ÷ total wgt.;

Purity = weight of sucrose × 100 ÷ weight of solids.

Available Sugar.—Brix, Sucrose and Purity.—Either by analysis of same grade of sugar made previous or from Table No. VII, which gives the Brix and purity for sugars of different polarizations. In the first case, the formula would be

$$\frac{(\text{Pur. total Prod.} - \text{Pur. 1st molasses})}{\text{Brix sugar (Pur. sugar} - \text{Pur. 1st molasses)}}$$

multiplied by the weight of the solids. In the second case the formula would be

(Pur. total prod. − Pur. 1st molasses) factor multiplied by the weight of the solids.

Weight Solids in Sugar.—Total weight × Brix of sugar.

Weight Sucrose in Sugars.—Total weight × per cent sucrose.

Weight of Solids in Molasses.—Weight solids in total product − Solids in sugar.

Weight of Sucrose in Molasses.—Weight sucrose in total product − Sucrose in sugar.

Brix of Molasses.—Since there is always a certain amount of dilution caused by washing the sugar, the Brix of the molasses is taken to be the same as when shipped, and the weight and gallons calculated from the weight of the solids.

Weight.—Weight solids ÷ Average Brix of molasses shipped.

Gallons.—Weight solids ÷ Weight solids in 1 gal., or, Weight of molasses ÷ Weight of gallon. (See Table No. VI.)

Purity.—Weight of sucrose × 100 ÷ Weight of solids.

TOTAL Y. C. SUGAR

Part 2.

Products.	Brix.	Sucrose.	Purity.	Packages.	Weight.	Solids.	Sucrose.
Y. C. Sugar—Weighed	....	....	....	....	....	....	....
Y. C. Sugar—In bins..	....	....	....	....	.. ..	....	....
Y. C. Sugar—In Stock	....	....	....	....	....	....	....
Total Y. C. Sugar.....	....	....	....	....	....	....	....
Previous report......	....	....	....	....	....	....	....
For Run............	....	....	....	....	....	....	....

Y. C. Sugar, Weighed.—The weight of all sugars, to date, is found under Form 17, with the weights of the solids and sucrose which may be copied into the above form.

Y. C. Sugar, In Bins.—The weight of any sugar in bins is estimated, a sample analyzed for total solids and sucrose, and all calculations made as in sugars weighed.

Y. C. Sugar, In Stock.—All columns are filled in from Part 1, following the heading "available sugar."

Total Y. C. Sugar.—Add columns headed, packages, weight, solids, and sucrose, and obtain the average analysis in the usual manner.

Previous Report.—The total Y. C. sugars in the previous report are copied after the heading "Previous Report."

For Run.—The weight of the sugar, solids, and sucrose in the previous report are subtracted from the total Y. C. sugars, giving the weight of the sugar, solids, and sucrose for the run. The average analysis is found as usual.

FIRST MOLASSES

Part 3.

Products.	Brix.	Sucrose.	Purity.	Gallons.	Weight.	Solids.	Sucrose.
Molasses shipped...	.....	.....	.....	.....	.....	.....	.....
Molasses in tanks..	.....	.....	.....	.....	.....	.....	.....
Molasses in stock...	.....	.....	.....	.....	.....	.....	.....
Total molasses.....	.....	.....	.....	.....	.....	.....	.....
Previous report....	.....	.....	.....	.....	.....	.....	.....
For run..........	.....	.....	.....	.....	.....	.....	.....

All the calculations for this part are identical with that of Part 2.

TOTAL SUGAR AND MOLASSES

Part 4.

Products.	Brix.	Sucrose.	Purity.	Weight.	Solids.	Sucrose.
Total sugar.........	.....	......	......	......	......	......
Total molasses.....	.....	......	......	......	......	......
Total product......	.....	......	......	......	......	......
Previous report....	.....	......	......	......	......	......
For run..........	.....	......	......	......	......	......

Total Sugar.—Copied from Part 2.

Total Molasses.—Copied from Part 3.

The particular object in combining the weight of the sugar and molasses in Part 4 is to prove whether the calculations made above are correct and also to check the entire work of the laboratory in the chemical control of the factory. This is done by comparing the purity of the total product with that of the syrup used in the manufacture, for if there has been no mechanical or chemical losses during the boiling and curing processes, they should be identical, but if not, and the purity of the total product is higher or lower than that of the syrup, the cause is found,

First, in the weight of the molasses.

Second, in the weight of the sugar.

Third, in data used for the stock on hand calculation.

Fourth, in the analysis or methods of analysis used.

Fifth, in the sampling of the products.

Assuming an error in the weight of the molasses the correct amount may be determined by means of the formula for mixtures.

Let

Purity of total product be.........	80
Purity of syrup....................	78
Purity of sugar....................	98
Purity of molasses.................	50
Weight of sugar—tons solids......	1000
Weight of molasses—tons solids....	600

Then,

$$\frac{1000(98-78)}{78'-50}=714 \text{ tons.}$$

The weight of the molasses would therefore be 714 tons instead of 600. But if the weight, 600 tons, was the correct one and the error in the sugar, it would be detected by the same formula.

$$\frac{600(78-50)}{98-78}=840.$$

The weight of the sugar would be 840 tons instead of 1000 tons solids. But if the molasses has been weighed or the original weight confirmed, and there is no chance for an error in the weight of the sugar, the measurements and analysis used in calculating the stock on hand should be inspected, and the mistakes corrected if any should be found. But if there is no error found in the first three causes for the difference in the two purities, then the work of sampling and analysis in the laboratory must be investigated. A hydrometer used that is not correct will cause a difference in the purities of the total products, by increasing or decreasing the tons of solid matter accounted for. The same may be said of the flasks used, or the polariscope, the accuracy of the laboratory work having a direct relation to the calculations of the laboratory report.

STOCK ON HAND

Part 1. *Form* 22.

RAW SUGAR AND MOLASSES

Products.	Brix.	Sucrose.	Purity.	Gallons. Cu. Ft.	Weight.	Solids.	Sucrose.
JUICES:							
Dilute..........	.....	.....	.....	.....	.....	.....	.....
Clarified.........	.....	.....	.....	.....	.....	.....	.....
Filtered.........	.....	.....	.....	.....	.....	.....	.....
SYRUP:							
In effects........	.....	.....	.....	.....	.....	.....	.....
In tanks.........	.....	.....	.....	.....	.....	.....	.....
FIRST MASSECUITE:							
In pans.........	.....	.....	.....	.....	.....	.....	.....
In crystallizers...	.....	.....	.....	.....	.....	.....	.....
SECOND MASSECUITE							
In pans.........	.....	.....	.....	.....	.....	.....	.....
In crystallizers...	.....	.....	.....	.....	.....	.....	.....
THIRD MASSECUITE.							
In pans.........	.....	.....	.....	.....	.....	.....	.....
In crystallizers...	.....	.....	.....	.....	.....	.....	.....
FIRST MOLASSES...	.....	.....	.....	.....	.....	.....	.....
SECOND MOLASSES..	.....	.....	.....	.....	.....	.....	.....
Total product......	.....	.....	.....	.....	.....	.....	.....
Available sugar....	99.3	96.0	96.68	.....	.....	.....	.....
Final molasses.....	.....	.....	.....	.....	.....	.....	.....

The calculations used in Form 20 are the same as that in Form 19. Parts 2, 3, and 4 are also identical.

STOCK ON HAND

Part 1a. *Form 23.*

FIRST SUGAR

Products.	Brix.	Sucrose.	Purity.	Gallons, Cu. Ft.	Weight.	Solids.	Sucrose.
JUICES:							
Dilute..........	....	....	....	....	....	....	....
Clarified.........	....	....	....	....	....	....	....
Filtered.........	....	....	....	....	....	....	....
SYRUP:...........	....	....	....	....	....	....	....
In effects........	....	....	....	....	....	....	....
In tanks.........	....	....	....	....	....	....	....
FIRST MASSECUITE:							
In pans.........	....	....	....	....	....	....	....
In mixers........	....	....	....	....	....	....	....
Total product.....	....	....	....	....	....	....	....
Available sugar....	99.3	96.0	96.68	....	....	....	....
First molasses.....	....	....	....	....	....	....	....

SECOND SUGAR

Part 1b.

Products.	Brix.	Sucrose.	Purity.	Gallons, Cu. Ft.	Weight.	Solids.	Sucrose.
FIRST MOLASSES:							
In stock........	....	....	....	....	....	....	....
Tanks..........	....	....	....	....	....	....	....
SECOND MASSECUITE							
Pans...........	....	....	....	....	....	....	....
Crystal.........	....	....	....	....	....	....	....
Total product......	....	....	....	....	....	....	....
Available sugar....	97.7	88.0	90.07	....	....	....	....
Second molasses....	....	....	....	....	....	....	....

THIRD SUGAR

Part 1c.

Products.	Brix.	Sucrose.	Purity.	Gallons, Cu. Ft.	Weight.	Solids.	Sucrose.
SECOND MOLASSES:							
Stock..........	....	....	....	....	....	....	....
Tanks..........	....	....	....	....	....	....	....
THIRD MASSECUITE:							
Pans...........	....	....	....	....	....	....	....
Tanks..........	....	....	....	....	....	....	....
Total products.....	....	....	....	....	....	....	....
Available sugar....	97.7	88.0	90.07	....	....	....	....
Final molasses.....	....	....	....	....	....	....	....

TOTAL SUGARS

Part 2.

Products.	Brix.	Sucrose.	Purity.	Gallons, Pckgs.	Weight.	Solids.	Sucrose.
FIRST SUGARS:							
Weighed........	....	....	....	....	....	....	....
Stock...........	....	....	....	....	....	....	....
Total...........	....	....	....	....	....	....	....
SECOND SUGARS:							
Weighed........	....	....	....	....	....	....	....
Stock...........	....	....	....	....	....	....	....
Total...........	....	....	....	....	....	....	....
Third sugars.......	....	....	....	....	....	....	....
Total sugars......	....	....	....	....	....	....	....
Previous..........	....	....	....	....	....	....	....
For run...........	....	....	....	....	....	....	....

TOTAL FINAL MOLASSES

Part 3.

Products.	Brix.	Sucrose.	Purity.	Gallons.	Weight.	Solids.	Sucrose.
MOLASSES:							
Shipped.........	....	....	....	....	....	....	....
Tanks...........	....	....	....	....	....	....	....
Stock...........	....	....	....	....	....	....	....
Total molasses....	....	....	....	....	....	....	....
Previous..........	....	....	....	....	....	....	....
For run...........	....	....	....	....	....	....	....

Part 4 is the same as in Form 19.

CHAPTER VI

LABORATORY REPORTS

The laboratory report is a condensed statement of the work of the factory compiled by either the superintendent in charge of the manufacture or the head chemist from the data contained in the previous forms. The object of the report is to present to the management and owners, in a concise and systematic manner, the progress made in the grinding, and by means of comparing consecutive runs, determine whether the maximum results are being obtained. The report contains totals, averages of analyses, and such percentages that give definite information. A comparison of reports from Louisiana and the tropics shows a marked difference, due partly to the individuality of the men in charge and partly to the methods of manufacture. For example, in Louisiana the yield is calculated as pounds per ton of cane, whereas in other countries this is given as per cent on cane. Then, too, in the tropics one grade of sugar is made, while in Louisiana two and sometimes three are manufactured. For this reason a typical form of laboratory report is given, which is adapted the conditions existing in Louisiana, which will be followed by such changes as will be necessary to make it suitable for factories in the tropics.

THE .... SUGAR CO.

LABORATORY REPORT *Form* 24.

Run No...........From...................191....to 191....

	For Run.	To Date.

WORK OF THE MILLS:

Total hours available for grinding.
Actual grinding time.
Lost time—Per cent available time.

