U. S. DEPARTMENT OF AGRICULTURE.

DIVISION OF CHEMISTRY.

BULLETIN No. 15.

REPORT

OF

EXPERIMENTS IN THE MANUFACTURE OF SUGAR

AT

MAGNOLIA STATION, LAWRENCE, LA.,

SEASON OF 1886-1887.

THIRD REPORT,

BY

GUILFORD L. SPENCER.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1887.

U. S. DEPARTMENT OF AGRICULTURE.
DIVISION OF CHEMISTRY.
BULLETIN No. 15

REPORT

OF

EXPERIMENTS IN THE MANUFACTURE OF SUGAR

AT

MAGNOLIA STATION, LAWRENCE, LA.,

SEASON OF 1886-1887.

THIRD REPORT,

BY

GUILFORD L. SPENCER.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1887.

19623—No. 15

LETTERS OF TRANSMITTAL.

UNITED STATES DEPARTMENT OF AGRICULTURE,
Washington, D. C., April 12, 1887.

SIR: I have the honor to submit herewith for your inspection and approval the results of the experimental work carried on by your direction in Louisiana during the manufacturing season of 1886 by Mr. G. L. Spencer, assistant in the Division of Chemistry.

The information collected is of the highest interest to Louisiana sugar growers, and is made still more valuable by some comparative studies of the Cuban sugar industry.

Very respectfully,

H. W. WILEY,
Chemist.

Hon. NORMAN J. COLMAN,
Commissioner.

UNITED STATES DEPARTMENT OF AGRICULTURE,
DIVISION OF CHEMISTRY,
Washington, D. C., March 31, 1887.

SIR: I have the honor to submit the third report of the Department's experiment station at Magnolia plantation.

Included in this report is a brief statement of the work of three Cuban sugar-houses, indicating certain economies that it would be well for the planters of this country to adopt.

Accompanying this report is an article on sugar analysis, prepared at my request by Dr. C. A. Crampton. This contains a valuable table, devised by Dr. Crampton some years since, and which is now employed at the Department's stations for the calculation of analyses.

Very respectfully,

G. L. SPENCER,
Assistant Chemist.

Dr. H. W. WILEY,
Chemist.

EXPERIMENTS IN THE MANUFACTURE OF SUGAR.

The manufacturing season at Magnolia commenced November 7, 1886, and ended December 20. This completes the third season's work of the Department at this station.

I shall give, in as few words as possible, a comparison of the growing seasons of the past three years.

In 1884 the weather was favorable until the 1st of June, then followed a period of very wet weather, lasting until August, which was a very dry month. The conditions in September and October were favorable to the ripening of the cane. During the rolling season there were frequent and heavy rains.

Season of 1885.—The early part of this season was exceptionally wet. From April to July the rainfall was limited to but three or four showers; in August and September the rains were frequent and heavy; in October and the rest of the season the weather was exceptionally dry and cool, the mean temperature being considerably below that of 1884. The cane was prostrated in September by a heavy wind storm.

Season of 1886.—In consequence of cold, wet weather in February, March, and April the cane obtained a very late start. May was dry and cool; June and July were so wet that it was impossible to properly cultivate the cane; August was dry and exceedingly hot. In September, October, and the rolling season the weather was very dry. The drought probably saved the cane from damage in the heavy wind storm of October, when the lower coast of the Mississippi near Pointe à la Hâche was seriously damaged. There was a killing freeze November 17. This is the earliest freeze, with one exception, noted in the plantation records, extending over a long period of years. December was cold.

It may be seen from the above statements that these three seasons differed very materially from one another. That of 1884 might be considered very favorable. The tonnage was fair and the cane rich. In 1885 the conditions were also favorable, with the exception of the wet weather in September and the heavy wind storm. The tonnage was large, but the quality of the cane was poor.

In January, 1886, there was a severe freeze, perhaps the most severe on record in Louisiana. At the time of this freeze it was feared that the stubble had been damaged by the frost, but such did not prove to be the case.

It is customary at Magnolia to burn the trash in the fields soon after the cane is all harvested. There is a general impression among planters that this exposes the stubble to danger from frost. The experience of the past season at Magnolia demonstrates that such is not the case.

The tonnage this season has been unusually small, but the cane has been a little richer in available sucrose than any time since the station was established.

In comparing the work of the sugar-house it is probably better to compare this season's work with that of 1884–'85. The same grades of sugar were made these seasons.

The yield per acre in 1885–'86 was 2,988 pounds of first, second, and third sugars. In 1886 the yield, first and second sugars, was 1,964 pounds. A decrease of 6.66 tons of cane per acre resulted in a decrease of 1,024 pounds of sugar.

The yield of sugar per ton of cane the past season has been exceedingly satisfactory, but nevertheless it is expected that a few changes in the house will materially increase the output of sugar.

This season only two sugars were made. The first graded "Choice off white." The yield of first sugar would have been larger had it been possible to boil the *masse cuite* stiffer, but the strike valve of the pan would not admit of doing so. As large a proportion of the sugar as possible should be obtained in the firsts, not only on account of the higher price of this grade of sugar, but because less sugar is left to be reboiled for lower grades and consequently the loss from inversion is diminished.

Since most of the sugars and molasses in Louisiana are made to enter directly into consumption, the planter is compelled to lime the juice lower and boil hotter than he would otherwise. Were it practicable by present methods to work alkaline the loss from inversion even at high temperatures would be greatly diminished.

I have examined beet molasses from sugars boiled with a vacuum of less than 24 inches that contained but little more than a trace of invert sugar. The clarified juices and sirups were always worked alkaline.

IMPROVEMENTS IN THE SUGAR-HOUSE AND THE PLANTATION.

Very few changes were made in the house preparatory to this season's work, and those only for the improvement of the work of machinery already in place.

The tanks for skimmings were provided with a better arrangement for decanting the clear juice. The lowest outlets from these tanks are about 2 inches above the bottoms. Outlets should be provided so located that the tanks could be drained, effecting a large saving in sugar.

It is not necessary to wash these tanks very often. The wash-out valve should be out of the control of the filter-press man. These tanks should not be encumbered with coils, but should have double bottoms, that they may be easily discharged and washed.

Perhaps the most important improvement this season was in the work of the double effect. The substitution of a larger sweet-water pump enabled it to concentrate all the juice and obviated the necessity of employing an open pan as last season.

Among other improvements in progress at Magnolia is the introduction of tile drainage. Lines of tile will be laid 30 feet apart, running from the front or river to the rear or marsh side of the plantation. The ditches will be dug by machinery; 3-inch, 4-inch, 5-inch, and 6-inch tiles will be used.

Governor Warmoth intends draining 1,000 acres of land. This drainage system will necessitate an expenditure of about $12,000.

Aside from benefits to be derived from better drainage there will be important advantages gained from closing the ditches. The amount of tillable land will be increased about 70 acres; the large annual expenditure for keeping the ditches and quarter-drains open will be stopped; the cultivation will be easier and less expensive, and the steam plows can be handled more advantageously.

Should the work of this station be continued very interesting and valuable data can be obtained.

ACCIDENTS TO THE MILLS.

The mills were stopped several times by small pieces of iron. Some of this iron passed through the shredder; other pieces must have been introduced after the cane left the shredder. It was evident that this iron was put on the carrier maliciously. This trouble finally culminated in the breaking of the shell of one of the rolls of the supplemental mill. A few changes were made in the disposition of the laborers detailed for work about the mills, and the rolling was finished without further accident than the breaking of three couplings.

The average extraction and consequently the yield of sugar would have been larger had the supplemental mill not have been damaged.

THE BAGASSE-BURNER.

The burner,[1] as improved last season, continued to work satisfactorily. The consumption of coal was materially reduced.

CONSUMPTION OF FUEL.

The amount of coal consumed was determined as follows:

The coal was weighed for half the season and the total consumption was based on the data obtained.

---

[1] Chem. Bulletin No. 11, p. 6.

Pounds of coal consumed in twenty-one days, 436,338; average of 20,778 pounds per day. From the time the fires were kindled until the work was entirely finished was forty-five days, hence the total consumption was 45×20,778=935,010 pounds. The total quantity of sugar made was 1,159,768 pounds, therefore the consumption of coal per 1,000 pounds of sugar was 906 pounds or 4.42 barrels. These figures do not include the coal used in the revivification of the char.

This house could be worked almost entirely without coal if the following improvements were made:

(1) Substitute copper coils for the iron ones now in use in the clarifiers.

(2) Discontinue the practice of clarifying the juice after defecation.

(3) Introduce a condenser employing juice to condense the vapors from the double effect. An illustration of such apparatus is given opposite page 114, Chem. Bulletin No. 5, and is there termed a *Calorisateur à contre-courant.*

(4) Substitute a low-pressure vacuum-pan for the one now in use.

Under these conditions the juice-heater described in last year's[1] report would not be necessary. It could probably be converted into a condenser.

The question of economical engines is of not so great importance, since the exhaust steam is employed for evaporation.

COMPOSITION OF THE JUICE.

The chemical work this season at Magnolia Station was not begun until the 24th of November. Although the work of the sugar-house nominally commenced November 7th, but very little cane was rolled before the 13th. The analyses, therefore, show the composition of the juice for all but eleven days of the season; in which time 2,113 tons of cane were rolled. The cane yielded 8 pounds less sugar per ton than the next 2,000 tons, consequently it is fair to presume that it contained less sucrose.

---

[1] Chem. Bulletin No. 11, page 8.

TABLE I.—*Composition of the raw juices.*

[When two analyses are given the same date the first was sampled in the morning, the second in the afternoon.]

Date.	Numbers.	Degree Baumé.	Degree Brix (per cent. total solids.)	Specific gravity.	Sucrose.	Reducing sugars.	Albuminoids.	Albuminoids per cent. sucrose.	Coefficient of purity.
					Per cent.	*Per cent.*	*Per cent.*		
Nov. 24	1	9.4	17.00	1.0709	13.50	.57	.2438	1.80	79.41
24	2	9.0	16.30	1.0669	12.84	.66	.2063	1.61	78.77
25	3	9.2	16.66	1.0682	13.90	.82	.0625	.45	83.43
26	4	8.6	15.55	1.0634	12.28	.87	.1625	1.32	78.97
26	5	9.1	16.37	1.0674	13.60	.74	.0875	.64	83.08
27	6	8.6	15.55	1.0634	12.00	.73	.2250	1.88	77.17
28	7	9.5	17.21	1.0709	14.36	.46	.1500	1.04	83.43
28	8	9.5	17.07	1.0704	14.21	.49	.1625	1.14	83.24
29	9	9.9	17.88	1.0739	15.04	.43	.1375	.91	84.11
29	10	9.6	17.33	1.0713	14.54	.53	......	......	83.90
30	11	9.4	16.90	1.0695	13.91	.46	.1188	.85	82.30
30	12	9.2	16.69	1.0687	14.21	.39	......	......	85.14
Dec. 1	13	9.5	17.16	1.0709	13.95	.68	.1375	.99	81.29
1	14	9.2	16.63	1.0682	13.97	.55	......	......	84.00
2	15	8.9	16.00	1.0656	14.04	.60	.1313	.94	87.68
2	16	9.0	16.29	1.0669	13.00	.58	.1250	.96	79.80
3	17	9.0	16.23	1.0665	13.76	.69	.1375	1.00	84.78
3	18	9.0	16.17	1.0665	13.01	.77	.1500	1.15	80.45
4	19	8.6	15.59	1.0639	12.75	.49	.1813	1.42	81.78
4	20	8.8	15.78	1.0647	13.12	.60	......	......	83.14
5	21	8.9	16.05	1.0656	13.33	.51	.2063	1.55	83.05
6	22	8.9	16.16	1.0660	13.90	......	......	......	86.01
6	23	8.6	15.46	1.0634	12.89	......	......	......	83.39
7	24	8.2	14.76	1.0604	11.67	......	.2813	2.41	79.06
8	25	8.5	15.36	1.0630	12.88	.58	......	......	83.85
8	26	8.8	15.89	1.0652	13.63	......	......	......	85.77
9	27	9.5	17.07	1.0704	14.97	.72	......	......	87.69
10	28	8.6	15.47	1.0634	13.19	.48	.1313	.99	85.26
10	29	8.9	16.11	1.0660	13.84	.45	.2063	1.49	85.90
11	30	8.9	16.09	1.0660	13.45	.46	.2000	1.49	83.59
11	31	9.0	16.17	1.0665	13.70	.46	.2000	1.46	84.72
12	32	8.5	15.39	1.0630	12.32	.91	.1500	1.22	80.05
12	33	8.6	15.47	1.0634	13.56	.64	.1063	.79	87.65
13	34	8.5	15.40	1.0630	12.91	.72	.1625	1.26	83.83
13	35	8.6	15.57	1.0639	12.97	.51	.3000	2.31	83.80
14	36	8.5	15.27	1.0626	13.04	.51	.2500	1.92	85.39
14	37	8.8	15.87	1.0652	12.92	.72	......	......	81.41
15	38	9.1	16.43	1.0674	13.74	.55	.1938	1.41	83.62
15	39	9.0	16.18	1.0665	13.85	.58	.1313	.95	85.59
16	40	9.2	16.62	1.0682	14.87	.55	.1563	1.05	89.47
16	41	9.1	16.46	1.0678	14.81	.47	.1250	.84	89.97
17	42	9.0	16.19	1.0665	13.76	.60	.1625	1.18	84.99
17	43	9.2	16.69	1.0687	14.34	.52	.1313	.91	85.91
18	44	9.0	16.29	1.0669	13.60	.55	.1625	1.19	83.42
18	45	8.4	15.19	1.0621	12.50	......	......	......	82.29
19	46	8.5	15.39	1.0630	12.73	......	......	......	82.06

Résumé showing the mean composition of the raw juice for the campaign of 1886.

[November 24 to December 20.]

	Means.	Maxima.	Minima.
Specific gravity	1.0665	1.0739	1.0604
Degree Baumé	9.00	9.90	8.20
Degree Brix (per cent. total solids)	16.20	17.88	14.76
Sucrose ... per cent.	13.50	15.04	11.67
Reducing sugars (glucose, &c.) ... do	.61	.91	.61
Albuminoids ... do	.1669	.3000	.0625
Albuminoids, per cent. sucrose	1.24	2.41	.45
Coefficient of purity	83.33	89.47	77.17
Total number of analyses, 46.			

COMPARISON OF RAW AND CLARIFIED JUICES.

In the following table analyses of the raw juices are only given for those days when the clarified juices were also examined:

TABLE II.—*Comparison of raw and clarified juices.*

[When two analyses are given the same date the first was sampled in the morning and the second in the afternoon.]

Date.	Number.	Degree Baumé.	Degree Brix.	Sucrose.	Reducing sugar.	Albuminoids per cent. sucrose.	Coefficient of purity.
				Per cent.	*Per cent.*		
Nov. 25	3	9.2	16.66	13.90	.82	....	83.43
26	4	8.6	15.55	12.28	.87	1.32	78.97
26	5	9.1	16.37	13.60	.74	.64	83.08
27	6	8.6	15.55	12.00	.73	1.88	77.17
28	7	9.5	17.21	14.36	.46	1.04	83.43
28	8	9.5	17.07	14.21	.49	1.14	83.24
29	9	9.9	17.88	15.04	.43	.91	84.11
29	10	9.6	17.33	14.54	.53	....	83.90
30	11	9.4	16.90	13.91	.46	.85	82.30
30	12	9.2	16.69	14.21	.39	....	85.14
Dec. 1	13	9.5	17.14	13.95	.68	.99	81.39
1	14	9.2	16.63	13.97	.55	....	84.00
2	15	8.9	16.00	14.04	.69	.95	87.75
2	16	9.0	16.29	13.00	.58	.96	79.80
3	17	9.0	16.23	13.76	.69	1.00	84.78
3	18	9.0	16.17	13.01	.77	1.15	80.45
4	19	8.6	15.59	12.75	.49	1.42	81.78
4	20	8.8	15.78	13.12	.60	....	83.14
9	27	9.5	17.07	14.97	.72	....	87.69
10	28	8.6	15.47	13.19	.48	....	85.26
10	29	8.9	16.11	13.84	.45	1.49	85.90
11	30	8.9	16.09	13.45	.46	1.49	83.59
12	32	8.5	15.39	12.32	.91	1.22	80.05
12	33	8.6	15.47	13.56	.64	....	87.65
13	34	8.5	15.40	12.91	.72	1.26	83.83
13	35	8.6	15.57	12.97	.51	2.31	83.30
14	36	8.5	15.27	13.04	.51	1.92	85.39
14	37	8.8	15.87	12.92	.72	....	81.41
15	38	9.1	16.43	13.74	.55	....	83.62
15	39	9.0	16.18	13.85	.58	1.26	85.59
17	42	9.0	16.19	13.76	.60	1.18	84.99
17	43	9.2	16.69	14.34	.52	.91	85.91
18	44	9.0	16.29	13.60	.55	1.19	83.48
Means		....	16.26	13.58	.60	1.24	83.52

TABLE II.—*Comparison of raw and clarified juices*—Continued.

Date.	Number.	Degree Baumé.	Degree Brix.	Sucrose.	Reducing sugar.	Albuminoids per cent. sucrose.	Coefficient of purity.
				Per cent.	*Per cent.*		
Nov. 25	3	10.2	18.37	14.92	.85	....	81.22
26	4	9.9	17.87	14.82	.79	.51	82.93
26	5	9.6	17.34	14.38	.79	.52	82.93
27	6	9.1	16.37	12.95	.82	1.01	79.11
28	7	9.3	17.79	14.98	.61	.71	84.20
28	8	10.0	18.04	15.17	.50	.74	84.09
29	9	10.5	18.98	16.01	.68	.47	84.35
29	10	10.1	18.19	15.71	.53	....	86.37
30	11	10.3	18.70	16.04	.61	.55	85.78
30	12	9.7	17.47	14.63	.46	....	83.74
Dec. 1	13	9.7	17.46	14.11	.84	.71	80.81
1	14	9.7	17.39	14.59	.42	....	82.94
2	15	9.9	17.87	14.27	.46	.88	79.85
2	16	9.4	16.89	14.85	.55	.58	87.92
3	17	9.6	17.27	14.56	.43	.69	84.31
3	18	9.7	17.47	14.86	.71	.59	85.06
4	19	9.9	17.79	14.64	.49	.56	82.29
4	20	9.4	16.89	14.18	.46	....	83.96
9	27	9.1	16.40	14.20	.60	....	86.59
10	28	9.5	17.07	14.57	.62	....	85.35
10	29	9.5	17.19	15.07	.49	.87	87.67
11	30	9.6	17.39	15.15	.50	.83	87.11
12	32	9.5	17.09	14.56	.70	.86	85.20
12	33	8.8	15.87	13.48	.62	....	84.94
13	34	9.0	16.31	14.07	.65	.98	86.14
13	35	9.6	17.39	15.09	.63	.79	86.77
14	36	9.7	17.47	14.94	.50	1.09	85.52
14	37	9.4	16.94	14.31	.48	....	84.47
15	38	9.6	17.33	14.91	.62	....	86.04
15	39	10.5	18.93	16.35	.43	.95	86.37
17	42	10.1	18.17	15.91	.45	.63	87.56
17	43	9.7	17.47	15.23	.55	.57	87.18
18	44	9.4	17.00	14.90	.64	.59	87.65
Means........		....	17.46	14.80	.59	.72	84.76

The increase in the coefficient of purity, as shown by Table II, was 1.24. There was but little change in the relative proportions of sucrose and reducing sugars. In the raw juice the average quantity of reducing sugars per cent. sucrose was 4.41; after clarification this proportion was reduced to 3.98. This slight reduction was probably due to the formation of a glucosate of lime, which was subsequently decomposed, leaving the products of the decomposition in solution.

In order to render the percentages of albuminoids more readily comparable they have been expressed in terms of the sucrose. To obtain the actual per cent. albuminoids based on the weight of the juice, multiply the per cent. sucrose by the number given in the column albuminoids per cent. sucrose.

In the raw juice the albuminoids per cent. sucrose was 1.24, and in the clarified juice .72, showing that some of the total albuminoids were still retained by the juice.

In 1884 the processes of defecation and clarification removed 45.71 per cent. of the total albuminoids; in 1885–'86, 45.01; in 1886, 41.93.

COMPARISON OF RAW, CLARIFIED, AND FILTERED JUICES AND FILTERED SIRUP.

Analyses were conducted for a period of sixteen days to determine the effect of filtration through animal charcoal on the juice. These analyses are given in Table III.

TABLE III.—*Comparison of raw juices, clarified juices, filtered juices, and filtered sirup for a period of sixteen days.*

RAW JUICES.