Tons of cane ground.
Tons of cane ground per hour.
Rate of grinding per day.

Per cent mill extraction.
Per cent dilution.
Per cent saturation (by calculation).
Per cent admixture.

Bagasse ratio.
Roller speed per minute in feet.
Tons of cane per lineal foot, first mill.

Per cent sucrose extracted from sucrose in juice.

YIELD OF SUGAR AND MOLASSES:

Pounds first sugar made and estimated.
Pounds second sugar made and estimated.
Pounds total sugar made and estimated.

Per ton of cane,

First sugar.
Second sugar.
Total sugar.
Sugar weighed.
Sugar in process.

Pounds total sugar made per hour (grinding time).
Rate per day, in packages.

Pounds total sugar reduced to basis of 96 test.
Pounds 96 test sugar per ton of cane.
Pounds 96 test sugar for 1 per cent sucrose in normal test.

Gallons of molasses made and estimated.

Gallons of molasses, per ton of cane.
Gallons of molasses per hour.
Rate per day.

SUCROSE ACCOUNT:

Per ton of cane,

Pounds sucrose in cane.
Pounds sucrose in juice.
Pounds sucrose in bagasse.
Pounds sucrose in sugars.
Pounds sucrose in molasses.
Pounds sucrose lost in manufacturing.

Per cent sucrose in juice from sucrose in cane.
Per cent sucrose in sugar from sucrose in cane.

Per cent sucrose in sugars from sucrose in juice.
Per cent sucrose in molasses from sucrose in juice.
Per cent sucrose lost in mfg. from sucrose in juice.

Sucrose lost—per ton of cane.
In bagasse.
In molasses.
In manufacturing.
Total.

Per cent sucrose lost—from sucrose in cane.
In bagasse.
In molasses.
In manufacturing.
Total.

Fuel Account:

Tons bagasse burned.
Tons coal.
Gallons fuel oil.
Cords wood.

B.T.U. —per ton of cane.
Bagasse.
Coal.
Oil.
Wood.

In percentage.
Bagasse.
Coal.
Oil.
Wood.

Supplies:

Barrels of lime used.
Pounds used—per ton of cane.
Pounds sulphur used.
Pounds used—per ton of cane.

COMPOSITION OF CANE AND BAGASSE

	Cane.		Bagasse.	
	For Run.	To Date.	For Run.	To Date.
Sucrose....	....	....	....	....
Moisture...	....	....	....	....
Fibre......	....	....	....	....
Non-sugars.	....	....	....	....

COMPOSITION OF SUGARS

	First Sugar.		Second Sugar.		Average.	
	For Run	To Date	For Run	To Date	For Run	To Date
Polarization .	......	......	......	......	......	......
Glucose.....	......	......	......	......	......	......
Moisture....	......	......	......	......	......	......
Ash.........	......	......	......	......	......	......

COMPOSITION OF FINAL MOLASSES

	For Run.	To Date.
Brix.......	....	....
Sucrose....	....	....
Glucose....	....	....
Non-sugars.	....	....
Ratio......	....	....
Purity.....	....	....
Ash.......	....	....

COMPOSITION OF PRODUCTS IN PROCESS OF MANUFACTURE

Products.	Brix.	Sucrose	Glucose	Non-sugars.	Ratio.	Purity.
Run. Dilute juice—To date	......	......	......	......	......	......
Normal juice.	......	......	......	......	......	......
Residual juice.	......	......	......	......	......	......
Syrup.	......	......	......	......	......	......
First massecuite.	......	......	......	......	......	......
First molasses.	......	......	......	......	......	......
Mixed massecuite.	......	......	......	......	......	......
Second molasses.	......	......	......	......	......	......
Third massecuite.	......	......	......	......	......	......
	......	......	......	......	......	......

RESULTS OF CLARIFICATION

	Glucose Ratio.		Purity.	
	Increase.	Decrease.	Increase.	Decrease.
Dilute to Sulphured......	....	....	....	....
Sulphured to Clarified....	....	....	....	....
Claiified to Filtered......	....	....	....	....
Clarified to Syrup........	....	....	....	....

Total Hours Available for Grinding.—Each calendar day of the grinding season multiplied by 24, with the exception of the first and last days, where a deduction is made for the part of the day not utilized for grinding.

Lost Time, Per Cent Available Time:

$$\frac{100(\text{Available time} - \text{actual grinding time})}{\text{Available time}}.$$

Bagasse Ratio:

$$\frac{100\ (\text{Per cent sucrose in bagasse})}{\text{Per cent sucrose in normal juice}}.$$

Roller speed per minute, in feet.—Circumference $\times$revolutions per minute.

Tons of Cane per Lineal Foot, First Mill:

$$\frac{\text{Tons of cane ground per hour}}{\text{Length of roller in feet}}.$$

In Spanish-speaking countries the weights differ slightly from the American standards, so that a correction must be made if the specific gravity tables given in the previous chapter are to be used in the calculations. Cane and sugar are bought and sold by the *arroba*, or 25 pounds, Spanish weight. The relation between the two standards and factor used in changing from one to the other are given below:

One Spanish pound = 460.1 grams.
One American pound = 453.6 grams.

Therefore,

One Spanish pound	= 1.01433 American pounds.
One arroba	= 25.358 American pounds.
One Spanish ton	= 2028.66 American pounds.

To reduce Spanish tons to American tons:

Multiply by 1.01433.

To reduce arrobas to American tons:

Multiply by .01269.

The bags used in shipping the raw sugars have a capacity of either 12, 12.5 or 13 arrobas, and weigh 304.3, 316.97 and 329.65 American pounds. To reduce to American tons:

Multiply No. of 12 arroba bags by .1522
Multiply No. of 12.5 arroba bags by .1585
Multiply No. of 13 arroba bags by .1598

In factories where the cane ground is reported in arrobas, the following should be added to the report, under the heading of *Work of the Mill:*

Arrobas of cane ground.
Arrobas of cane ground, per hour.
Rate of grinding, per day.

A complete change is made in the part of the report relating to the yield, and in the sucrose account.

YIELD OF SUGAR AND MOLASSES:

No. bags of sugar weighed.
No. bags in process of manufacture.
No. bags—total.

Per cent on cane,

Sugar weighed.
Sugar in process of manufacture.
Total sugar.
Total sugars. Reduced to 96 test basis.

Factor of yield. $\frac{\text{100 per cent yield 96 test}}{\text{Per cent sucrose in normal juice}}$.

Bags made per hour. (Grinding time.)
Rate per day.

Gallons of molasses.
Gallons of molasses per ton of cane.
Gallons of molasses per bag of sugar.
Gallons made per hour.
Rate per day.

SUCROSE ACCOUNT:

Tons of sucrose,
- In cane.
- In juice.
- In bagasse.
- In sugars.
- In molasses.
- Lost in mfg.

Per cent on cane,
- In cane.
- In juice.
- In bagasse.
- In sugars.
- In molasses.
- Lost in mfg.

Per cent on sucrose in cane,
- In juice.
- In bagasse.
- In sugars.
- In molasses.
- Lost in mfg.

Per cent on sucrose in juice,
- In sugars.
- In molasses.
- Lost in mfg.

Sucrose lost—per cent on cane,
- In bagasse.
- In molasses.
- Lost in mfg.
- Total.

CHAPTER VII

THE CALCULATED COMMERCIAL YIELD PER TON OF CANE

THE yield of commercial products depends upon:

First, the per cent mill extraction.

Second, the per cent sucrose in the extracted juice.

Third, the polarization of the sugar manufactured.

Fourth, the increase of the purity of the syrup over the purity of the juice.

Fifth, the mechanical and chemical losses in manufacturing.

Sixth, the purity of the final molasses.

In the following tables the last three factors are assumed to have certain definite values, based on the records of factories, both in Louisiana and the tropics, and the yield calculated for the different percentages of mill extraction, per cent sucrose in the juice and polarization of the sugars.

PROBLEM.—Find the number of pounds of Yellow Clarified sugar (99.0) polarization per ton of cane and also the number of gallons of molasses, when the juice has 11.4 per cent sucrose.

From Table No. X we find

11.0%	106.4 lbs. Y. C. sugar
.4 (4×.97).....	3.9
11.4..............	110.3
11.0..............	10.00 gals. molasses
.4 (4×.013)....	.05
11.4..............	10.05

Answer:

Lbs. Y. C. sugar.....................	110.3
Gals. molasses......................	10.5

TABLE X

YIELD OF SUGAR AND MOLASSES FROM ONE TON OF CANE

9

Per cent sucrose in juice

Polarization of sugar.......... 99.0
Brix of molasses.............. 83.4

Per Cent Extraction.	Pounds Sugar.	Gallons Molasses.	For $\frac{1}{10}$ Per Cent.	
			Sugar.	Molasses.
68	79.1	8.71	.88	.013
69	80.2	8.83	.89	Same for
70	81.4	8.96	.90	each per
71	82.6	9.09	.91	cent
72	83.7	9.22	.93	Extraction
73	84.8	9.35	.95	
74	85.9	9.48	.97	
75	87.1	9.60	.98	
76	88.2	9.74	1.00	
77	89.4	9.86	1.01	
78	90.6	9.99	1.02	
79	91.7	10.12	1.03	
80	92.9	10.25	1.04	
81	94.1	10.37	1.05	
82	95.3	10.50	1.06	

Table X—(*Continued*)

YIELD OF SUGAR AND MOLASSES FROM ONE TON OF CANE

10

Per cent sucrose in juice

Polarization of sugar.......... 99.0
Brix of molasses.............. 83.4

Per Cent Extraction.	Pounds Sugar.	Gallons Molasses.	For $\frac{1}{10}$ Per Cent.	
			Sugar.	Molasses.
68	87.9	8.92	.88	.013
69	89.1	9.05	.89	Same for
70	90.4	9.18	.91	each
71	91.7	9.31	.92	per cent
72	93.0	9.45	.93	Extraction
73	94.3	9.58	.94	
74	95.6	9.71	.96	
75	96.9	9.84	.97	
76	98.2	9.97	.98	
77	99.5	10.11	.99	
78	100.8	10.23	1.01	
79	102.0	10.37	1.02	
80	103.3	10.50	1.03	
81	104.6	10.63	1.04	
82	105.9	10.76	1.06	

TABLE X—(*Continued*)

YIELD OF SUGAR AND MOLASSES FROM ONE TON OF CANE

11

Per cent sucrose in juice

Polarization of sugar.......... 99.0
Brix of molasses.............. 83.4

Per Cent Extraction.	Pounds Sugar.	Gallons Molasses.	For $\frac{1}{10}$ Per Cent.	
			Sugar.	Molasses.
68	96.6	9.05	.88	.013
69	98.0	9.18	.89	Same for
70	99.4	9.32	.91	each
71	100.8	9.45	.92	per cent
72	102.2	9.59	.93	Extraction
73	103.6	9.72	.94	
74	105.0	9.86	.96	
75	106.4	10.00	.97	
76	107.8	10.13	.98	
77	109.2	10.26	.99	
78	110.6	10.40	1.01	
79	112.0	10.53	1.02	
80	113.4	10.67	1.03	
81	114.8	10.80	1.05	
82	116.2	10.94	1.06	

Table X—(*Continued*)

YIELD OF SUGAR AND MOLASSES FROM ONE TON OF CANE

12

Per cent sucrose in juice

Polarization of sugar.......... 99.0
Brix of molasses.............. 83.4

Per Cent Extraction.	Pounds Sugar.	Gallons Molasses.	For $\frac{1}{10}$ Per Cent.	
			Sugar.	Molasses.
68	105.4	9.10	.88	.013
69	107.0	9.23	.89	Same for
70	108.5	9.36	.91	each
71	110.1	9.50	.92	per cent
72	111.6	9.63	.93	Extraction
73	113.2	9.76	.94	
74	114.7	9.89	.96	
75	116.3	10.03	.97	
76	117.8	10.16	.98	
77	119.4	10.29	.99	
78	120.9	10.42	1.01	
79	122.5	10.56	1.02	
80	124.1	10.69	1.03	
81	125.6	10.82	1.04	
82	127.1	10.96	1.06	

TABLE X—(*Continued*)

YIELD OF SUGAR AND MOLASSES FROM ONE TON OF CANE

13

Per cent sucrose in juice

Polarization of sugar 99.0
Brix of molasses 83.4

Per Cent Extraction.	Pounds Sugar.	Gallons Molasses.	For $\frac{1}{10}$ Per Cent.	
			Sugar.	Molasses.
68	114.2	9.07	.88	.013
69	115.9	9.21	.89	Same for
70	117.6	9.34	.91	each
71	119.2	9.48	.92	per cent
72	120.9	9.61	.93	Extraction
73	122.6	9.74	.94	
74	124.3	9.88	.96	
75	126.0	10.01	.97	
76	127.6	10.15	.98	
77	129.3	10.28	.99	
78	131.0	10.41	1.01	
79	132.7	10.55	1.02	
80	134.4	10.68	1.03	
81	136.0	10.82	1.05	
82	137.7	10.96	1.06	

Table X—(*Continued*)

YIELD OF SUGAR AND MOLASSES FROM ONE TON OF CANE

14

Per cent sucrose in juice

Polarization of sugar 99.0
Brix of molasses 83.4

Per Cent Extraction.	Pounds Sugar.	Gallons Molasses.	For $\frac{1}{10}$ Per Cent.	
			Sugar.	Molasses.
68	123.0	8.99	.88	.013
69	124.8	9.12	.89	Same for
70	126.6	9.26	.90	each
71	128.4	9.39	.91	per cent
72	130.2	9.52	.93	Extraction
73	132.0	9.65	.95	
74	133.9	9.79	.97	
75	135.7	9.92	.98	
76	137.5	10.05	.99	
77	139.3	10.18	1.00	
78	141.1	10.31	1.01	
79	142.9	10.44	1.02	
80	144.7	10.58	1.03	
81	146.5	10.71	1.04	
82	148.3	10.84	1.06	

TABLE XI

YIELD OF SUGAR AND MOLASSES FROM ONE TON OF CANE

9

Per cent sucrose in juice

First sugar, polarization....... 99.0
Second sugar, polarization..... 88.0
Third sugar, polarization...... 88.0
Final molasses, purity......... 25.0

Per Cent Extraction.	Pounds of Sugar.					Molasses.	
	First.	Second.	Third.	Total.	$\frac{1}{10}$%	Gals.	$\frac{1}{10}$%
68	79.1	16.6	8.9	104.6	1.46	6.22	.009
69	80.2	16.8	9.0	106.0	1.49	6.31	Same
70	81.4	17.1	9.2	107.7	1.50	6.40	for
71	82.6	17.3	9.3	109.2	1.52	6.49	each
72	83.7	17.6	9.4	110.7	1.55	6.59	per
73	84.8	17.8	9.6	112.2	1.57	6.68	cent
74	85.9	18.1	9.7	113.7	1.60	6.77	Extrac-
75	87.1	18.3	9.8	115.2	1.63	6.86	tion
76	88.2	18.5	10.0	116.7	1.65	6.95	
77	89.4	18.8	10.1	118.3	1.67	7.06	
78	90.6	19.0	10.2	119.8	1.69	7.15	
79	91.7	19.3	10.3	121.3	1.72	7.24	
80	92.9	19.5	10.5	122.9	1.73	7.33	
81	94.1	19.7	10.6	124.4	1.75	7.42	
82	95.3	20.0	10.8	126.1	1.77	7.52	

TABLE XI—(*Continued*)

YIELD OF SUGAR AND MOLASSES FROM ONE TON OF CANE

10

Per cent sucrose in juice

First sugar, polarization....... 99.0
Second sugar, polarization...... 88.0
Third sugar, polarization...... 88.0
Final molasses, purity......... 25.0

Per Cent Extraction.	Pounds of Sugar.					Molasses.	
	First.	Second.	Third.	Total.	$\frac{1}{10}$%	Gals.	$\frac{1}{10}$%
68	87.9	22.9	8.4	119.2	1.49	5.86	.009
69	89.1	23.3	8.4	120.8	1.52	5.95	Same
70	90.4	23.6	8.5	122.5	1.54	6.04	for
71	91.7	23.9	8.6	124.2	1.57	6.13	each
72	93.0	24.3	8.7	126.0	1.59	6.22	per
73	94.3	24.6	8.8	127.7	1.61	6.31	cent
74	95.6	25.0	8.9	129.5	1.63	6.40	Extrac-
75	96.9	25.3	9.0	131.2	1.65	6.48	tion
76	98.2	25.6	9.1	132.9	1.68	6.57	
77	99.5	26.0	9.2	134.7	1.70	6.66	
78	100.8	26.3	9.3	136.4	1.73	6.75	
79	102.0	26.7	9.4	138.1	1.75	6.84	
80	103.3	27.0	9.5	139.8	1.77	6.93	
81	104.6	27.3	9.6	141.5	1.80	7.02	
82	105.9	27.7	9.7	143.3	1.81	7.10	

Table XI—(*Continued*)

YIELD OF SUGAR AND MOLASSES FOR ONE TON OF CANE

11

Per cent sucrose in juice

First sugar, polarization....... 99.0
Second sugar, polarization..... 88.0
Third sugar, polarization...... 88.0
Final molasses, purity......... 25.0

Per Cent Extraction.	Pounds of Sugar.					Molasses.	
	First.	Second.	Third.	Total.	1/10%	Gals.	1/10%
68	96.6	29.8	7.7	134.1	1.53	5.39	.0076
69	98.0	30.2	7.8	136.0	1.56	5.47	Same
70	99.4	30.6	7.9	137.9	1.58	5.55	for
71	100.8	31.1	8.0	139.9	1.61	5.63	each
72	102.2	31.5	8.2	141.9	1.62	5.71	per
73	103.6	31.9	8.3	143.8	1.65	5.79	cent
74	105.0	32.4	8.4	145.8	1.66	5.87	Extrac-
75	106.4	32.8	8.5	147.7	1.70	5.95	tion
76	107.8	33.3	8.6	149.7	1 71	6.03	
77	109.2	33.7	8.8	151.7	1.74	6.11	
78	110.6	34.2	8.9	153.7	1.75	6.20	
79	112.0	34.6	9.0	155.6	1.79	6.28	
80	113.4	35.0	9.1	157.5	1.83	6.36	
81	114.8	35.5	9.2	159.5	1.84	6.44	
82	116.2	35.9	9.3	161.4	1.86	6.52	

Table XI—(*Continued*)

YIELD OF SUGAR AND MOLASSES FOR ONE TON OF CANE

12

Per cent sucrose in juice

First sugar, polarization....... 99.0
Second sugar, polarization..... 88.0
Third sugar, polarization...... 88.0
Final molasses, purity......... 25.0

Per Cent Extraction.	Pounds of Sugar.					Molasses.	
	First.	Second.	Third.	Total.	1/10%	Gals.	1/10%
68	105.4	37.1	6.9	149.4	1.56	4.80	.0072
69	107.0	37.6	7.0	151.6	1.58	4.87	Same
70	108.5	38.1	7.1	153.7	1.61	4.94	for
71	110.1	38.7	7.2	156.0	1.62	5.02	each
72	111.6	39.2	7.3	158.1	1.64	5.09	per
73	113.2	39.7	7.4	160.3	1.67	5.16	cent
74	114.7	40.2	7.5	162.4	1.71	5.23	Extrac-
75	116.3	40.8	7.6	164.7	1.72	5.31	tion
76	117.8	41.3	7.7	166.8	1.75	5.38	
77	119.4	41.9	7.8	169.1	1.76	5.45	
78	120.9	42.4	7.9	171.2	1.80	5.53	
79	122.5	42.9	8.1	173.5	1.81	5.60	
80	124.1	43.5	8.2	175.8	1.82	5.67	
81	125.6	44.0	8.3	177.9	1.85	6.74	
82	127.1	44.5	8.4	180.0	1.88	5.82	

TABLE XI—(*Continued*)

YIELD OF SUGAR AND MOLASSES FROM ONE TON OF CANE

13

Per cent sucrose in juice

First sugar, polarization....... 99.0
Second sugar, polarization..... 88.0
Third sugar, polarization...... 88.0
Final molasses, purity......... 25.0

Per Cent Extraction.	Pounds of Sugar.					Molasses.	
	First.	Second.	Third.	Total.	1/10%	Gals.	1/10%
68	114.2	44.8	5.9	164.9	1.59	4.08	.0064
69	115.9	45.5	6.0	167.4	1.60	4.14	Same
70	117.6	46.1	6.1	169.8	1.62	4.21	for
71	119.2	46.8	6.2	172.2	1.64	4.27	each
72	120.9	47.4	6.2	174.5	1.68	4.34	per
73	122.6	48.1	6.3	177.0	1.70	4.40	cent
74	124.3	48.8	6.4	179.5	1.72	4.46	Extrac-
75	126.0	49.4	6.5	181.9	1.75	4.53	tion
76	127.6	50.1	6.6	184.3	1.77	4.59	
77	129.3	50.7	6.7	186.7	1.80	4.66	
78	131.0	51.4	6.8	189.2	1.81	4.72	
79	132.7	52.1	6.8	191.6	1.83	4.78	
80	134.4	52.7	6.9	194.0	1.86	4.84	
81	136.0	53.4	7.0	196.4	1.89	4.91	
82	137.7	54.0	7.1	198.8	1.91	4.98	

TABLE XI—(*Continued*)

YIELD OF SUGAR AND MOLASSES FROM ONE TON OF CANE

14

Per cent sucrose in juice

First sugar, polarization 99.0
Second sugar, polarization 88.0
Third sugar, polarization 88.0
Final molasses, purity 25.0

Per Cent Extraction.	Pounds of Sugar.					Molasses.	
	First.	Second.	Third.	Total.	$\frac{1}{10}$%	Gals.	$\frac{1}{10}$%
68	123.0	53.0	4.8	180.8	1.61	3.34	.005
69	124.8	53.7	4.8	183.3	1.63	3.39	Same
70	126.6	54.7	4.9	186.0	1.65	3.44	for
71	128.4	55.3	5.0	188.6	1.68	3.49	each
72	130.2	56.1	5.0	191.3	1.70	3.54	per
73	132.0	56.9	5.1	194.0	1.72	3.59	cent
74	133.9	57.6	5.2	196.7	1.75	3.64	Extrac-
75	135.7	58.4	5.3	199.4	1.77	3.69	tion
76	137.5	59.2	5.3	202.0	1.80	3.74	
77	139.3	60.0	5.4	204.7	1.81	3.79	
78	141.1	60.7	5.5	207.3	1.83	3.84	
79	142.9	61.5	5.5	209.9	1.86	3.89	
80	144.7	62.3	5.6	212.6	1.89	3.94	
81	146.5	63.1	5.7	215.3	1.91	3.99	
82	148.3	63.9	5.7	217.9	1.93	4.04	

TABLE XII

YIELD OF SUGAR AND MOLASSES FROM ONE TON OF CANE

9

Per cent sucrose in juice

First sugar, polarization....... 96.0
Second sugar, polarization..... 88.0
Third sugar, polarization...... 88.0
Final molasses, purity......... 25.0