Date.	Number.	Degree Baumé.	Degree Brix.	Sucrose.	Reducing sugars.	Coefficient of purity.
				Per cent.	*Per cent.*	
Nov. 25	3	9.2	16.66	13.90	.82	83.43
26	4	8.6	15.55	12.28	.87	78.97
26	5	9.1	16.37	13.60	.74	83.08
27	6	8.6	15.55	12.00	.73	77.17
28	7	9.5	17.21	14.36	.46	83.43
28	8	9.5	17.07	14.21	.49	83.24
29	9	9.9	17.88	15.04	.43	84.11
29	10	9.6	17.33	14.54	.53	83.90
30	11	9.4	16.90	13.91	.46	82.30
30	12	9.2	16.69	14.21	.39	85.14
Dec. 1	13	9.5	17.14	13.95	.68	81.39
2	15	8.9	16.00	14.04	.60	87.75
2	16	9.0	16.29	13.00	.58	79.80
3	17	9.0	16.23	13.76	.69	84.78
4	19	8.6	15.59	12.75	.49	81.78
4	20	8.8	15.78	13.12	.60	83.14
Means		9.1	16.52	13.67	.60	82.75

CLARIFIED JUICES.

Date.	Number.	Degree Baumé.	Degree Brix.	Sucrose.	Reducing sugars.	Coefficient of purity.
Nov. 25	3	10 2	18.37	14.92	.85	81.22
26	4	9.9	17.87	14.82	.79	82.93
26	5	9.6	17.34	14.38	.79	82.93
27	6	9.1	16.37	12.95	.82	79.11
28	7	9.3	17.79	14.98	.61	84.20
28	8	10.0	18.04	15.17	.50	84.09
29	9	10.5	18.98	16.01	.68	84.35
29	10	10.1	18.19	15.71	.53	86.37
30	11	10.3	18.70	16.04	.61	85.78
30	12	9.7	17.47	14.63	.46	83.74
Dec. 1	13	9.7	17.46	14.11	.84	80.81
2	15	9.9	17.87	14.27	.46	79.85
2	16	9.4	16.89	14.85	.55	89.92
3	17	9.6	17 27	14.56	.43	84.31
4	19	9.9	17.79	14.64	.49	82.29
4	20	9.4	16.89	14.18	.46	83.96
Means		9.7	17.64	14.76	.62	83.62

FILTERED JUICES.

Date.	Number.	Degree Baumé.	Degree Brix.	Sucrose.	Reducing sugars.	Coefficient of purity.
Nov. 25	3	9.0	16.17	12.48	.61	77.18
26	4	9.8	17.67	14.44	.77	82.86
26	5	9.2	16.61	13.71	.77	82.54
27	6	9.5	17.10	14.28	.89	83.51
28	7	9.6	17.33	13.60	.87	78.48
28	8	10.6	19.14	16.19	.60	84.59
29	9	10.2	18.58	15.34	.48	82.56
29	10	10.7	19.29	16.24	.55	84.19
30	11	12.3	22.22	18.52	.67	83.35
30	12	10.2	18.37	15 27	.44	83.12
Dec. 1	13	10.7	19.39	15.63	.66	80.61
2	15	9.7	17.47	14.20	.51	80.28
2	16	9.4	16.89	14.45	.62	84.96
3	17	10.6	19.07	14.95	.70	78.40
4	19	9.5	17.19	14.56	.58	84.70
4	20	9.1	16.49	14.08	.44	85.26
Means		10.0	18.06	14.87	.64	82.14

TABLE. III.—*Comparison of raw juices, clarified juices, &c.*—Continued

FILTERED SIRUPS.

Date.	Number.	Degree Baumé.	Degree Brix.	Sucrose.	Reducing sugars.	Coefficient of purity.
				Per cent.	*Per cent.*	
Nov. 25	3	24.3	44.55	36.10	1.88	81.07
26	4	23.4	42.79	35.93	2.29	83.97
26	5	21.7	39.56	33.22	2.35	83.97
27	6	22.3	40.70	33.56	2.61	82.46
28	7	23.3	42.59	34.84	3.00	81.80
28	8	22.6	41.36	33.01	2.19	79.81
29	9	19.8	36.09	38.00	1.67	77.58
29	10	23.6	43.15	36.10	1.96	83.66
30	11	23.4	42.92	35.75	1.90	83.29
30	12	23.7	43.40	36.54	1.88	83.96
Dec. 1	13	23.6	43.22	35.49	1.67	82.11
2	15	21.4	39.10	32.58	1.98	83.32
2	16	24.8	45.38	37.23	1.65	82.04
3	17	24.1	44.10	36.24	1.70	84.44
4	19	24.3	44.60	36.91	1.48	82.76
4	20	20.8	38.00	31.80	1.64	83.68
Means	....	23.0	41.17	34.58	2.00	82.39

The results of these analyses are not surprising, when we consider the quality of the bone-black used. Mr. O. B. Stillman, a Boston refiner, examined this char and pronounced it to be in a very bad condition. It weighed nearly seventy pounds to the cubic foot. This is nearly twenty pounds heavier than good char should weigh.

The decolorizing properties of this bone-black were good, but as it was already laden with impurities it did not improve the purity of the juice, but, on the contrary, reduced it. This was due to the impurities in the char being redissolved. The sirups being heavier, and already nearly saturated with soluble matter, yield their impurities more readily to the action of the bone-black and are improved in purity. [1]Reference to the first report of this station, giving analyses of raw and filtered juices, will show this same result. The char in use at that time was even worse than last season.

I do not believe that the benefit from the mechanical filtration and the decolorization will balance the damage to the juice resulting from the use of spent bone-black.

THE FILTER-PRESSES.

The use of the filter-presses was continued this season with even greater success than in 1885–'86.

[1] Chem. Bulletin No. 5, pp. 49–50.

Very few analyses of the press-cakes were made, except to determine their value for fertilizing purposes. However, the few analyses that were made are presented in the following table:

TABLE IV.—*Analyses of press-cake.*

Date.	Sucrose.
1886.	*Per cent.*
November 30	7.40
December 1	7.24
3	7.34
4	8.06
Means	7.51

No record was kept in the sugar-house of the quantity of juice recovered by the presses. In fact it would be quite difficult to determine just the proportion of the juice flowing from the presses that would be lost in ordinary work.

This season we found it necessary to empty one press once for every 2,889 gallons of juice expressed by the mills. The total amount of juice was 1,271,205 gallons, hence the number of presses of press-cake was $1{,}271{,}205 \div 2{,}889 = 440$. The average weight of the press-cake per press was 330 pounds: $330 \times 440 = 145{,}200$ pounds of press-cake for the entire season. The amount of press-cake per ton of cane was 20.15 pounds.

In the work with the[1] experimental press in 1884 on thoroughly drained "blanket" scums the yield of juice was 80 per cent. The average skimmings and settlings, after long standing and decantation of the clear juice, are much thinner than the blanket, and would yield from 85 to 90 per cent. juice by filter-pressing. In order to under rather than over estimate the work of the presses, I will base my estimates on the actual yield obtained with the small experimental press. It may be well to state here that the work on a small scale was no better than with the large presses.

On the above basis the press-cake forms 20 per cent. of the total weight of skimmings filtered, hence $145{,}200 \div 20 \times 100 = 726{,}000$, the total number of pounds of skimmings. These figures show that even on a low estimate $6\frac{1}{2}$ per cent. of the juice is lost in the skimmings.

As the presses save at least 80 per cent. of this loss, the saving of juice at Magnolia this season was 580,000 pounds.

As I have repeatedly stated, I consider this estimate a very low one. I have no doubt but that carefully conducted experiments would show a saving of 820,000 pounds of juice. With the filter-press arrangement at Magnolia it is impossible to keep a separate account of the juice recovered.

[1] Chem. Bulletin No. 5, p. 59.

COMMERCIAL VALUE OF THE PRESS-CAKE.

The samples of press-cake sent to Washington for analysis reached there in such a damaged condition that it was useless to analyze them, hence the value of the cake is based on last season's determinations.[1]

Total weight of press-cake 145,200 pounds, or 72.6 tons of 2,000 pounds each. The total value at $10.64 per ton is $772.46.

PRESSURE-REGULATOR FOR FILTER-PRESSES.

In order to do good work with the presses it is essential to maintain a regular pressure, free from sudden changes or shocks. This can be accomplished by several methods, but the simplest and one as reliable as any other is the following, devised some years since by Mr. O. B. Stillman:

This apparatus consists of a pump (Blake or other suitable pattern), an air-tight receiver similar to an ordinary *montejus* in shape, and a damper-regulator.

In the bottom of the receiver there is a central depression. The discharge-pipe from the pump connects directly with the receiver; the feed-pipe to the presses passes through the top of the receiver and dips to the central depression; connection with the damper-regulator is made by means of a small tube leading from the top of the receiver. The lever of the regulator is connected with the steam-inlet to the pump. The operation of the apparatus is as follows:

The pump is started and forces the liquor into the receiver, whence it passes through the feed-pipe to the presses. When the pressure exceeds that required the lever on the regulator raises and partly or entirely closes the steam-inlet to the pump, and as soon as the pressure falls below the limit the steam-valve is automatically opened.

The use of this apparatus relieves the press-man from the necessity of regulating the pump. The pressure increases or decreases gradually, hence the presses work to the best advantage. This device is employed at the Soledad Estate, near Cienfuegos, Cuba, and gives perfect satisfaction.

ANALYSES OF SUGARS.

TABLE V.—*First sugars.*

Date.	Lot.	Sucrose.	Date.	Lot.	Sucrose.
1886.		*Per cent.*	1886.		*Per cent.*
Nov. 22	13	99.0	Dec. 6	27	99.1
24	14	99.3	9	28	98.7
24	15	98.8	9	29	98.0
25	16	99.1	10	30	98.2
26	17	99.3	12	31	98.8
28	18	99.5	13	32	99.0
28	19	98.5	15	33	99.2
29	20	97.8	17	34	98.7
30	21	98.9	17	35	99.2
Dec. 1	22	98.9	19	36	98.9
2	23	98.8	20	37	98.8
3	24	97.8	21	38	98.9
4	25	97.8			
6	26	99.2	Mean	......	98.78

[1] Chem. Bulletin No. 11, p. 16.

TABLE VI.—*Second sugars.*

Date.	Lot.	Sucrose.	Date.	Lot.	Sucrose.
1886.		*Per cent.*	1886.		*Per cent.*
Nov. 22	1	90.6	Dec. 10	9	91.3
26	2	91.4	15	10	91.5
29	3	92.6	19	11	91.6
Dec. 1	4	85.2	22	12	92.8
3	5	88.1	22	13	90.8
5	6	90.5			
7	7	89.2	Mean.	......	90.3
9	8	89.1			

The first sugars graded "off white," the seconds were boiled to string proof. But two sugars were made.

ANALYSES OF MOLASSES.

TABLE VII.—*Analyses of molasses from first sugars.* (*II Molasses.*)

Date.	Lot.	Degree Baumé.	Degree Brix.	Sucrose	Reducing sugars.	Sucrose at 50° Brix or 27°.2 Baumé.	Reducing sugars at 50° Brix or 27°.2 Baumé.	Coefficient of purity.
				Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	
Nov. 25	16	30.9	57.08	35.00	5.88	30.66	5.15	61.32
26	17	29.9	55.20	35.70	6.25	32.34	5.66	64.68
28	19	28.8	53.24	33.00	6.45	31.02	6.06	62.04
29	20	29.2	53.84	34.00	5.00	31.57	4.64	63.15
30	21	28.9	53.30	34.20	4.00	32.08	3.75	64.16
Dec. 1	22	30.3	56.00	36.70	5.40	32.85	4.83	65.54
2	23	26.8	49.20	32.00	5.00	32.51	5.08	65.02
3	24	29.6	54.70	35.00	6.37	31.99	5.82	63.98
9	28	29.7	54.90	36.20	5.40	32.96	4.92	65.92
12	31	29.1	53.70	38.80	4.63	36.12	4.31	72.24
13	32	29.6	54.70	37.00	5.62	33.82	5.14	67.63
15	33	29.1	53.70	37.10	4.83	34.54	4.49	69.08
17	34	30.1	55.50	39.80	4.83	35.86	4.35	71.72
17	35	30.1	55.50	38.50	4.44	34.69	4.00	69.38
19	36	29.5	54.50	38.40	3.97	35.23	3.64	70.46
20	37	28.7	52.80	38.70	5.71	31.91	5.40	63.83
Means	......	29.4	54.24	35.94	5.24	33.13	4.83	66.26

TABLE VIII.—*Analyses of molasses from second sugars.* (*III Molasses.*)

Date.	Lot.	Degree Baumé.	Degree Brix.	Sucrose, single polarization.	Sucrose, double polarization.	Reducing sugars.	Sucrose, single polarization at 76° Brix or 40°.3 Baumé.	Sucrose, double polarization at 76° Brix or 40°.3 Baumé.	Reducing sugars at 76° Brix or 40°.3 Baumé.	Coefficient of purity (based on single polarization).
				Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	
Nov. 26	1	40.8	76.92	32.80	39.90	19.75	32.41	39.42	19.51	42.64
26	2	40.3	75.92	32.30	40.07	19.60	32.46	40.20	19.67	42.71
Dec. 2	3	41.5	78.51	33.40	41.21	13.90	32.23	39.78	13.41	42.41
2	4	40.5	76.41	32.80	40.39	13.15	32.66	40.21	13.09	42.97
3	5	40.5	76.43	32.90	40.62	13.90	32.75	40.44	13.84	43.09
7	7	34.8	64.85	28.80	....	11.42	33.71	....	13.36	44.35
9	8	40.1	75.48	31.20	39.48	13.80	31.30	39.24	13.94	41.18
10	9	42.2	79.91	32.50	40.61	15.74	31.62	39.40	15.31	41.61
15	10	41.9	79.31	33.70	40.68	14.04	32.27	38.95	13.44	42.46
19	11	41.7	78.86	35.00	42.20	13.80	33.78	40.72	13.31	44.46
Means	......	40.5	76.26	32.54	41.13	14.91	33.52	39.62	14.89	42.79

It will be noticed in the above tables that the analyses have been reduced to the basis of a molasses of a stated density. This facilitates the comparison of the results, the percentages being directly comparable with one another.

The arbitrary density 50° Brix (Baumé 27°.2) has been taken for molasses from firsts and 76° Brix (Baumé 40°.3) for molasses from seconds.

Fifty and seventy-six degrees Brix were selected as standards of comparison, since they represent approximately the average densities of molasses from first and second sugars.

LOSS OF SUGAR IN THE PROCESSES OF MANUFACTURE.

Unless careful arrangements for measurements are provided it is almost impossible to trace losses in manufacture. At Magnolia there is no provision for measuring either sirups or *masses cuites*. The quantities of cane juice, sugars, and molasses are accurately known, and they, together with the analytical work, are the basis for the following calculations:

Loss of sugar in the processes of manufacture.

[Data for calculations.]

First sugar (98°.78 polarization), per ton of cane........................pounds..	120.47
Second sugar (90°.30 polarization, .50 per cent. glucose) per ton of cane.do....	40.53
Molasses (41°.13 double polarization, 14.91 per cent. glucose, 76°.26 Brix), per ton of cane ....pounds..	58.17
Press cake (7°.51 polarization .30 per cent. glucose), per ton of cane...do....	20.15
Sucrose in juice ....per cent..	13.50
Glucose in juice..do....	.61
Juice per ton of cane..pounds..	1,560.00
Sucrose per ton of cane:	
In first sugars..pounds..	119.00
In second sugars..do....	36.60
In press cakes..do....	1.51
In molasses..do....	23.93
Total sucrose accounted for as above ....do....	181.04
Total sucrose in juice extracted..........................do....	210.60
Sucrose to be accounted for..........................do....	29.56
Sucrose in juice extracted..	210.60
Sucrose in sugars and press cake	157.11
Sucrose that would pass into the molasses were there no losses in manufacture..	53.49
Glucose per ton of cane:	
In the juice extracted ....pounds.	9.52
In the second sugars, .20 pounds; press cake, .06 pounds.........do....	.26
Glucose that would pass into the molasses were there no losses in manufacture	9.36

Assuming that had there been no inversion and no losses in evaporation, &c., the molasses would have contained the same proportion of non-sugars as the actual molasses did, we obtain the following:

	Theoretical composition of molasses.	Actual composition of molasses.
Sucrose ....per cent..	47.77	41.13
Glucose ....do....	8.27	14.91
Degree Brix	76.26	76.26
Glucose, per cent. sucrose...	17.31	36.25
Coefficient of purity.........	62.64	53.93
Pounds molasses	111.97	58.17

The actual loss from inversion is the difference between the sucrose in the theoretical molasses and the actual: 47.77—41.13 = 6.64 per cent. sucrose inverted, based on the weight of the molasses; 58.17 × .0664 = 3.86 pounds of sucrose per ton of cane.

The difficulty is to exactly locate this inversion. The analyses of juices and sirups show very little inversion between the juice box and the vacuum-pan, but the actual extent of this inversion could not be determined.

The beet-sugar manufacturers charge about .60[1] per cent. the weight of the beets of sucrose to loss in the evaporation and bone-charcoal filters. This is based on an average sugar content in beet about the same as that in our cane. This corresponds to a loss of 12 pounds of sucrose.

RÉSUMÉ.

Sucrose extracted in the juice per ton of cane	pounds..	210.60
Sucrose in sugars, molasses, and press-cake per ton of cane	do....	181.04
Sucrose inverted	do....	3.86
Sucrose lost in evaporation and bone-black	do....	12.00
Total sucrose accounted for	do....	196.90
Total percentage of the sucrose accounted for		93.49
Total percentage of the sucrose unaccounted for		6.51
		100.00

Accounting for the sucrose on a basis of the weight of the juice we have:

Sucrose, per cent. juice.

First sugars	pounds..	7.628
Second sugars	do....	2.346
Molasses	do....	1.533
Press-cake	do....	.097
Inverted	do....	.248
Lost in evaporation, &c	do....	.768
Unaccounted for	do....	.880
		13.500

[1] Fabrication du Sucre. Horsin-Deon, p. 133.

It will be seen from the above table that there is a large proportion of sugar unaccounted for, even after a liberal deduction for losses in evaporation, filtration, &c. This loss of sugar should be located, if possible. Unfortunately the available data are insufficient to do so this season, and this important problem must be left to another crop.

SUMMARY OF DATA COLLECTED AT MAGNOLIA STATION, SEASON OF 1886–'87.

Governor Warmoth kindly allowed me free access to the records of the sugar-houses, from which the following data were obtained:

TABLE IX.—*Tons of cane worked, weight of juice extracted, per cent. of extraction, weight of first and second sugars and molasses per ton of cane for each of the four periods*[1] *into which the season was divided.*

Period.	Cane worked.	Juice extracted.	Extraction.	Weight of sugar per ton.		Molasses per ton.
				First sugar.	Second sugar.	
	Tons	*Pounds.*	*Per cent.*	*Pounds.*	*Pounds.*	*Pounds.*
First period	2, 113. 76	3, 225, 385	76. 29	116. 40	36. 27	54. 05
Second period	2, 410. 72	3, 848, 740	79. 82	124. [illegible]6	43. 75	63. 12
Third period	920. 47	1, 430, 881	77. 72	111. 57	34. 16	48. 53
Fourth period	1, 758. 35	2, 757, 870	78. 42	124. 43	44. 59	61. 06
Total	7, 203. 30	11, 262, 876	Means: 78. 17	120. 47	40. 53	58. 17

[1] The divisions of the season into periods were arbitrary, and were made when bad weather or other cause of delay permitted a thorough cleaning of the house.

Per cent. of yield, sugars	8. 05
Per cent. of yield, first sugar	6. 02
Per cent. of yield, second sugar	2. 03
Pounds first sugar (polarization 98°.78) per ton of cane	120. 47
Pounds second sugar (polarization 90°. 03) per ton of cane	40. 53
Total sugar per ton of cane	161. 00
Per cent. of total sugar obtained in first product	74. 82
Per cent. of total sugar obtained in second product	25. 18
Total number of acres of cane rolled	590. 81
Total tons of cane rolled	7, 203. 3
Tons of cane per acre	12. 19
Total pounds of sugar made	1, 159, 768
Pounds of sugar per acre	1, 962. 6
Total pounds molasses made (11.6 pounds per gallon)	418, 563
Pounds molasses per acre	708. 45
Pounds molasses per ton of cane	58. 1

TABLE X.—*Comparison of yield of sugar and molasses, seasons of* 1884–'85, 1885–'86, *and* 1886–'87.

	1886–'87.	1885–'86.	1884–'85.
Yield of first and second sugars ... per cent..	8. 05	7. 43	6. 87
Yield of all sugars ... do....	....	....	[2]7. 92
Yield of first and second sugars per ton of cane.. pounds..	161. 00	148. 75	137. 39
Yield of molasses per ton of cane ... do....	58. 17	....	58. 25

[2] In 1884–'85 three sugars were made.

EXPERIMENTS IN FILTRATION.

When in New Orleans in November I received an invitation to visit the experiment station and witness a test of the Kleemann process for the filtration of the juice. This test on a small scale was very successful, and demonstrated clearly that all the juice could easily be filtered through presses.