Per Cent Extraction.	Pounds of Sugar.					Molasses.	
	First.	Second.	Third.	Total.	$\frac{1}{10}$%	Gals.	$\frac{1}{10}$%
68	87.2	11.3	8.5	107.0	1.51	6.02	.0088
69	88.5	11.5	8.6	108.6	1.52	6.10	Same
70	89.8	11.7	8.7	110.2	1.54	6.19	for
71	91.1	11.8	8.9	111.8	1.55	6.28	each
72	92.3	12.0	9.0	113.3	1.59	6.37	per
73	93.6	12.2	9.1	114.9	1.62	6.46	cent
74	94.9	12.3	9.2	116.4	1.64	6.55	Extrac-
75	96.2	12.5	9.4	118.1	1.65	6.63	tion
76	97.5	12.7	9.5	119.7	1.66	6.72	
77	98.7	12.8	9.6	121.1	1.71	6.81	
78	100.0	13.0	9.7	122.7	1.73	6.90	
79	101.3	13.2	9.9	124.4	1.74	6.99	
80	102.6	13.3	10.0	125.9	1.77	7.07	
81	103.9	13.5	10.1	127.5	1.78	7.16	
82	105.2	13.7	10.2	129.1	1.80	7.25	

Table XII—(*Continued*)

YIELD OF SUGAR AND MOLASSES FROM ONE TON OF CANE

10

Per cent sucrose in juice

First sugar, polarization....... 96.0
Second sugar, polarization..... 88.0
Third sugar, polarization...... 88.0
Final molasses, purity......... 25.0

Per Cent Extraction.	Pounds of Sugar.					Molasses.	
	First.	Second.	Third.	Total.	$\frac{1}{10}$%	Gals.	$\frac{1}{13}$%
68	96.5	17.5	8.1	122.1	1.44	5.62	.0083
69	97.9	17.7	8.2	123.8	1.47	5.70	Same
70	99.3	18.0	8.3	125.6	1.49	5.78	for
71	100.7	18.2	8.4	127.3	1.51	5.87	each
72	102.2	18.5	8.5	129.2	1.53	5.95	per
73	103.6	18.8	8.7	131.1	1.55	6.03	cent
74	105.0	19.0	8.8	132.8	1.57	6.11	Extrac-
75	106.4	19.3	8.9	134.6	1.59	6.20	tion
76	107.8	19.5	9.0	136.3	1.61	6.28	
77	109.3	19.8	9.1	138.2	1.63	6.36	
78	110.7	20.0	9.3	140.0	1.66	6.44	
79	112.1	20.3	9.4	141.8	1.68	6.53	
80	113.5	20.6	9.5	143.6	1.70	6.61	
81	114.9	20.8	9.6	145.3	1.72	6.70	
82	116.3	21.1	9.7	147.1	1.75	6.78	

Table XII—(*Continued*)

YIELD OF SUGAR AND MOLASSES FROM ONE TON OF CANE

11

Per cent sucrose in juice

First sugar, polarization....... 96.0
Second sugar, polarization..... 88.0
Third sugar, polarization...... 88.0
Final molasses, purity......... 25.0

Per Cent Extraction.	Pounds of Sugar.					Molasses.	
	First.	Second.	Third.	Total.	$\frac{1}{10}$%	Gals.	$\frac{1}{10}$%
68	112.9	16.1	7.5	136.5	1.46	5.18	.0076
69	114.5	16.4	7.6	138.5	1.48	5.26	Same
70	116.2	16.6	7.7	140.5	1.50	5.33	for
71	117.8	16.9	7.8	142.7	1.52	5.41	each
72	119.5	17.1	7.9	144.5	1.54	5.48	per
73	121.2	17.3	8.0	146.5	1.58	5.56	cent
74	122.8	17.6	8.1	148.5	1.60	5.64	Extrac-
75	124.5	17.8	8.2	150.5	1.62	5.72	tion
76	126.1	18.0	8.3	152.4	1.65	5.79	
77	127.8	18.3	8.4	154.5	1.66	5.87	
78	129.5	18.5	8.6	156.6	1.67	5.94	
79	131.1	18.8	8.7	158.6	1.69	6.03	
80	132.8	19.0	8.8	160.6	1.72	6.09	
81	13:44	19.2	8.9	162.5	1.75	6.17	
82	136.1	19.5	9.0	164.6	1.77	6.25	

TABLE XII—(*Continued*)

YIELD OF SUGAR AND MOLASSES FROM ONE TON OF CANE

12

Per cent sucrose in juice

First sugar, polarization....... 96.0
Second sugar, polarization..... 88.0
Third sugar, polarization...... 88.0
Final molasses, purity......... 25.0

Per Cent Extraction.	Pounds of Sugar.					Molasses.	
	First.	Second.	Third.	Total.	1/10%	Gals.	1/10%
68	129.9	14.5	6.7	151.1	1.48	4.64	.0067
69	131.8	14.7	6.8	153.3	1.51	4.72	Same
70	133.7	14.9	6.9	155.5	1.54	4.78	for
71	135.6	15.1	7.0	157.7	1.55	4.86	each
72	137.5	15.3	7.1	159.9	1.57	4.92	per
73	139.5	15.6	7.2	162.3	1.58	4.99	cent
74	141.4	15.8	7.3	164.5	1.60	5.05	Extrac-
75	143.3	16.0	7.4	166.7	1.63	5.12	tion
76	145.2	16.2	7.5	168.9	1.66	5.19	
77	147.1	16.4	7.6	171.1	1.69	5.26	
78	149.0	16.6	7.7	173.3	1.70	5.32	
79	150.9	16.8	7.8	175.5	1.72	5.39	
80	152.8	17.1	7.9	177.8	1.74	5.46	
81	154.7	17.3	8.0	180.0	1.76	5.53	
82	156.7	17.5	8.1	182.3	1.78	5.59	

TABLE XII—(*Continued*)

YIELD OF SUGAR AND MOLASSES FROM ONE TON OF CANE

13

Per cent sucrose in juice

First sugar, polarization....... 96.0
Second sugar, polarization..... 88.0
Third sugar, polarization...... 88.0
Final molasses, purity......... 25.0

Per Cent Extraction.	Pounds of Sugar.					Molasses.	
	First.	Second.	Third.	Total.	$\frac{1}{10}$%	Gals.	$\frac{1}{10}$%
68	147.5	12.6	5.8	165.9	1.50	4.04	.0059
69	149.7	12.8	5.9	168.4	1.52	4.10	Same
70	151.9	13.0	6.0	170.9	1.63	4.16	for
71	154.0	13.1	6.1	173.2	1.56	4.22	each
72	156.2	13.3	6.1	175.6	1.60	4.27	per
73	158.4	13.5	6.2	178.1	1.62	4.34	cent
74	160.5	13.7	6.3	180.5	1.63	4.40	Extrac-
75	162.7	13.9	6.4	183.0	1.66	4.45	tion
76	164.9	14.1	6.5	185.5	1.67	4.51	
77	167.1	14.3	6.6	188.0	1.69	4.57	
78	169.2	14.4	6.7	190.3	1.72	4.63	
79	171.4	14.6	6.7	192.7	1.75	4.69	
80	173.6	14.8	6.8	195.2	1.77	4.75	
81	175.7	15.0	6.9	197.6	1.79	4.81	
82	177.9	15.2	7.0	200.1	1.81	4.86	

TABLE XII—(*Continued*)

YIELD OF SUGAR AND MOLASSES FROM ONE TON OF CANE

14

Per cent sucrose in juice

First sugar, polarization....... 96.0
Second sugar, polarization..... 88.0
Third sugar, polarization...... 88.0
Final molasses, purity......... 25.0

Per Cent Extraction.	Pounds of Sugar.					Molasses.	
	First.	Second.	Third.	Total.	$\frac{1}{10}$%	Gals.	$\frac{1}{10}$%
68	165.7	10.4	4.8	180.9	1.52	3.34	.005
69	168.2	10.5	4.9	183.6	1.54	3.39	Same
70	170.6	10.7	4.9	186.2	1.56	3.44	for
71	173.0	10.8	5 0	188.8	1.59	3.49	each
72	175.5	11.0	5.1	191.6	1.62	3.54	per
73	177 9	11.2	5.2	194.3	1.64	3.59	cent
74	180.3	11.3	5 5	196.8	1.66	3.64	Extrac-
75	182.8	11.5	5 3	199.6	1.67	3.68	tion
76	185.2	11.6	5.4	202.2	1.69	3.73	
77	187.7	11.8	5.4	204.9	1.72	3.78	
78	190.1	11.9	5.5	207.5	1.74	3.83	
79	192.6	12.1	5.6	210.3	1.77	3.88	
80	195.0	12.2	5.7	212.9	1.79	3.93	
81	197.4	12.4	5.7	215.5	1.81	3.98	
82	199.8	12.6	5.8	218.2	1.83	4.03	

TABLE XIII

"RENDIMIENTO"

14

Per cent sucrose in juice

Polarization.................. 96

Mill Extraction.	Purity of Final Molasses.					$\frac{1}{10}$ of One Per Cent.
	30	35	40	45	50	
70	9.10	8.93	8.75	8.53	8.25	.073
71	9.23	9.06	8.87	8.65	8.36	.074
72	9.36	9.19	9.00	8.78	8.49	.075
73	9.48	9.32	9.12	8.90	8.61	.076
74	9.61	9.45	9.25	9.02	8.73	.077
75	9.74	9.58	9.37	9.14	8.85	.078
76	9.87	9.70	9.50	9.27	8.96	.079
77	10.00	9.83	9.62	9.39	9.08	.080
78	10.13	9.96	9.75	9.51	9.21	.081
79	10.26	10.09	9.87	9.63	9.33	.081
80	10.39	10.22	10.00	9.74	9.45	.082
81	10.52	10.35	10.12	9.87	9.57	.083
82	10.65	10.48	10.25	9.99	9.69	.084
83	10.78	10.60	10.37	10.11	9.81	.085

Table XIII—(*Continued*)

"RENDIMIENTO"

15

Per cent sucrose in juice

Polarization.................. 96.0

Mill Extraction.	Purity of Final Molasses.					1/10 of One Per Cent.
	30	35	40	45	50	
70	9.80	9.66	9.47	9.25	8.96	.074
71	9.94	9.80	9.61	9.37	9.09	.075
72	10.09	9.93	9.75	9.52	9.23	.076
73	10.21	10.07	9.89	9.65	9.37	.077
74	10.34	10.22	10.02	9.78	9.50	.078
75	10.49	10.35	10.15	9.91	9.64	.079
76	10.65	10.48	10.28	10.02	9.77	.080
77	10.79	10.61	10.41	10.18	9.89	.081
78	10.93	10.75	10.55	10.32	10.03	.082
79	11.07	10.89	10.68	10.45	10.16	.084
80	11.21	11.02	10.82	10.56	10.29	.085
81	11.35	11.16	10.95	10.72	10.41	.086
82	11.49	11.30	11.09	10.85	10.54	.087
83	11.63	11.43	11.22	10.99	10.67	.089

TABLE XIII—(*Continued*)

"RENDIMIENTO"

16

Per cent sucrose in juice

Polarization.................. 96.0

Mill Extraction.	Purity of Final Molasses.					1/10 of One Per Cent.
	30	35	40	45	50	
70	10.52	10.38	10.22	10.00	9.76	.075
71	10.67	10.55	10.37	10.14	9.90	.076
72	10.82	10.68	10.51	10.28	10.04	.077
73	10.97	10.83	10.66	10.33	10.18	.078
74	11.12	10.98	10.80	10.57	10.32	.079
75	11.27	11.13	10.95	10.71	10.46	.080
76	11.42	11.27	11.09	10.85	10.60	.081
77	11.57	11.42	11.24	10.99	10.74	.081
78	11.72	11.57	11.38	11.14	10.88	.082
79	11.87	11.72	11.53	11.28	11.02	.082
80	12.02	11.87	11.67	11.43	11.16	.083
81	12.17	12.02	11.82	11.57	11.30	.083
82	12.32	12.17	11.96	11.71	11.44	.084
83	12.47	12.31	12.11	11.85	†11.58	.085