This process was invented by Fritz Kleemann, of Schoeningen, Brunswick, Germany. It has been patented in all sugar-producing countries.

The first tests on a large scale with cane were made in Demerara at the following estates: Nonpareil, Lusignan, Enmore, and others. The Nonpareil sugar-houses filtered the juice from 400 long tons of cane per day, through eight presses of eighteen chambers each. These tests were made in May, 1886, since when the process has been introduced into Porto Rico and Cuba.

The following description of the process was given me by Mr. Ernst Schulze, representing the owners of the process:

The raw juice is treated in the defecators or clarifiers with lime, as usual, except that smaller quantity is required. The juice is then heated to a temperature between 160° and 180° Fahr., and finely ground lignite or brown coal is added. The lignite must be reduced to as fine a state of division as is practicable. The quantity of lignite to be added varies with the amount of sugar contained in the juice, and ranges from 5 to 10 per cent. of the weight of the sugar. The temperature of the mixture is maintained at from 150° to 170° Fahr. fifteen or twenty minutes, and is then pumped to the filter-presses. The filtered juice passes directly to the evaporating pans, and the sirup without further clarification or settling can be immediately boiled in the vacuum-pan.

The juice left in the press-cake in the presses is obtained by displacement with cold water.

One thirty-chamber Kroog press will filter 20,000 gallons of juice treated by the Kleemann process in twenty-four hours, ample time being allowed for displacement of the juice left in the press-cake and for cleaning the presses, changing cloths, &c. An ordinary laborer can manipulate the presses.

The amount of precipitate retained by a thirty-chamber press will average 770 pounds. This precipitate contains 50 per cent. of its weight of juice, nearly all of which can be obtained by displacement.

The amount of press-cake per ton of cane is approximately 46 pounds, half of which is juice containing an average of about 13 per cent. sucrose. Were this juice thrown away with the press-cake it would entail a loss of $46 \times .50 \times .13 = 3$ pounds sucrose per ton of cane worked.

Even at a low valuation per pound for sucrose, this loss, amounting to nearly 30,000 pounds of sugar for an average crop at Magnolia, is a very large item. These figures are based on an extraction of 78 per cent. of juice from the cane.

The Kroog presses are provided with a graduated juice-box for measuring the amount of displaced juice. Practice has demonstrated that the theoretical amount of water required to displace the juice from the cakes is not sufficient, consequently a little more is always used. The quantity for a twenty-four-chamber press is 160 litres, and for a thirty-chamber press 200 litres of water.

Mr. Heine, of St. Burghard, near Halberstadt, Germany, made a number of experiments to determine the effect of using too much water. He analyzed the juice at different stages of the displacement process. The press used was a twenty-four chamber, Kroog system.

The normal juice from the presses had a coefficient of purity of 83.38.

The results of these experiments are given in the following table. Under the column marked "litres" the quantity of displacement water is indicated:

Litres.	Degree Brix.	Sucrose.	Coefficient of purity	Lime salts in 100 parts of dry matter in the juice, not precipitated by carbonic acid. Weighed as CaO.
		Per cent.		
40	9.23	7.78	84.29	0.9010
80	8.40	7.13	84.87	0.9095
120	7.83	6.41	81.89	0.9820
160	7.00	5.70	81.43	1.1265
200	5.50	4.15	75.04	1.6464
240	3.10	2.15	69.36	2.9750
280	1.83	1.04	56.83	5.1745
320	0.93	0.43	46.23	8.7973
360	0.80	0.31	38.75	12.0902

The water employed in these experiments was cold. The reason for limiting the quantity of water to 160 litres per twenty-four-chamber press is evident from an inspection of the above table.

KLEEMANN PROCESS.

In reply to a letter of inquiry, Mr. Kleemann, the inventor of this process, has kindly given me a detailed plan for working. The following extracts from his letter will be of interest to the planters:

The charcoal you mention as having used I suppose was vegetable charcoal ground to a fine powder. * * * Certainly you have employed a substance that next to brown coal is the best aid to filtration, owing to its specific gravity and its absorbing powers of mucilaginous matters. Certain precautions, however, have to be adopted in its use, and its price compares unfavorably with that of brown coal. Even when close-woven filter-cloth is used in the press, fine particles of char have a tendency to pass through the cloth along with the juice for some time after filtration[1] has started, and this liquor has to be turned back to be filtered over again after a suffi-

[1] This difficulty was not met with in the experiment at Magnolia. G. L. S.

ciently fine filtering surface of feculent matters and charcoal has been formed on the surface of the cloth.

Juice treated with brown coal, on the other hand, runs quite bright or nearly so from the first running of the press, decolorizes considerably, and the cakes formed in the press part easier with their sugar when it is desired to wash them out than cakes formed of vegetable char.

For your future guidance allow me to suggest what I consider the best mode of treating juice with brown coal to effect rapid and good filtration and at the same time use the minimum amount of brown coal in the operations. I make this suggestion on the supposition you are carrying out your experiments on an estate containing all the most modern appliances for successfully treating after it has been filtered, namely, double or triple effects vacuum-pans and centrifugals.

After the juice has been defecated in the usual manner allow it to subside for a few minutes, then brush off the skimmings into a tank and run the juice into another (preferably a circular one fitted with revolving stirrers), where the brown coal has to be added. As soon as the bottoms are reached they also have to be run into the skimmings tanks. The brown coal is now added to the tank containing the juice, and after being thoroughly mixed it is forced through the filter press, finishing off with a pressure of about 75 pounds per square inch. In some cases 50 to 60 pounds pressure will be found quite sufficient, and a speed in the filtration ought to be obtained of 9 gallons per square foot of filtering area per hour, or for a press containing 400 square feet of filtering area 3,600 gallons per hour of filtered liquor. After the thin juice has been brought to about 20° Baumé in the triple effect, certain albuminous compounds that were soluble in thin juice now[1] precipitate out at the higher density, and it is necessary to again add some ascertained proportion of brown coal to the liquor and pass through a press before being taken into the vacuum-pan.

By the action of the brown coal the liquor is considerably decolorized at this point, and as all gummy matters have been previously taken out of the juice the liquor will filter through rapidly by simple gravitation from a tank situated 6 to 10 feet above the press. The cakes taken from this press are used over again for the filtration of the defecated juice. The skimmings and bottoms are mixed either with fresh brown coal or with that taken from the gravitation-press and filtered in a press by themselves. By dividing the work in the manner I have suggested, more work can be got through in a given time, with better results and using a smaller proportion of brown coal, than if it had been added to the juice, skimmings, and bottoms together in the defecating tank.

Tests were made on a laboratory scale with lignite from Avery's Island. The results were very satisfactory. It is proposed to repeat these experiments on a large scale.

TEST OF THE KLEEMANN PROCESS AT MAGNOLIA.

Early in December, at the request of Mr. D. D. Colcock, of the Sugar Exchange, New Orleans, the Commissioner of Agriculture directed me to test this process on a practical working scale.

A sufficient quantity of lignite could not be procured, so, in accordance with the suggestion of Mr. Ernst Schulze, representing the owners of the process, finely ground charcoal was substituted. Experiment

[1] This was not the case in the experiment at Magnolia. The sirup remained perfectly clear without the slightest trace of precipitate. There was no necessity for a subsequent settling or filtration of the sirup. G. L. S.

on a small scale showed that a slight modification of the process must be made where charcoal, bituminous coal, or certain other substitutes for lignite are employed.

The clarifiers at Magnolia are of the ordinary form and have a capacity of 533 gallons. The filter-presses were manufactured by the Hallesche Maschinenfabrik, of Halle, Germany. An ordinary piston-pump was used to force the juice through the presses. The juice was limed as usual, *i. e.*, to neutrality. In order to determine the amount of charcoal required, experiments were made with varying quantities.

(1) Ten per cent. of the weight of the sugar in the juice.

(2) Seven and a half per cent.

(3) Five per cent.

Any difficulty in filtration would indicate too little charcoal. As a result of this experiment it was found that the juice filtered equally well with 5 per cent. as with 10. Five per cent. is probably as little as could be successfully employed.

The juice was rapidly heated to the boiling point, after liming, before the addition of the charcoal. The charcoal having been added the mixture was boiled and stirred thoroughly for ten or fifteen minutes and then forced through the presses.

One twenty-one-chamber press filtered 2,670 gallons of juice in three hours, at the end of which time it was opened and the press-cake removed. The chambers of these presses are not as large as those of the Kroog presses.

The filtered juice was perfectly clear and bright. It was immediately converted into sirup in the double effect. This sirup was as bright as the filtered juice. A portion of the sirup after standing several days in a glass vessel did not show the slightest sediment.

Analyses were made of the juice at frequent intervals during the work. A portion was taken from each sample for the determination of the albuminoids.

The proportion of albuminoids are expressed, in the table, both as a percentage of the weight of the juice and in terms of the sucrose.

The first sample of the juice was taken from the first clarifier; and the first sample of clarified juice from the first portion of the filtered juice, consequently these samples represent the same juice before and after clarification. The rest of the samples were taken at intervals from the presses and from every third clarifier of juice.

The average of these results will represent as nearly as possible the same juice before and after treatment.

TABLE XI.—*Showing analyses of juices before and after treatment by Kleemann process.*

Number.	A. Total solids (degree Brix.)	A. Sucrose.	A. Albuminoids.	A. Albuminoids per cent. sucrose.	A. Coefficient of purity.	B. Total solids (degree Brix.)	B. Sucrose.	B. Albuminoids.	B. Albuminoids per cent. sucrose.	B. Coefficient of purity.	B. Charcoal per cent. sucrose.
	Pr. ct.	*Pr. ct.*	*Pr. ct.*			*Pr. ct.*	*Pr. ct.*	*Pr. ct.*			
1	16.01	14.89	.2500	1.68	93.00	15.31	14.89	.1563	1.05	97.25	10.0
2	16.19	13.54	.1625	1.20	83.64	14.29	12.27	.1438	1.17	85.86	10.0
3	16.06	13.53	.2188	1.62	84.24	16.66	14.53	.1313	.90	87.21	10.0
4	16.57	14.13	.1875	1.32	85.27	16.93	14.78	.1369	.93	87.30	10.0
5	15.96	13.41	......	....	84.02	16.16	13.60	......	....	84.16	7.5
6	16.09	13.61	.2188	1.60	84.59	16.76	14.60	.1625	1.10	87.11	7.5
7	15.47	13.04	.2625	2.01	84.29	16.81	14.62	.1625	1.10	86.97	7.5
8	15.97	13.34	.3062	2.29	83.53	17.56	14.90	.1613	1.08	84.85	7.5
9	14.51	11.81	.2938	2.48	81.39	17.01	14.43	.1338	1.27	84.83	7.5
10	15.27	12.43	.2563	2.06	81.40	17.47	14.75	.1875	1.27	84.43	7.5
11	15.21	12.82	......	....	84.28	17.44	14.65	......	....	84.00	7.5
12	15.70	13.17	.2375	1.80	83.88	17.30	14.76	.1762	1.19	85.32	5.0
Means	15.75	13.31	.2394	1.81	84.46	16.47	14.40	.1552	1.11	86.60	......

Average increase in coefficient of purity equals 2.14.

In the preceding table column A represents raw juices, column B juices treated by Kleemann process. Referring to the table we find the average increase in the coefficient of purity by the ordinary process to be 1.24. Table XI shows an increase of 2.14 by the Kleemann process. This large increase in the purity of the juice would give a decided increase in the yield of sugars.

THE ALBUMINOIDS.

The reduction in the percentage of albuminoids was not as large as by the ordinary process. By the Kleemann process an average of 35.17 per cent. of the albuminoids were removed; by the ordinary process the reduction was nearly 45 per cent. I do not know to what extent this difference in the albuminoids would affect the working of the sirup. The sugarmaker reported that the sirup made by the Kleemann process in this test worked as easily as by the ordinary.

THE PRESS-CAKE.

The following analysis of the press-cake shows its value as a fertilizer:

Per cent. moisture	46.08
Per cent. phosphoric acid (P_2O_5)	1.64
Per cent. nitrogen	.42
Pounds phosphoric acid per ton	32.8
Value of phosphoric acid, at 9 cents per pound	$2.95
Pounds nitrogen per ton	8.4
Value of nitrogen, at 19 cents per pound	$1.60
Total commercial value, per ton	$4.55

This process yields twice as much press-cake as the ordinary.

ADVANTAGES OF THE KLEEMANN PROCESS.

The increased coefficient of purity is not the only advantage of this process. There is an increase in the yield of sugar due to rapidity of working both juice and sirup. The quantity of sugar lost in the scums is reduced to a minimum, and the expense for labor is less.

In addition the press-cake is in an excellent mechanical condition for use as a fertilizer.

This process certainly merits a more thorough test both by the Department and the planters. Lignite of good quality, I am informed, is abundant near the sugar area of Louisiana, and can be obtained at a small cost.

CUBAN SUGAR-HOUSES.

Although the average Cuban sugar-house does no better work than the average in Louisiana, there are many estates where the results obtained are as good, if not better, than those of this country.

The enormous size and the great strength of the milling machinery is very noticeable. The carts are backed up to the carriers upon which the cane is thrown without attempting to place each stalk lengthwise of the carrier, as is usual in Louisiana. The mills are fed very heavily. The average percentage of extraction of the juice is low. This is largely due to the woodiness of the cane. The proportion of marc or fiber is considerably higher than in Louisiana.

On leaving the mill the juice passes through a calorisator, which utilizes the waste heat from the double or tripple effect and condenses a large proportion of the vapors. This is a double economy. It reduces the quantity of water required for the house and effects a notable saving in consumption of fuel. Very few Cuban sugar-houses have a sufficient supply of water.

After leaving the calorisator the juice is conducted into double-bottom pans of 750 gallons capacity, termed defecators. Here it is limed and heated to the boiling point, then settled. The clear juice is drawn off and the scum and settlings are run into "blow-ups." The contents of the "blow-ups," after heating to the boiling point, are filter-pressed as at Magnolia. The clear juice, including that coming from the filter-presses, is immediately concentrated.

Many of the houses still employ high-pressure vacuum-pans. The best practice for obtaining a maximum yield of first sugar is to make a medium grain, boiling at as low a temperature as possible and discharge the *masse cuite* as stiff as the strike-valve of the pan will permit. The *masse cuite* is dropped into wagons and left several hours to become cold.

Through the courtesy of Mr. E. F. Atkins, of Soledad, I am enabled to present a table showing the work of his house last season. This house employs double-milling. The treatment of the juice is essentially that described above. The Soledad estate is the property of Messrs. E. Atkins & Co, of Boston. It is located on the Caunao River, about 15 miles from Cienfuegos.

Monthly results of work on Soledad estate for year 1886.

	January.	February.	March.	April.	May.	Entire crop.
Juice from cane	66.79	66.73	66.94	65.77	65.25	66.30
Density of juice Baumé	9.40	10.17	10.70	11.09	11.19	10.49
Polarization of juice	15.29	16.32	17.10	17.46	18.20	16.87
Coefficient of purity of juice	88.30	88.86	88.43	88.10	90.00	88.74
Total sugars in juice	10.21	10.89	11.44	11.48	11.87	11.18
Yield of first sugars from cane	7.89	8.50	9.02	8.88	8.98	8.66
Test of first sugars	96.61	96.70	96.40	96.60	96.31	96.52
Yield of second sugars from cane	1.49	1.53	1.82	1.75	2.08	1.74
Test of second sugars	88.00	86.60	86.80	86.80	86.87	87.01
Total sugars from cane	9.38	10.03	10.84	10.63	11.06	10.40
Test of first molasses	50.36	53.63	54.10	53.20	54.56	53.17
Test of second molasses	38.10	38.00	41.50	39.70	40.43	39.55
Yield of first sugars, calculated into pure sugar of 100 polarization	7.62	8.22	8.70	8.58	8.64	8.35
Yield of second sugars, calculated into pure sugar of 100 polarization	1.31	1.32	1.58	1.50	1.81	1.50
Total yield of sugars, calculated into pure sugar of 100 polarization	8.93	9.54	10.28	10.08	10.45	9.85

Above percentages are calculated upon 100 pounds of cane ground.

Mr. Atkins is conducting a series of experiments to determine what cane will give him a maximum output of sugar at the least cost. Such experiments if made in Louisiana would probably prove very valuable.

The following table gives the results of analyses of cane from experimental plots:

Analyses of canes from experimental plots.

Number.	Variety.	Date.	Per 100 lbs. cane.		Analysis of juice.						Sugar extracted from 100 pounds cane.
			Juice extracted.	Bagasse.	Solids.	Density, Baumé.	Coefficient of purity.	Polarization.	Glucose.	Impurities.	
1	Crystalina	Mar. 26	72.78	27.22	20.9	11.6	91.8	19.2	.66	1.04	13.97
2	Red Ribbon	Mar. 26	73.17	26.83	20.2	11.2	91.5	18.5	.14	1.56	13.54
3	....do	Apr. 9	73.17	26.83	21.7	12.0	93.0	20.2	.10	1.40	14.78
4	Crystalina	Apr. 9	71.58	28.42	22.0	12.2	81.3	17.9	1.80	2.30	12.81
5	....do	Apr. 17	73.07	26.93	21.7	12.0	89.8	10.5	.13	2.07	14.25
6	Red Ribbon	Apr. 17	70.29	29.71	20.4	11.3	90.1	18.4	.15	1.85	12.93
7	Crystalina	Apr. 19	74.52	25.48	22.6	12.5	90.7	20.5	.20	1.90	15.27
8	Red Ribbon	Apr. 19	76.23	23.77	22.3	12.3	91.7	20.5	.15	1.65	15.63
9	Crystalina	Apr. 20	71.48	28.52	22.4	12.4	90.1	20.2	.28	1.92	14.43
10	Red Ribbon	Apr 20	71.85	28.15	21.9	12.1	91.3	20.0	.31	1.69	14.37
11	Black Java	Apr. 21	71.68	28.32	22.0	12.2	96.8	21.3	trace	.70	15.26
12	... do	Apr. 24	71.64	28.36	21.4	11.8	96.3	20.6	.08	.71	[1]14.75

[1] Sucrose in juice from 100 pounds cane.

NOTE.—Samples 1 and 2 from fields four years planted; samples 3, 4, 5, 6, 7, 8, 9, and 10, spring cane, ten months planted; samples 11 and 12, known as caña obscura field, eight years planted. The samples 1 to 10 were from river lands, 11 to 12 from side hill.

The results of these and other experiments indicate that the Black Java is the largest sugar producer for this locality.

These experiments are under the charge of the chemist of the house, Mr. F. A. Terry, of 19 Exchange Place, Boston.

CAROLINA ESTATE.

The work of the Carolina estate, near Cienfuegos, will be of great interest to Louisiana planters. Mr. John O'Bourke, the administrator of this estate, has kindly given me a statement of last season's crop. This is the only house in Cuba employing an eight-roller mill.

THE MILL.

This may be termed a combination mill, consisting of four pairs of rolls of uniform length and diameter, and driven at the same periphery speed. The rolls are so arranged in a horizontal plane that the cane passes from one pair to the next without the use of a carrier, a narrow knife only being employed.

Dimensions.

	Length.	Diameter.
	Inches.	*Inches.*
Rolls	66	33
Journals	21	14

Periphery speed of rolls from 18 to 20 feet per minute. Maximum capacity of the mill, 30 tons of cane per hour.

The bagasse is saturated with live steam between the second and third, and third and fourth pairs of rolls.

The mill is double-geared, fifteen to one, *i. e.*, fifteen revolutions of the engine to one of the rolls. The motive power is a pair of engines 21 inch cylinders and 41 inch stroke. The steam for the house is furnished by six boilers 40 by 6 feet; two flues. The milling machinery was built by Brissonneau, Fréres & Cie, of Nantes, France.

TREATMENT OF THE JUICE.

The juice is defecated in the usual manner. The clear juice is drawn off and is clarified by boiling and skimming. The sirup is boiled, as at Magnolia, in a high-pressure pan. The *masse cuite* falls directly into the mixer and is centrifugaled hot. Two molasses sugars are made.

Statistics of the crop of 1886.

Cane ground (2,000 pounds)	tons..	33,750.87
Juice extracted	per cent..	68.15
Sugars extracted	do....	10.637
First sugar	do....	7.534
Molasses sugar	do....	3.103
Sugar made	pounds..	7,948,525
Sugar per ton of cane (2,000 pounds)	do....	212.74

Unfortunately this house does not employ a chemist, consequently these figures are of but little value for comparison with those obtained at Magnolia.

The mangement of the Carolina estate should be congratulated upon the neatness and the sytematic working of the sugar-house.

CENTRAL SAN LINO.

Reports of a successful burner for bagasse led me to visit this estate.

The American planters are probably aware that the handling of the bagasse is a large item in the expenses of a Cuban estate. The bagasse is carted to the yard and spread out to dry. After drying it is carted back to the sugar-house and is deposited in front of the boilers. It requires a large force of firemen to handle this material.