Table XIII—(*Continued*)

"RENDIMIENTO"

17

Per cent sucrose in juice

Polarization.................. 96.0

Mill Extraction.	Purity of Final Molasses.					$\frac{1}{10}$ of One Per Cent.
	30	35	40	45	50	
70	11.24	11.11	10.95	10.76	10.53	.075
71	11.39	11.27	11.11	10.91	10.68	.076
72	11.55	11.42	11.27	11.07	10.83	.077
73	11.71	11.58	11.42	11.22	10.98	.078
74	11.87	11.73	11.57	11.37	11.12	.079
75	12.03	11.89	11.72	11.52	11.27	.080
76	12.19	12.04	11.88	11.67	11.42	.081
77	12.35	12.20	12.03	11.82	11.57	.082
78	12.52	12.35	12.19	11.98	11.71	.083
79	12.68	12.50	12.34	12.13	11.86	.084
80	12.84	12.66	12.50	12.28	12.01	.085
81	13.00	12.81	12.65	12.43	12.15	.086
82	13.16	12.97	12.81	12.59	12.30	.086
83	13.32	13.12	12.96	12.74	12.45	.087

Table XIII—(*Continued*)

"RENDIMIENTO"

18

Per cent sucrose in juice

Polarization.................. 96.0

Mill Extraction.	Purity of Final Molasses.					1/10 of One Per Cent.
	30	35	40	45	50	
70	11.96	11.84	11.70	11.51	11.30	.078
71	12.13	12.01	11.86	11.67	11.46	.079
72	12.30	12.17	12.03	11.83	11.62	.080
73	12.46	12.33	12.10	11.99	11.77	.082
74	12.63	12.50	12.35	12.16	11.93	084
75	12.79	12.66	12.51	12.32	12.09	.086
76	12.96	12.83	12.68	12.48	12.25	.087
77	13.13	12.99	12.84	12.64	12.40	.088
78	13.50	13.16	13.02	12.81	12.56	.089
79	13.47	13.32	13.18	12.97	12.72	.090
80	13.63	13.49	13.35	13.13	12.87	.091
81	13.80	13.65	13.50	13.30	13.03	.093
82	13.97	13.82	13.67	13.45	13.19	.094
83	14.14	13.98	13.83	13.62	13.33	.096

TABLE XIII—(*Continued*)

"RENDIMIENTO"

19

Per cent sucrose in juice

Polarization.................. 96.0

Mill Extraction.	Purity of Final Molasses.					1/10 of One Per Cent.
	30	35	40	45	50	
70	12.71	12.61	12.48	12.31	12.11	
71	12.89	12.79	12.66	12.59	12.28	
72	13.08	12.97	12.83	12.66	12.46	
73	13.26	13.15	13.01	12.84	12.64	
74	13.45	13.33	13.19	13.01	12.82	
75	13.63	13.51	13.37	13.19	12.98	
76	13.80	13.69	13.55	13.36	13.15	
77	13.98	13.87	13.73	13.54	13.33	
78	14.17	14.05	13.90	13.71	13.50	
79	14.35	14.23	14.08	13.88	13.61	
80	14.53	14.41	14.26	14.06	13.84	
81	14.72	14.59	14.43	14.23	14.02	
82	14.90	14.77	14.61	14.41	14.19	
83	15.08	14.95	14.79	14.58	14.36	

CHAPTER VIII

MANUFACTURING ECONOMIES

THE financial success of a factory depends on obtaining the largest amount of sugar and molasses from a ton of cane and also producing the grade which will net the greatest profit. The factors that influence the yield are

Mill extraction;
Maceration;
Dilution of the scums;
Increase of purity of syrup;
Decrease of purity of final molasses.

1. *Effect of Mill Extraction on Yield.*—Two tables are given to illustrate the effect of the mill extraction on the yield, one showing the actual yield of 96 test sugar per ton of cane when the per cent sucrose in the juice is 10 per cent, 12 per cent, and 14 per cent, and the final molasses 25 per cent purity, and the other, the actual gain in pounds of sugar per ton of cane, starting with an extraction of 68 per cent. By multiplying the pounds available by the price of 96 test sugar, the gain in dollars and cents is obtained, for any increase in the per cent extraction.

Table XIV

YIELD OF 96 TEST SUGAR PER TON OF CANE

Per Cent Extraction.	Per Cent Sucrose.		
	10.0	12.0	14.0
68	119.07	148.59	179.10
69	120.81	150.78	181.74
70	122.55	152.97	184.38
71	124.29	155.16	187.02
72	126.03	157.35	189.66
73	127.77	159.54	192.30
74	129.51	161.73	194.94
75	131.25	163.92	197.58
76	132.99	166.11	200.22
77	134.73	168.30	202.86
78	136.47	170.49	205.50
79	138.21	172.68	208.14
80	139.95	174.87	210.78
81	141.69	177.06	213.42
82	143.43	179.25	216.06

Table XV

GAIN IN YIELD DUE TO INCREASED EXTRACTION

Increase in Extraction.	Per Cent Sucrose.		
	10.0	12.0	14.0
1	1.74	2.19	2.64
2	3.48	4.38	5.28
3	5.22	6.57	7.92
4	6.96	8.76	10.56
5	8.70	10.95	13.20
6	10.44	13.14	15.84
7	12.18	15.33	18.48
8	13.92	17.82	21.12
9	15.66	19.71	23.76
10	17.40	21.90	26.40
11	19.14	24.09	29.04
12	20.88	26.28	31.68
13	22.62	28.47	34.32
14	24.36	30.66	36.96

Example:

Price of 96 test sugar.......... 5 cents
Per cent sucrose in the juice... 12%
Increased extraction.......... 3 points

To find actual gain in cents per ton of cane:

$$6.57\times 5=\$0.33.$$

2. *Effect of Maceration on the Yield.*—The addition of water between the mills is for the purpose of diluting the juice in the bagasse, thereby increasing the extraction and the sucrose recovered. The actual results are difficult to calculate, since the efficiency of the mills depends largely on the speed of the rollers, the weight on the hydraulics, and the regularity of the feed. By assuming certain data, comparative percentages may be obtained, which give an approximation of the work performed.

Kind of mill	9 roller
Mill extraction, without water	75.00%
Total per cent admixture	50
After first mill	40
After second mill	60
Per cent water in juice	80
Per cent water in bagasse	20
Per cent sucrose in normal juice	12
Ratio of fibre in bagasse to juice in bagasse	1 : 1.5

Table XVI

EFFECT OF MACERATION

Per Cent Maceration.	Pounds Sucrose Extracted by Second Mill.	Pounds Sucrose Extracted by Third Mill.	Pounds Sucrose Extracted by Total.	Total Increase.	Per Cent Efficiency.	Pounds 96 Test Sugar for each per cent.
4.0	1.07	1.73	2.80	2.80	100.0	.63
8.0	1.03	1.43	2.46	5.26	87.8	.55
12.0	1.00	1.12	2.12	7.38	75.7	.48
16.0	.94	1.01	1.95	9.33	69.6	.44
20.0	.90	1.85	1.75	11.08	62.5	.39
24.0	.87	.71	1.58	12.66	56.4	.36
28.0	.83	.59	1.42	14.08	50.7	.32
32.0	.80	.49	1.29	15.37	46.1	.29
36.0	.77	.41	1.18	16.55	41.8	.26
40.0	.74	.35	1.09	17.64	38.9	.24

The most important information is contained in the last two columns, which show the comparative efficiency of the first 4 per cent maceration, which is indicated by 100 per cent, with the subsequent 4 per cent additions; also the average number of pounds of 96 test sugar obtained from each per cent of maceration.

In actual practice the amount of water added to the mill depends on the heating surface available, the cost of evaporation, and also the amount of sugar obtained by the process. Naturally the per cent of maceration in one factory cannot be used as a guide for maceration in any other, but the data necessary must be worked out independently. For example, assume that the cost of evaporating 20 pounds of water in the effects to be 2 cents and sugar sold for 5 cents per pound, then it would not pay to add more than 20 per cent of water, as the sugar recovered between 16 per cent and 20 per cent is only .39 pound, worth 1.95 cents and not sufficient to warrant further additions, which would entail a loss.

3. *The Effect of Diluting the Scums on the Yield.*—Under ordinary conditions, the scums that are drawn from the clarifiers and tanks amount to 10 per cent on the weight of the cane ground, and the "cake" taken from the filter presses, to .135 per cent, having the following composition in pounds per ton of cane:

Lime precipitate and other impurities	9 lbs.
Juice..............................	18 lbs.
Total weight....................	27 lbs.
Sucrose, (assuming 12% in juice)....	2.16 lbs.

In order to obtain one-half of the sucrose contained in the cake, it will be necessary to add to the scums an equal weight of water, thereby reducing the per cent sucrose in the juice to 6 per cent and the sucrose in the cake to 1.08 pounds per ton of cane. But in order to recover the 1.08 pounds of sucrose in 96 test sugar, it will be necessary to evaporate the 10 per cent of water added, or less than .1 of 96 test sugar for each 1 per cent of water added. Referring to the preceding table it will be seen that 1 per cent maceration between 36 per cent and 40 per cent will recover .24 pound of 96 test sugar per ton of cane, or double the amount recovered when diluting the scums. For this reason, the small amount of sugar obtained for the water added, it would not be profitable to use water at this point in the manufacturing process.

The same objection does not hold against the practice of disintegrating the cake, mix with water and again filter, as the amount of water necessary to dilute the juice will be but 18 pounds per ton of cane, and the sugar recovered for 1 per cent maceration .6 pound, so that, under ordinary conditions, a profit may be expected, sufficient to justify the extra work called for.

4. *Effect of Increasing the Purity of the Syrup on the Yield.*—During the clarification process, a certain part of the non-sugars present in the juice are removed, thereby increasing the purity of the syrup and also the pounds of available sugar per ton of cane. Assuming the mill extraction to be 75 per cent, the gain in the yield from juices having a sucrose percentage of from 9 to 14 is shown on the following page.

TABLE XVII

Per Cent Sucrose.	One Point.	Two Points.	Three Points.
9.0	.90	1.80	2.70
10.0	.92	1.84	2.77
11.0	.94	1.88	2.82
12.0	.95	1.90	2.85
13.0	.96	1.92	2.87
14.0	.97	1.94	2.89

The gain of one point in purity would be equal to nearly one pound of 96 test sugar per ton of cane, and is sufficient to warrant the most careful attention to the process of clarification.

5. *The Effect of Lowering the Purity of the Final Molasses on the Yield.*—

TABLE XVIII

Per Cent Sucrose.	Average Yield Between Purities.		
	25–28	35–38	45–48
9.0	1.02	1.31	1.96
10.0	.95	1.23	1.85
11.0	.88	1.12	1.71
12.0	.79	.98	1.53
13.0	.68	.84	1.33
14.0	.60	.67	1.10

The cane-sugar manufacturer has two ways of disposing of his crop, one by making raw sugars and selling to the refiners and the other by producing a grade suitable for direct consumption or one that has a special value in another line of manufacture. In the former case, the sugar has only a "sucrose value," being purchased on the percentage of pure sugar it contains, whereas the latter possesses, besides the "sucrose value," an "intrinsic value" as well. The prices paid for sugar having an intrinsic value are higher, but this does not necessarily indicate a larger profit, since there is a greater expense for manufacture and the market is not as certain as that of raw sugars. It is therefore a serious problem to decide what grade of sugar to manufacture, and to do this intelligently it is first necessary to find out the market quotations and then the yield to be expected from 1 ton of cane. With this data at hand, the grades of sugar bringing the largest returns may always be manufactured.