At San Lino the green bagasse is handled in a different manner from the above, and is burned directly after leaving the mills. This method of burning bagasse is known as the "Sodal."

This invention consists in a plan for burning green bagasse or any other damp combustible. The combustion of the bagasse itself dries the fresh bagasse, which is fed to the fires from the end opposite to the grate bars. A very simple device is employed to carry the fuel to the fires. It requires ten minutes to transport the bagasse the length of boilers, in which time the flames passing over it evaporate a large proportion of the moisture.

The apparatus for charging the furnaces is driven by an independent engine and is perfectly automatic in its operations. This apparatus has reduced the number of laborers employed by about 150 men. In addition, the house is enabled to work in all kinds of weather now that it is not dependent upon the sun to dry its fuel. This process is especially applicable to large houses rolling thirty to forty or more tons of cane per hour.

Through courtesy of the owners, Messrs. Montalvo, and M. Boulanger, chemist of this house, I have obtained the following statistics, showing average of several seasons' work of this house.

Statistics of crops at San Lino.

	December.	January.	February.	March and April.
Extraction, per cent	71.50	70.90	70.29	69.80
Baumé	8.00	8.80	9.50	10.50
Brix	14.20	15.50	16.80	18.60
Sucrose, per cent	11.50	13.02	15.09	16.75
Glucose, per cent	1.45	1.10	0.70	0.65
Coefficient of purity	80.99	84.00	89.82	90.04
Glucose, per cent. sucrose	12.60	8.44	4.62	3.88
Masse cuite, per cent. cane	11.09	12.34	13.40	13.99
Yield of first sugar from masse cuite	64.00	65.59	66.40	67.90
Yield of first sugar, per cent. cane	7.10	8.10	8.90	9.50
Yield of second sugar, per cent. cane	0.85	1.10	1.45	1.55
Polarization of first sugar	95.50	96.00	96.50	97.00

CENTRAL SUGAR-HOUSES.

The manufacture of sugar in Cuba is gradually being consolidated into large houses, the smaller estates furnishing the cane.

The Cuban manufacturers are beginning to realize what the Germans long since learned, viz, that it is more profitable for the sugar-house to attend to the manufacture only and leave the agriculture to tenants or independent farmers.

This system should be adopted by the planters of Louisiana. Our houses are too small to be worked economically. One house making 10,000,000 pounds of sugar can manufacture for a far smaller proportionate cost than three estates working three and a third millions each.

One of the owners of the largest houses in Cuba and probably the largest cane-sugar house in the world, told me that on the scale in which they manufacture (175,000 to 200,000 pounds per day) they make good profits even with the present prices. This house purchases its cane from tenants and independent farmers at a price dependent upon the average market value of sugar for each month. Hence, if the price of sugar rises, the cultivator profits by the rise; if it falls he divides the loss with the manufacturer. In these contracts, which are made for a term of years, it is specified that the density of the juice must not fall below a certain degree, but if it should, the manufacturer pays a lower price for the cane. The time of harvesting and the price to be paid for burnt cane in case of the fields being swept by fire also enter into these contracts.

THE ECONOMY OF STEAM.

The cost of fuel is a very large expense on Cuban estates, especially if this fuel is coal, which must be imported from other countries. The best houses employ every device for economy of combustible.

The evaporation is conducted in multiple-effect pans. The juice is pumped from the mill to a calorisator, consisting of a large number of tubes about which the vapors from the last pan of the system circulate, and accomplishes a large proportion of the condensation. This is a very considerable economy. In the final concentration in the strike-pan exhaust steam at about five pounds pressure is employed.

I believe that the work at Magnolia could be done with a very largely reduced quantity of coal, and possibly with bagasse and a very little wood only, if these improvements were adopted. This would not include the bone-black department.

THE ANALYSIS OF SUGAR-CANE AND BEET-JUICES; WITH A TABLE FOR THE CALCULATION OF ANALYSES.

C. A. CRAMPTON.

In the routine work of cane- and beet-sugar houses the greater part consists in the analysis of large numbers of samples of juice. A method of manipulation for these analyses is therefore desirable, which will unite a reasonable degree of accuracy with considerable speed. The method and routine of analysis given below has been pursued by myself and others for several years in the work of the United States Department of Agriculture in its experiments on sorghum and sugar-cane, and found very expedient in the brief "sugar season," when the saving of time is so important an object.

For very accurate work, of course it is necessary to weigh out the sample of juice taken for analysis, but for all ordinary purposes the sample may be measured by volume, increasing greatly thereby the rapidity of the operation. By taking the specific gravity with accurate spindles, having their graduations well spaced, and correcting the volume taken, a very close approximation to the actual weight is obtained; this correction may be applied in two ways:

(1) By dividing the normal weight for the polariscope, or a multiple of it, by the specific gravity of the juice, to find the number of cubic centimeters of the liquid exactly corresponding to this weight, and then measuring out this quantity from a burette into a 100cc. flask, adding subacetate of lead solution, making up the volume to 100cc., filtering and polarizing. The reading of the polariscope gives directly the percentage of sugar in the juice, only multiplied by the number of times the normal weight was taken.

(2) By measuring out a certain volume of the juice, adding lead solution, making up to another definite volume, polarizing and applying the correction for specific gravity to the reading obtained.

I prefer the latter method as more expeditious and convenient, for in the other the specific gravity must be determined and the calculation made before the sample for polarization can be taken; while in the second method the specific gravity may be taken at any time through the day, and the calculation of the results postponed indefinitely.

The custom among sugar chemists in the beet-houses in France and Germany is to measure 100cc. of juice in a flask graduated to 100 and 110cc., add 10cc. of a dilute solution of subacetate of lead, filter, and polarize; the increase in volume being corrected either by reading in a 220mm. tube or by adding one tenth to the reading. I have found it more advantageous, however, to take 50cc. of the juice, add lead, and make the volume up to 100cc. This gives a much more satisfactory liquid for polarization, especially with impure juices, and the filtration is greatly facilitated. The only object attained by using 100cc. is the increase of the reading and consequent lessening of errors of observation. This is of but little importance, however, as 50cc. is three times the normal quantity for most instruments. Even this objection may be done away with by using a double length (400mm.) tube, providing the instrument used will admit of the long tube, and this is entirely practicable so far as the lucidity of the solution is concerned; for I have never failed to get clear, bright solutions by proceeding in the manner I have indicated, except in cases where juices had been allowed to stand and mucous fermentation had set in.

The detailed procedure is as follows:

Fifty cubic centimeters of the juice is measured out by means of an accurately calibrated pipette and run into a 100cc. flask; to it is added from 1 to 4cc. of a strong solution of sub-acetate of lead,[1] the whole made up to the mark with water, filtered, and polarized.

The same solution is then used for the determination of the reducing sugars by Fehling's solution, the excess of lead being precipitated by sulphate of soda. As the reduction of copper sub-oxide by sugars has been shown to be affected by the amount of dilution in which the action takes place, it is desirable to have as nearly as possible a constant amount of dilution, and the most favorable dilution is such that from 10 to 20cc. of the solution will be required to reduce the copper from 10cc. of Fehling's solution; so, for juice presumed to contain from 1 to 2 per cent. of reducing sugars, 50cc. of the solution, which has been polarized, made up to 100cc. will furnish the proper dilution; for those containing from 2 to 3 per cent., 50 to 100cc., and so on. In the case of juices containing less than 1 per cent. of reducing sugars the excess of lead may be removed by adding the sodic sulphate[2] before the lead precipitate is filtered off, when the same solution can be used for polarization and for the reducing-sugar determination. The copper solution used is Violette's modification, and the operation is performed in large test-tubes from 9 to 10 inches long and of about 1 to 1½-inch caliber, and the end reaction is obtained with ferrocyanide of potash and acetic acid, the small

[1] Prepared by rubbing up in a mortar 1 kilo of acetate of lead and ½ kilo of litharge and boiling with ½ litre of water.

[2] For very exact work it is better to take a separate sample of the juice for the copper test and dispense with the lead altogether if the purity of the juice admits, for the presence of lead produces an error, and even when precipitated by sulphate of soda there is said to be an error from the slight solubility of the sulphate of lead.

portion of clear liquid required being filtered out by means of Wiley's tubes, already described.[1] These tubes are simply glass tubes about 9 to 10 inches long and ¼-inch caliber. At one extremity a slight rim is made by turning back the edge while hot, and over this is stretched and tied a piece of fine linen cloth. To use the tube it is inserted into a beaker of water containing in suspension a quantity of very finely ground asbestos; by suction at the other end of the tube the linen cap is covered with a film of asbestos and it is then immediately inserted into the test-tube containing the hot precipitated Fehling solution; suction is again made on the tube and the portion of clear liquid obtained is run into a porcelain dish containing the test solution by simply inverting the tube. These tubes may be cleaned and used over and over again by washing off the asbestos film, dissolving out any sub-oxide of copper which may remain in the cloth by soaking in nitric acid and rinsing in water until they no longer taste acid. One covering of linen suffices for many tests, and when worn out it is easily replaced.

Working in this way a large number of samples can be analyzed in a day, twenty-five to thirty being generally a fair day's work for operators on the stations of the Department of Agriculture, both sucrose and glucose being determined, and also the total solids (from the specific gravity), and this number is much exceeded in case of stress of work by allowing the polarizations to stand until night, using all the daylight for glucose determinations. By having a boy measure out the samples and prepare them for analysis the amount of work done can be nearly doubled.

It remains to calculate the results obtained, and to facilitate this calculation I have compiled the following table. In it will be found the specific gravity and degree Brix,[2] and opposite to them factors for the calculation of sucrose and glucose in juices of the corresponding specific gravity, according to the method of procedure given above. Two factors for sucrose are given, one for instruments using as a normal quantity 26.048 grams, such as Soleil-Scheibler, and one for those using 16.3 grams, such as the Laurent. These factors are the quotients from division of the normal quantity by 50 × sp. gr. To use them it is necessary simply to multiply by the reading of the polariscope, the result giving directly the per cent. of sucrose in the juice. The glucose factor is simply the reciprocal of the specific gravity multiplied by ten. To use it, it is divided by the number of cubic centimeters of the normal solution (50 to 100cc.) required to precipitate 10cc. of Fehling's solution, which gives the result directly in per cent. If the solution has been diluted twice (50 to 200cc.), divide the factor by half the number of cubic centimeters required; if one and one-half times (50 to 150cc.), by one and one-half times the number of cubic centimeters required.

[1] Bull. de l'Assoc. des Chim. de Sucre. et de Dist, Apr., 1884.