In purchasing raw sugars, the refiners have selected as a basis for settlement, 96 test, or sugars containing 96 per cent pure sugar, and for molasses sugars, 89 polarization, and regulate the prices of other tests in the following manner:

For each degree polarization above 96, $\frac{1}{16}$ cent additional.

For each degree polarization below 96, to 94, $\frac{1}{10}$ cent deduction.

For each degree polarization below 94, $\frac{1}{8}$ cent deduction.

There is a difference between 96 test and 89 test of 75 cents per hundred.

For each degree polarization above 89, $\frac{1}{16}$ cent additional.

For each degree polarization below 89, $\frac{1}{10}$ cent deduction.

The price of raw sugars follows that of Standard Granulated, and this in turn is regulated by the world's supply and demand, the average difference, between the two grades, covering a period of ten years being .83 cent per pound. Plantation Granulated, Yellow and White Clarified, made direct from the cane, sell a few points under Standard Granulated. The prices of syrup, first, second, and third molasses, follow the prices of sugars to a certain extent, so that all the products obtained from the cane are dependent on whether the world supply is adequate for the world's consumption. Still, there is sufficient variation in the market quotations to warrant the manufacture of certain grades at one time and to change to other grades when conditions are different. This is especially true of the syrup and molasses, due to the fact that the purchaser represents different interests, and the supply and demand is as much dependent on the yield of corn, from which commercial glucose is made, as the world's supply of sugar.

The problems relating to the manufacture of raw sugars will first be discussed.

1. *Does it Pay to Melt Molasses Sugars?*—The object of melting the molasses sugar is to obtain a higher polarization and a correspondingly better price, but in doing so there is always a loss, which may interfere with the expected profits, to a certain extent. By minimizing the mechanical losses attendant upon the process, the gain is sufficient to warrant its use, which is clearly shown by the following table and accompanying calculation.

TABLE XIX

POUNDS OF 96 TEST SUGAR OBTAINED FROM 100 POUNDS OF MOLASSES SUGARS

Polarization, Molasses Sugar.	Pounds 96 Sugar	Gallons Molasses.
80.0	76.36	2.04
82.0	79.37	1.77
84.0	82.32	1.52
86.0	85.14	1.27
88.0	88.15	1.01
90.0	91.10	.76
92.0	94.12	.50

EXAMPLE:

Polarization of molasses sugar	88.0
Price of molasses sugar per lb	3.35¢
Price of 96 test sugar per lb	4.20¢
Price of molasses per gal	10.0¢

Then:

100 lbs. 88 test sugar @ 3.35¢		$3.35
88.15 lbs. 96 test sugar @ 4.20¢	$3.70	
1.01 gallons molasses @ 10¢	.10	
	$3.80	
Gain by melting		$ .55

The increase in polarization may be made without melting the grain by mixing the sugar with a first molasses to the consistence of massecuite and drying direct in the centrifugals; or it may be mixed with a syrup and drawn into the pan to furnish sufficient grain for a strike. In this case the time taken for boiling a strike is materially reduced, thereby possessing a double advantage, especially should the boiling capacity of the factory be insufficient.

2. *The Relation of the Average Polarization of the Sugar to the Profits.*—The average polarization for a season is found by multiplying the pounds per ton of each grade by the polarization, adding the results, and dividing by the total pounds.

EXAMPLE:

	Pounds	Polarization	Sucrose
First sugar......	143.3	96.00	137.57
Second sugar....	16.0	88.00	14.08
Third sugar.....	7.4	88.00	5.92
Total.......	166.7	94.53	157.58

$$\frac{100 \times 157.58}{166.7} = 94.53.$$

It has been generally believed that the sale of sugars polarizing 96 was the most economical one for the manufacturer, but this is not the case. The refiners' cost depends on the amount of impurities present that must be removed by the filters and the higher the polarization the more is paid for the sucrose. This difference is sufficient to induce the raw-sugar manufacturer to partially refine the sugars sold and deliver all of the crop at the highest polarization possible. This may be clearly shown by means of the two tables given below.

Table XX

YIELD OF FIRST SUGARS FROM 100 POUNDS OF SUCROSE IN FIRST MASSECUITE

Polarization.	Pounds Sugar.	Market Quotation Cents.	Value of Sugar.	Pounds Sucrose.	Value of 100 Lbs. Sucrose.	Reduced Value.
99.0	66.9	4.387	$2.935	66.23	$4.431	....
98.0	68.4	4.325	2.958	67.03	4.411	.020
97.0	69.7	4.262	2.971	67.61	4.394	.037
96.0	71.2	4.200	2.990	68.35	4.383	.048
95.0	72.8	4.100	2.985	69.19	4.314	.127
94.0	74.4	4.000	2.976	69.94	4.255	.176
93.0	76.2	3.875	2.953	70.87	4.167	.264
92.0	78.0	3.750	2.925	71.76	4.076	.355

In addition to receiving a lower price for the sucrose sold, there is a complete loss of the molasses left in the sugar, making the total loss for each ton of cane still greater. This may be seen by calculating the yield of raw sugar from a ton of cane polarizing 98, 96, and 92 degrees and sold at prices based on the refiners' schedule. The molasses in each case is assumed to have a value of 10 cents per gallon.

TABLE XXI

RELATION OF THE POLARIZATION TO THE PROFITS

Polarization of Sugars.	Pounds per Ton.	Gals. Molasses.	Price of Sugar.	Price of Molasses.	Value of Sugar.	Value of Molasses.	Total Value.
92	173.48	4.56	$3.75	10	$6.505	$.456	$6.961
96	164.22	5.34	4.20	10	6.858	.534	7.389
98	159.94	5.69	4.325	10	6.916	.569	7.489

3. *The Relative Prices of Sugar and Syrup which Warrants the Making of Syrup.*—There are a few factories in Louisiana so arranged that either syrup or sugar may be manufactured, and are therefore able to change from one grade to another when the prices warrant. In order to decide this, it is necessary to know the prices of syrup, Y. C. sugar, second and third sugar, and final molasses, and the pounds of solid matter from one ton of cane, and apply these prices to the tables of yields found in the previous chapter. If the total income from the sugar and molasses divided by the total solid and then multiplied by 8.64, the solids in one gallon of syrup are less than the price of syrup, then syrup should be manufactured, but if it is more, Y. C. sugar, low grades, and final molasses.

EXAMPLE:

Mill extraction....................	75%
Sucrose in juice....................	12%

Yield:

Y. C. sugars......	116.3	@	4.60¢	$5.35
Second sugar.....	40.8	@	3.35¢	1.37
Third sugars.....	7.6	@	3.35¢	.25
Molasses.........	5.31	@	10¢	.53
				$7.50

Pounds solids in syrup per ton of cane, 216.45

$$\$7.50 \div 216.45 = 3.47¢.$$

3.47 cents is the price received for 1 pound of solids.

$$3.47c. \times 8.64 = 30¢.$$

If the syrup brings 31 or 32 cents per gallon, then syrup should be manufactured, but if the price is 28 or 29 cents, there will be a greater profit in the making of sugar and molasses, providing the cost of manufacture is the same for both grades. Otherwise the profits are calculated from the prices paid and the cost of manufacture combined.

4. *Relative Prices which Warrant the Selling of First Molasses.*—A similar calculation will decide this question.

Gallons first molasses from Y. C sugar..10.03

When manufactured into sugar and final molasses there will be,

Pounds second sugar,	40.8	@ 3.55¢..	$0.37
Pounds third sugar,	7.6	@ 3.35¢.....	.25
Gallons molasses,	5.31	@ 10¢........	.53
			$2.15

$2.15 ÷ 10.03 = 21.43 per gallon.

From this result it is evident that when the price of molasses falls below 21.43 cents per gallon, the larger profits will be received by making sugar and final molasses, and if it is above 21.43 cents per gallon, it will be more profitable to make the first molasses.

5. *Sucrose Value of Molasses.*—It is often desirable at times to know whether to sell molasses of different purities or manufacture into sugar, when the relation of the molasses to the yield per ton is unknown. This may be done by applying the formula for available sugar, calculating the 88 test sugar and molasses, multiplying by the market quotations for the various grades, and comparing the total returns with the price paid for the original molasses.

Example:

Analysis of molasses:

Brix	83.4
Sucrose	50.04
Purity	60.00

Weight of one gallon:

Total solids	10.00
Sucrose	6.00

Available sugar, 5.505 lbs. @ 3.35 cents	19.5 cents
Molasses, .462 gals. @ 10 cents	4.6 cents
	24.12

Therefore the molasses must sell for 24.12 cents per gallon to bring in returns equal to that of the available sugar and black-strap.

6. *The Composition of Cane Suitable for the Manufacture of Syrup.*—It has been shown that factories prepared to make either syrup or sugar and molasses, may calculate which will bring the greatest profits, by using the market quotations, and the amount of each of the products per ton of cane. There is, however, another factor in such a calculation, the composition of the cane ground as shown by the analysis of the extracted juice, which much be considered, for it has been found that when the value of the syrup will just equal the value of the sugar and molasses in cane of *average* sucrose content, that cane with lower percentage of sucrose will pay better when made into syrup, while cane with a higher sucrose will pay a larger profit for the output of sugar and molasses. This may be illustrated by three examples, using the price of granulated sugar at 5 cents, final molasses at 10 cents per gallon, a mill extraction of 75 per cent and 12 per cent sucrose in the juice, to represent cane of average sucrose content, the yield of syrup being 25 gallons per ton.

First Example:

Find the price of syrup which will give the same income per ton of cane as sugar and molasses.

Granulated sugar, 155.84 @ 5 cents.......	$7.79
Final molasses, 6.06 @ 10 cents..........	.61
Total..............................	$8.40

$8.40÷25=33.6 cents

Second Example:

To find the increased value of syrup selling for 33.6 cents per gallon obtained from a ton of cane, yielding a juice of 9 per cent sucrose.

Granulated sugar 109.93 lbs. @ 5 cents....	$5.50
Final molasses, 7.33 gals. @ 10 cents......	.73
	$6.23
21.2 gals. of syrup @ 33.6 cents..........	$7.12
Increased value of syrup.................	.89

Third Example:

To find the increased value of sugar and molasses obtained from a ton of cane yielding a juice of 14 per cent sucrose.

Granulated sugar, 187.76 @ 5 cents.......	$9.39
Final molasses, 4.69 @ 10 cents...........	.47
	$9.86
27.2 gals. of syrup at 33.6 cents..........	$9.14
Increased value of sugar and molasses	.72

7. *The Two-Factory System.*—The distribution of the sucrose in the cane stalk has been investigated by different Experimental Stations, both in this and other countries, and the conclusions reached completely establish the fact that the bottom joints mature first and the ripening process proceeds from the bottom toward the top as the season advances. Dr. Geerligs, in "Cane Sugar and Its Manufacture," gives the results of his work on this subject in a series of tables, which show the analyses of each joint of the cane stalk at regular intervals. These figures have been condensed and so arranged that the sucrose found in the lower and upper half of the stalk, at the end of six, eight, ten and twelve months are given.

	Lower Half.	Upper Half.
Six months.......	10.08	6.65
Eight months....	12.65	5.94
Ten months......	13.17	13.46
Twelve months...	14.81	15.30

These figures would indicate that if the cane is allowed to grow until fully mature, as is possible in the tropics, there will be an even distribution of the sucrose in the cane stalk, but in Louisiana, where the growing season extends only from March until October or November, the greater part of the available sugar is found in the lower joints of the cane. Analyses made by the author in 1913 of juices obtained from the lower and upper half of the cane stalks are as follows:

	Lower Half.	Upper Half.
Brix.............	15.92	12.93
Sucrose..........	13.72	7.99
Purity...........	86.19	61.80

It was also found that the weight of the juice extracted from the lower half of the stalk, due to the larger diameter, was nearly double the weight of the juice from the upper part, showing that two-thirds of the juice extracted comes from the lower half of the stalk. In calculating the yield this fact is utilized, the extraction assumed to be 75 per cent, and the two kind of juices manufactured into 96 test sugar and final molasses.