[2] Taken from the tables of Mategczek, Scheibler, and Stammer, as given by Dr. Tucker in his "Manual of Sugar Analysis."

Table for the calculation of sugar juices.

Specific gravity.	Degree Brix.	Sucrose factor for instruments requiring—		Glucose factor.	Specific gravity.	Degree Brix.	Sucrose factor for instruments requiring—		Glucose factor.
		26.048 grams.	16.3 grams.				26.048 grams.	16.3 grams.	
1.0197	5.0	.5109	.3197	9.807	1.0502	12.4	.4961	.3104	9.523
1.0201	5.1	.5107	.3196	9.803	1.0506	12.5	.4959	.3103	9.519
1.0205	5.2	.5105	.3195	9.799	1.0510	12.6	.4957	.3102	9.515
1.0209	5.3	.5103	.3193	9.795	1.0514	12.7	.4955	.3101	9.511
1.0213	5.4	.5101	.3192	9.791	1.0519	12.8	.4953	.3099	9.507
1.0217	5.5	.5099	.3191	9.788	1.0523	12.9	.4951	.3098	9.503
1.0221	5.6	.5097	.3190	9.784	1.0527	13.0	.4949	.3097	9.499
1.0225	5.7	.5095	.3189	9.780	1.0531	13.1	.4947	.3096	9.496
1.0229	5.8	.5093	.3187	9.776	1.0536	13.2	.4945	.3094	9.491
1.0233	5.9	.5091	.3186	9.772	1.0540	13.3	.4943	.3093	9.488
1.0237	6.0	.5089	.3185	9.768	1.0544	13.4	.4941	.3092	9.484
1.0241	6.1	.5087	.3184	9.765	1.0548	13.5	.4939	.3091	9.480
1.0245	6.2	.5085	.3183	9.761	1.0553	13.6	.4937	.3090	9.476
1.0249	6.3	.5083	.3182	9.757	1.0557	13.7	.4935	.3088	9.472
1.0253	6.4	.5081	.3181	9.753	1.0561	13.8	.4933	.3087	9.469
1.0257	6.5	.5079	.3180	9.749	1.0566	13.9	.4931	.3085	9.464
1.0261	6.6	.5077	.3178	9.746	1.0570	14.0	.4929	.3084	9.461
1.0265	6.7	.5075	.3177	9.742	1.0574	14.1	.4927	.3083	9.457
1.0269	6.8	.5073	.3175	9.738	1.0578	14.2	.4925	.3082	9.453
1.0273	6.9	.5071	.3174	9.734	1.0583	14.3	.4923	.3080	9.449
1.0277	7.0	.5069	.3173	9.730	1.0587	14.4	.4921	.3079	9.446
1.0281	7.1	.5067	.3171	9.727	1.0591	14.5	.4919	.3078	9.442
1.0286	7.2	.5065	.3170	9.723	1.0596	14.6	.4917	.3077	9.438
1.0290	7.3	.5063	.3169	9.719	1.0600	14.7	.4915	.3076	9.434
1.0294	7.4	.5061	.3167	9.715	1.0604	14.8	.4913	.3074	9.430
1.0298	7.5	.5059	.3166	9.711	1.0609	14.9	.4911	.3073	9.426
1.0302	7.6	.5057	.3164	9.707	1.0613	15.0	.4909	.3072	9.422
1.0306	7.7	.5055	.3163	9.703	1.0617	15.1	.4907	.3071	9.419
1.0310	7.8	.5053	.3162	9.699	1.0621	15.2	.4905	.3069	9.415
1.0314	7.9	.5051	.3160	9.696	1.0626	15.3	.4903	.3068	9.411
1.0318	8.0	.5049	.3159	9.692	1.0630	15.4	.4901	.3067	9.407
1.0322	8.1	.5047	.3158	9.688	1.0634	15.5	.4899	.3066	9.404
1.0327	8.2	.5045	.3157	9.684	1.0639	15.6	.4897	.3064	9.399
1.0331	8.3	.5043	.3156	9.680	1.0643	15.7	.4895	.3063	9.396
1.0335	8.4	.5041	.3154	9.676	1.0647	15.8	.4893	.3062	9.392
1.0339	8.5	.5039	.3153	9.672	1.0652	15.9	.4891	.3061	9.388
1.0343	8.6	.5037	.3152	9.668	1.0656	16.0	.4889	.3059	9.385
1.0347	8.7	.5035	.3151	9.665	1.0660	16.1	.4887	.3058	9.381
1.0351	8.8	.5033	.3150	9.661	1.0665	16.2	.4885	.3057	9.377
1.0355	8.9	.5031	.3148	9.657	1.0669	16.3	.4883	.3056	9.373
1.0359	9.0	.5029	.3147	9.653	1.0674	16.4	.4881	.3054	9.369
1.0364	9.1	.5027	.3146	9.649	1.0678	16.5	.4879	.3053	9.365
1.0368	9.2	.5025	.3144	9.645	1.0682	16.6	.4877	.3052	9.362
1.0372	9.3	.5023	.3143	9.641	1.0687	16.7	.4875	.3051	9.358
1.0376	9.4	.5021	.3142	9.638	1.0691	16.8	.4873	.3049	9.354
1.0380	9.5	.5019	.3141	9.634	1.0695	16.9	.4871	.3048	9.350
1.0384	9.6	.5017	.3140	9.630	1.0700	17.0	.4869	.3047	9.346
1.0388	9.7	.5015	.3138	9.626	1.0704	17.1	.4867	.3046	9.342
1.0393	9.8	.5013	.3137	9.622	1.0709	17.2	.4865	.3044	9.338
1.0397	9.9	.5011	.3136	9.618	1.0713	17.3	.4863	.3043	9.334
1.0401	10.0	.5009	.3134	9.614	1.0717	17.4	.4861	.3042	9.331
1.0405	10.1	.5007	.3133	9.611	1.0722	17.5	.4859	.3041	9.327
1.0409	10.2	.5005	.3132	9.607	1.0726	17.6	.4857	.3039	9.323
1.0413	10.3	.5003	.3131	9.603	1.0730	17.7	.4855	.3038	9.320
1.0418	10.4	.5001	.3129	9.599	1.0735	17.8	.4853	.3037	9.315
1.0422	10.5	.4999	.3128	9.595	1.0739	17.9	.4851	.3036	9.312
1.0426	10.6	.4997	.3127	9.591	1.0744	18.0	.4849	.3034	9.308
1.0430	10.7	.4995	.3126	9.588	1.0748	18.1	.4847	.3033	9.304
1.0434	10.8	.4993	.3125	9.584	1.0753	18.2	.4845	.3032	9.300
1.0439	10.9	.4991	.3123	9.580	1.0757	18.3	.4843	.3031	9.296
1.0443	11.0	.4989	.3122	9.576	1.0761	18.4	.4841	.3029	9.293
1.0447	11.1	.4987	.3121	9.572	1.0766	18.5	.4839	.3028	9.289
1.0451	11.2	.4985	.3119	9.568	1.0770	18.6	.4837	.3027	9.285
1.0455	11.3	.4983	.3118	9.565	1.0775	18.7	.4835	.3026	9.281
1.0459	11.4	.4981	.3117	9.561	1.0779	18.8	.4833	.3024	9.277
1.0464	11.5	.4979	.3115	9.557	1.0783	18.9	.4831	.3023	9.274
1.0468	11.6	.4977	.3114	9.553	1.0788	19.0	.4829	.3022	9.270
1.0472	11.7	.4975	.3113	9.549	1.0792	19.1	.4827	.3021	9.266
1.0476	11.8	.4973	.3112	9.545	1.0797	19.2	.4825	.3019	9.262
1.0481	11.9	.4971	.3110	9.541	1.0801	19.3	.4823	.3018	9.258
1.0485	12.0	.4969	.3109	9.537	1.0806	19.4	.4821	.3017	9.254
1.0489	12.1	.4967	.3108	9.534	1.0810	19.5	.4819	.3016	9.251
1.0493	12.2	.4965	.3107	9.530	1.0815	19.6	.4817	.3014	9.246
1.0497	12.3	.4963	.3106	9.527	1.0819	19.7	.4815	.3013	9.243

Table for the calculation of sugar juices—Continued.

Specific gravity.	Degree Brix.	Sucrose factor for instruments requiring— 26.048 grams.	Sucrose factor for instruments requiring— 16.3 grams.	Glucose factor.
1.0824	19.8	.4813	.3012	9.239
1.0828	19.9	.4811	.3011	9.235
1.0832	20.0	.4809	.3009	9.232
1.0837	20.1	.4807	.3008	9.228
1.0841	20.2	.4805	.3007	9.224
1.0846	20.3	.4803	.3006	9.220
1.0850	20.4	.4801	.3005	9.216
1.0855	20.5	.4798	.3003	9.212
1.0859	20.6	.4797	.3002	9.209
1.0864	20.7	.4795	.3001	9.205
1.0868	20.8	.4794	.3000	9.201
1.0873	20.9	.4791	.2998	9.197
1.0877	21.0	.4790	.2997	9.194
1.0882	21.1	.4787	.2996	9.190
1.0886	21.2	.4786	.2995	9.186
1.0891	21.3	.4783	.2993	9.182
1.0895	21.4	.4782	.2992	9.179
1.0900	21.5	.4779	.2991	9.174
1.0904	21.6	.4778	.2990	9.171
1.0909	21.7	.4775	.2988	9.167

Specific gravity.	Degree Brix.	Sucrose factor for instruments requiring— 26.048 grams.	Sucrose factor for instruments requiring— 16.3 grams.	Glucose factor.
1.0914	21.8	.4773	.2987	9.163
1.0918	21.9	.4772	.2986	9.159
1.0923	22.0	.4769	.2984	9.155
1.0927	22.1	.4768	.2983	9.151
1.0932	22.2	.4765	.2982	9.148
1.0936	22.3	.4764	.2981	9.144
1.0941	22.4	.4762	.2980	9.140
1.0945	22.5	.4760	.2979	9.137
1.0950	22.6	.4758	.2977	9.132
1.0954	22.7	.4756	.2976	9.129
1.0959	22.8	.4754	.2974	9.125
1.0964	22.9	.4752	.2973	9.121
1.0968	23.0	.4750	.2972	9.117
1.0973	23.1	.4748	.2971	9.113
1.0977	23.2	.4746	.2970	9.110
1.0982	23.3	.4744	.2968	9.106
1.0986	23.4	.4742	.2967	9.102
1.0991	23.5	.4740	.2966	9.098
1.0996	23.6	.4738	.2965	9.094
1.1100	23.7	.4736	.2963	9.091