	Lower Half, ⅔ Wgt.	Upper Half, ⅓ Wgt.	Full Stalk.
Pounds 96 test sugar	130.62	32.18	162.80
Gallons molasses....	1.98	2.87	4.85

The value of the lower and upper part of the cane may be found by taking the price of 96 test sugar at 4.2 cents per pound and final molasses at 10 cents per gallon.

	Lower Half, ⅔ Wgt.	Upper Half, ⅓ Wgt.	Full Stalk.
96 test sugar........	$5.48	$1.35	$6.83
Final molasses......	.20	.28	.48
Total..........	$5.68	$1.63	$7.31

The profit or loss to be expected by manufacturing the juices from the two parts of the cane, into 96 test sugar and molasses, can be determined by deducting from the total income of each two-thirds and one-third of the cost of manufacture and the cane, this cost being as follows:

Cost of cane..............................	$4.20
Operation, insurance, upkeep, etc.........	2.20
	$6.40
Two-thirds cost of manufacture..........	$4.27
One-third cost of manufacture............	2.13

	Lower Half, ⅔ Wgt.	Upper Half, ⅓ Wgt.	Full Stalk.
Total income.......	$5.68	$1.63	$7.31
Total cost..........	4.27	2.13	6.40
Profit..............	$1.41	.....	$0.91
Loss...............	.....	.50	.....

It would appear from these results that when immature cane is ground, there is a serious loss sustained from the manufacture of the upper part, a handsome profit from the lower part, and that the profit on the entire stalk depends on how much greater this profit is than the loss. By grinding only the lower part, the cost of the cane would be increased, since the amount expended in the cultivation is divided into the number of tons obtained, and the profits made by the manufacture of richer juices would be absorbed by the larger proportional cost of the cane itself. The one solution of the problem, therefore, will be to manufacture the upper part of the cane stalk into syrup, which has just been shown to bring in a larger profit than sugar, where the cane yields a juice of low sucrose content. If the upper half of the stalk is ground by itself, and the juices boiled down to the proper density, there will be seven gallons of syrup, and, at 33.5 cents per gallon, would have a value of $2.35, or $0.72 more than when manufactured into sugar, and insures a profit on the manufacture.

	Lower Half, ⅔ Wgt.	Upper Half, ⅓ Wgt.	Full Stalk.
Total income.......	$5.68	$2.35	$8.03
Total cost..........	4.27	2.13	6.40
Profit..............	$1.41	$0.22	$1.63
Loss...............	.....	.....	.....

$1.63 − $0.91 = $0.72

The profits obtained by grinding and manufacturing the two parts of the cane stalk in different factories amount to $0.72 per ton and are sufficient to justify each sugar planter in building or operating a syrup factory in connection with his sugar factory. The cane may easily be cut in the field so that the part intended for the syrup mill will have a sucrose percentage between 7 and 9 per cent, while the lower part will have a juice containing from 12 to 14 per cent sucrose. By manufacturing a cane with a high sugar yield, the cost per pound will be reduced and it will be much easier to produce a grade suitable for direct consumption, since the coloring matter is found largely in the upper part of the stalk. Cane growers, who are shipping cane to central factories, may use a part of the cane stalk for syrup and send the more valuable part, which will be paid for by the sucrose test, thus avoiding the cost of the freight on one-third of the cane that does not pay the factory to manufacture into sugar.

CHAPTER IX

THE PURCHASE OF CANE BY THE "UNIT" METHOD

THE cane contract used in Louisiana contains the following clause relating to the method of settlement:

"—— the party of the first part agrees to pay the party of the second part, for the faithful performance of the above written contract, the sum of — cents per ton of 2,000 pounds cane for each cent and fraction of a cent thereof, in proportion to the weekly average price of prime yellow clarified sugar, as sold on the New Orleans market during the week of delivery; said weekly average to be established by the Secretary of the Louisiana Sugar Exchange in New Orleans."

In some instances the basis of settlement is made the price of 96 test sugar instead of prime yellow clarified. The amount the cane grower receives per ton of cane, when the contract specifies different rates and for different prices for either yellow clarified or 96 test sugar, is shown in the table given below:

TABLE XXII

PRICES PAID FOR ONE TON OF CANE

Prices of Sugar in Cents.	Basis of Settlement.				
	.80	.85	.90	.95	1.00
4.00	$3.20	$3.40	$3.60	$3.80	$4.00
4.20	3.26	3.57	3.78	3.99	4.20
4.40	3.52	3.74	3.96	4.18	4.40
4.60	3.68	3.91	4.14	4.37	4.60
4.80	3.84	4.08	4.32	4.56	4.80
5.00	4.00	4.25	4.50	4.75	5.00

This schedule makes it possible for the manufacturer to pay the grower more for his cane when the prices of sugar are high and he is making a good profit, and less when the prices are low, and in this respect the plan is excellent. But the method of settlement, based solely on the weight of the product, is unfair to both parties, since no account is taken of the solid matter contained in the cane, and it is this part of the cane that is of value. Under these conditions the profit the grower secures depends on the tons of cane he obtained from an acre of land, which places a premium on delivering immature and green cane and favors the custom of topping as high as possible, for it will cost no more to plant, cultivate and fertilize an acre which yields 30 tons per acre than on that which will y eld 10 tons per acre, the only difference being in the cost of harvesting more tons in one case than the other.

To illustrate the inequalities of the present method of settlement for cane, two tables will be given, showing the profit and loss for the grower, when the yield per acre is 10, 15, 20, 25, 30 and 35 tons, and then the profit and loss for the manufacturer when the sucrose in the cane is 9 to 14 per cent. It is assumed that the cost of harvesting is $0.75 per ton and all other expenses $55.00, and the price paid per ton $4.20.

TABLE XXIII

PROFIT AND LOSS FOR CANE GROWER

Tons per Acre.	Cost of Growing.	Cost of Harvesting.	Total Cost.	Cost per Ton.	Profit.	Loss.
10	$55.00	$ 7.50	$62.50	$6.25	.....	$2.05
15	55.00	11.25	66.25	4.41	.....	.21
20	55.00	15.00	70.00	3.50	$0.70	
25	55.00	18.75	73.75	2.95	1.25	
30	55.00	22.50	77.50	2.58	1.62	
35	55.00	26.25	81.25	2.32	1.88	

The data used in calculating the profit and loss for the manufacturer per ton of cane are:

Price paid for cane...........	$4.20
Cost of manufacture.........	2.20
	$6.40

Price of 96 test sugar......... 4.2 ¢ per pound
Price of 88 test sugar......... 3.35¢ per pound
Price of molasses............. 10. ¢ per gallon

TABLE XXIV

PROFIT AND LOSS IN MANUFACTURE

Per Cent Sucrose.	Total Income.	Total Cost.	Profit.	Loss.
9.0	$5.29	$6.40	....	$1.11
10.0	6.03	6.40	....	.37
11.0	6.67	6.40	$0.27	
12.0	7.32	6.40	.92	
13.0	7.96	6.40	1.56	
14.0	8.61	6.40	2.21	

While it will be impossible to establish a definite relationship between the sucrose in the juice and the tons of cane per acre, yet experience has shown that a light tonnage will usually give a high yield per ton, while a heavy tonnage will give a low yield. This may be explained by the weather conditions which prevail during the growing period, the rains and temperature having an important function in the proper growth of the cane. From the time the cane sprouts until laid by in July, dry weather is the most favorable, but with sufficient rainfall to insure a steady growth. Later, a high temperature with heavy rains bring the stalk to its maximum size, and during the month preceding the beginning of grinding, cool dry weather, to cause the cane to ripen. If there is a drought during the first two periods, and the stalk does not reach its full size, the tonnage will be light and the per cent of sucrose high, but if rains continue during the time the cane usually ripens the tonnage will be heavy and the sucrose low. For this reason, the cane grower can well afford to sell at a lower price when his yield is high and thus prevent a probable loss by the manufacturer, while the price per ton may be increased when the available sugar is above the average. The solution of the problem is, therefore, a method of buying cane which will take into consideration the intrinsic value of the cane, and this may be done by using the "unit" method, which will now be explained.

The "unit," as it is used in this connection, is a figure, having no value in itself, but when multiplied by the price of granulated sugar and the per cent sucrose in the juice, will give the total income to be expected from a ton of cane. The price of standard granulated is used instead of yellow clarified or 96 test because it depends on the world's supply of sugar and will not be increased or decreased by local conditions, thus insuring the cane grower the full value of his crop and the manufacturer a price for the raw material which will enable him to make a regular profit on each ton ground.

The first step in developing the "unit" will be to calculate the pounds of available sugar per ton of cane for each per cent sucrose from 9 to 14 per cent and also the resulting final molasses.

TABLE XXV

YIELD OF GRANULATED SUGAR PER TON

Per Cent Sucrose.	Pounds Gran. Sugar.	Gallons Molasses.
9.0	109.93	7.33
10.0	124.93	7.03
11.0	140.22	6.60
12.0	155.84	6.06
13.0	171.69	5.42
14.0	187.76	4.69

It will be noted that the sugar increases and the molasses decreases from the lowest to the highest per cent sucrose, due to the constant increase in the purities corresponding to the sucrose percentage, so that it is impossible to obtain a "unit" in this form. To remedy this, there is a relationship determined between the gallons of molasses and the pounds of sugar by means of the price:

Price of granulated sugar.. 5 cents
Price of molasses......... 10 cents

When the products are sold, one gallon of molasses will bring as much as two pounds of sugar, so that if the gallons of molasses are multiplied by two and added to the pounds of granulated sugar, the result, multiplied by the price of granulated sugar, will be the same as when the usual method is followed to obtain the total returns from a ton of cane. In the table given below this has been done and the number obtained divided by the per cent sucrose that corresponds to the yield.

TABLE XXVI

UNITS FOR DETERMINING THE YIELD

Per Cent Sucrose.	Granulated Sugar.	Units.
9.0	124.59	13.84
10.0	138.99	13.90
11.0	153.42	13.95
12.0	167.96	13.99
13.0	182.53	14.04
14.0	197.14	14.08

The use of six "units" in calculating the available sugar would be inconvenient, especially as the figures are so nearly the same, and in all probability the number 14 would be selected for use in all cases, which would be admissible since in the calculation no allowance has been made for the effect of the fibre on the per cent extraction. For if the extraction is assumed to be 75 per cent and the fibre 10 per cent, then the fibre will hold 15 per cent of juice, or a ratio of 1 : 1.5. It is a well-known and accepted fact that as the cane matures the per cent fibre increases, so that there would be expected a higher percentage of fibre in the cane that yielded a juice having 14 per cent sucrose than from cane yielding 9 per cent sucrose. Accepting the number 14 as the "unit," the effect on the fibre and extraction is shown in the next table, and is believed to correspond closely to the actual conditions existing in actual grinding operations.

TABLE XXVII

EFFECT OF "UNIT" 14 ON EXTRACTION AND FIBRE

Per Cent Sucrose.	Granulated Sugar.	Extraction.	Fibre.
9.0	126.0	75.87	9.65
10.0	140.0	75.54	9.78
11.0	154.0	75.27	9.89
12.0	168.0	75.00	10.00
13.0	182.0	74.79	10.08
14.0	196.0	74.58	10.17

This table shows that the mill extraction decreases as the per cent sucrose in the juice and the fibre increase, so that the same "unit" may be used, irrespective of the percentage of sucrose in the juice, and the total value of the commercial products obtained from a ton of cane may be found by multiplying the product of the per cent sucrose in the juice and the price of granulated sugar by the number 14.

Example:

Price granulated sugar......... 4.85¢ per pound
Per cent sucrose in juice.......12.00

Then,

$$14 \times 12 \times 4.85¢ = \$8.15$$

But as the value of the output from a ton of cane when made into 96 test sugars and final molasses is much less than when refined, the "unit" in this form will be of little benefit to the manufacturer of raw sugars and it will be necessary to develop one that will be suitable for the purpose. If we accept as true the assertion just made that each per cent sucrose will give a proportional amount of granulated sugar per ton of cane, then the same will be equally true of raw sugars as well, for in the refining process there is a well-known relationship existing between the weight of the raw sugar melted and the finished product. Under these conditions the value of the two grades will be in direct proportion to the prices and the "unit" for raw sugar obtained by the following formula:

Raw sugar "unit" =

$$\frac{\text{Price 96 test sugar} \times 100}{\text{Price of granulated sugar}} \times .1458.$$

Example.—Find the value of the commercial products obtained from a ton of cane, the per cent sucrose being 12, the price of granulated and 96 test, 4.85¢ and 4.02¢ respectively per pound.

$$\frac{4.02 \times 100}{4.85}.1458 = 12.08 \text{ Unit for raw sugars.}$$

$$12.08 \times 12 \times 4.85 = \$7.03.$$

The question of what part of the total value of the cane will be paid to the grower depends upon conditions, and must be adjusted between the two parties interested. An equitable method would be by finding out the investment made by each in the cane and divide the proceeds in the same proportion.

	Cane Grower.	Manu-facturer.	Total.
Cost of cane..................	$3.56	$2.20	$5.76
Interest on investment........	.21	.13	.34
Depreciation of factory.......	.....	.40	.40
Total..................	$3.77	$2.73	$6.50

$$\frac{100 \times \$3.77}{\$6.50} = 58\%.$$

The division of the total proceeds from the sale of the commercial products between the cane grower and the manufacturer would be 58 per cent to the former and 42 per cent to the latter. But as the same result will be obtained by dividing the "unit" itself in this proportion, a table is given below that shows the part of the "unit," which, if multiplied by the per cent sucrose in the juice and the price of granulated sugar, will give the price to be paid for the cane. In the first column is given the per cent difference between granulated sugar and 96 test, using the weekly market quotations, and the "unit" corresponding to this per cent difference, while in the last two columns are given the part of the "unit" that should be paid the cane grower and the part retained by the manufacturer.

TABLE XXVIII

UNITS FOR PURCHASING CANE

Per Cent Difference in Price.	Units.	58 Per Cent Cane Grower's.	42 Per Cent Manufacturer's.
10	13.12	7.61	5.51
11	12.97	7.52	5.45
12	12.83	7.44	5.39
13	12.68	7.35	5.33
14	12.54	7.27	5.27
15	12.39	7.19	5.20
16	12.24	7.10	5.14
17	12.10	7.01	5.09
18	11.96	6.93	5.03
19	11.81	6.84	4.97
20	11.66	6.76	4.90
21	11.51	6.68	4.83
22	11.37	6.59	4.78
23	11.22	6.51	4.71
24	11.08	6.42	4.66
25	10.93	6.34	4.59
26	10.78	6.25	4.53
27	10.64	6.17	4.47
28	10.49	6.08	4.41
29	10.35	6.00	4.35
30	10.20	5.92	4.28

Rule.—Determine the per cent sucrose in the juice obtained from the cane of each grower, and multiply by the price of granulated sugar and the "unit" corresponding to the difference in per cent between the prices of granulated sugar and 96 test sugar.

Example.—Find price to be paid for cane when the price of granulated sugar is 5¢, that of 96 test sugar 4¢ per pound and the sucrose in the juice 11.5 per cent.

$$\frac{100(5¢-4¢)}{5¢}=20\%.$$

From table,

$$20\%=6.76.$$

Then,

$$6.76\times 11.5\times 5¢=\$3.89.$$

The fairness of this method will recommend itself to both the cane grower and the manufacturer, as the price paid for the cane increases and decreases in direct proportion to the value of the commercial products obtained. Using the same unit as in the example, the price to be paid for cane when the per cent sucrose is 9 to 14 will be shown in the table below.

TABLE XXIX

PRICE PAID FOR CANE

Per Cent Sucrose.	Price Paid for Cane.	Per Cent Sucrose.	Price Paid for Cane.
9.0	$3.04	12.0	$4.06
10.0	3.38	13.0	4.40
11.0	3.73	14.0	4.74

The cane delivered by the different cane growers to the sugar house may be sampled by first providing a set of shelves in the mill room upon which are placed wide-mouth bottles that are labeled with the name of each grower. As the cane passes through the first mill, a sample is taken, and 100 c.c. measured out and emptied into the bottle, to which is then added 1.2 grams of dry lead acetate, which both preserves the sample and prepares it for the polariscope as well. As many samples are taken as there are cars or carts delivered and at the end of each day or six hours, the samples are polarized and the percentage of sucrose found from the reading in the following table.

TABLE XXX

SUCROSE TABLE

FIRST MILL JUICE

Polariscope Reading.	Per Cent Sucrose.	Polariscope Reading.	Per Cent Sucrose.
36	8.91	50	12.24
37	9.15	51	12.47
38	9.36	52	12.71
39	9.62	53	12.95
40	9.87	54	13.19
41	10.11	55	13.42
42	10.38	56	13.66
43	10.58	57	13.90
44	10.82	58	14.13
45	11.06	59	14.38
47	11.53	60	14.61
48	11.77	61	14.84
49	12.00		

Polariscope Reading.	Per Cent Sucrose.
.1	.03
.2	.05
.3	.07
.4	.09
.5	.12
.6	.14
.7	.17
.8	.19
.9	.21

Cane that has been frozen or otherwise damaged so that it is impossible to obtain the usual yield for each per cent sucrose in the juice, may also be settled for by the "unit" method, but with a reduction made in proportion to the percentage of acidity in the juice above the normal. From what has been learned in the laboratories during the manufacture of sugar from sour cane, certain bacteria attack the glucose and sucrose and change them into alcohol, gums and acids. The analysis of alcohol and the gums are not practicable, but the determination of the acidity is both easy and accurate, and forms the best indication of the progress of the fermentation and therefore to judge the damage caused by the freeze to the value of the cane. When the juice extracted from frozen and sour cane is manufactured into sugar, it is found that there is great difficulty experienced in evaporating the water in the effects and concentrating the syrup in the vacuum pans to the proper density. As a result the cost of manufacture is increased, first by the necessity of using more fuel oil, and second by reducing the capacity of the mill, less cane being ground than when normal cane is received. There is also a definite loss, some of the available sugar being held in the final molasses as the massecuites contain a larger percentage of water than ordinary. In justice to the manufacturer a deduction should be made on the price of the damaged cane that will at least cover the increased cost of manufacture.

But on the other hand, owing to the custom of " topping " lower when the cane has been frozen or windrowed, the part delivered to the factory may have a greater value for sugar-making purposes than the entire stalk, delivered before the freeze, and it is only fair that additional pay should be given the cane grower to compensate him for the tops left in the field. Recent decisions of the Supreme Court of Louisiana hold that if the cane has been frozen, the purchaser has the right to reject it entirely or pay for it in proportion to its value. Under these conditions the juice from the cane delivered by each grower should be analyzed for the per cent sucrose and acidity and calculations made to determine whether the cane is of less value and what reduction should be made in the price. As has been intimated the reduction is made when the value of the commercial products is less than would be obtained from sound cane having the same per cent sucrose and also when the cost of manufacturing the damaged cane has been increased. The data necessary for the purpose are as follows:

Weekly average per cent sucrose in the juice.

Weekly average per acidity in the juice.

Weekly average of pounds of first, second and third sugar and the final molasses.

Weekly average prices for first, second and third sugars and the final molasses.

Unit of Value: Multiply the pounds of the different grades of sugar and molasses by the prices, add the results and divide by the per cent sucrose in the juice.

Unit of Cost: Divide the average cost of manufacture per ton of cane by the per cent sucrose in the juice.

These different percentages are averaged from the beginning of grinding until damaged cane is received and are used as a standard with which the results, obtained from the damaged cane, are compared.

First.—Find the reduction in the price of damaged cane due to the lower value of the commercial products.

Let A = Unit of Value—sound cane;
B = Unit of Value—damaged cane;
X = Per cent Reduced Value.

Then,

$$X = \frac{A-B}{A}.$$

Second.—Find the reduction in the price of damaged cane due to the increased cost of manufacture.

Let C = Unit of Cost—sound cane;
D = Unit of Cost—damaged cane;
X' = Per cent Increased Cost.

Then,

$$X' = \frac{D-C}{A}.$$

The total reduction in the price of the damaged cane would be expressed by the formula:

$(X+X')$ Unit of Value—sound cane.

Third.—Find the relationship between the per cent acidity caused by fermentation and the total reduction in the price of the damaged cane.

Let M = Per cent acidity—sound cane;
N = Per cent acidity—damaged cane;
X'' = Per cent acidity caused by fermentation.

Then

$$X'' = N - M.$$

Also

$X'' = (X+X')$ Unit of Value—sound cane

and

1% acidity $= \left(\frac{X+X'}{X''}\right)$ Unit of Value—sound cane.

In order to obtain the reduction in price paid for damaged cane, in dollars and cents, it will be necessary to multiply the Unit of Value—sound cane by the per cent sucrose from sound cane which will give the total value of the commercial products from one ton of cane. But it has been shown that this may be found by multiplying the "unit" for raw sugars by the per cent sucrose in the juice and the price of granulated sugar, so the formula may be changed to the following:

$$1\% \text{ acidity} = \frac{X+X'}{X''} (\text{"Unit"} \times \text{per cent sucrose} \times \text{price granulated sugar}).$$

Example.—Find the price to be paid for cane when the price of granulated sugar is 5¢ per pound, 96 test, 4¢ per pound, the per cent sucrose in the juice 11.5% and the acidity caused by fermentation 1.7 per cent.

The "unit" for raw sugars is 11.66 and for the cane grower 6.76.

The price for the cane, if sound, would be $3.89. (See page 176.)

$$\frac{X+X'}{X''} = 10\%.$$

$$10 \times 1.7 = 17.$$

Then,

$$.17(11.66 \times 11.5 \times 5) = \$1.13.$$

$$\$3.89 - \$1.13 = \$2.76.$$

In order to utilize the method just given in making settlements for purchased cane, the paragraph found at the beginning of this chapter may be omitted and the following substituted in the cane contracts.

"—— the party of the first part agrees to pay to the party of the second part, for the faithful performance of the above written contract, fifty-eight per cent of the value of the commercial products obtained from the cane delivered, such value to be determined from the per cent of pure sugar contained in the extracted juice and based on the weekly average price of Standard Granulated sugar, 96 test, and molasses as sold on the New Orleans market during the week of delivery, said weekly average to be established by the Secretary of the Louisiana Sugar Exchange of New Orleans. In the event of a freeze and the cane delivered at the sugar house by the party of the second part, is found to be seriously damaged, so that its value for sugar making purposes has been impaired, the party of the first part is given the right to make such reductions in the price, that will balance the reduced yield obtained and the increased cost of manufacture, such reductions in price to be in direct proportion to the per cent acidity of the extracted juice from said cane, that is above the normal acidity of sound cane, and therefore caused by the cane being exposed to freezing weather. And if the cane so delivered by the party of the second part is found to be absolutely worthless, and would, if ground with other cane having a real value, interfere with proper manufacture of said cane, the party of the first part is given the right to grind the worthless cane and run the extracted juice into the ditch and shall in no way be held responsible for either the price of the cane, the derrick charges, or the freight from the loading station to the sugar house."

INDEX

TABLES