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Waianae Co.	***	Fred Meyer	Waianae
Waialua Agricultural Co.	*	W. W. Goodale	Waialua
Kahuku Plantation Co.	x*	Andrew Adams	Kahuku
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Oahu Sugar Co.	x	E. K. Bull	Waipahu
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KEY.	HONOLULU AGENTS.	
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**	W. G. Irwin & Co.	(8)
***	J. M. Dowsett	(1)
x	H. Hackfeld & Co.	(9)
*x	T. H. Davies & Co.	(8)
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x**	F. A. Schaefer & Co.	(2)
x*x	H. Waterhouse Trust Co.	(2)
‡‡	Hind, Rolph & Co.	(2)
xx	Bishop & Co.	(1)

THE HAWAIIAN PLANTERS' MONTHLY

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SUGAR PRICES FOR MONTH ENDING SEPTEMBER 18, 1906.

	Centrifugals.	Beets.
August 14	3.875¢	9s.
August 21	3.90¢	9s. 2½d.
August 28	4¢	9s. 6d.
September 4	4¢	9s. 6d.
September 11	4.0625¢	9s. 7½d.
September 18	4.125¢	9s. 11¼d.

The Cuban revolution, notwithstanding the strong efforts of the government to crush it, seems to be growing, and the situation there is becoming intense.

But three months now intervene before the next grinding season begins there, and if the disturbance continues for this period, the work on the crop will be most seriously interfered with. Undoubtedly at the present time the sugar cane is being neglected with consequent loss.

The estimates for the next season's output of Cuba's plantations show that under favorable conditions a large tonnage can be expected, in fact, that it would be a "bumper crop."

If the present disturbed conditions continue there will be a delay in getting off the cane and a consequent shortage of the output. With a shortage in the Cuban crop, and if the expected decrease in European beets materializes, the prospects for a strong market are very good.

Messrs. Czarnikow, Macdougall & Co., under date of August 31, report as follows:

The raw sugar market has been dull and uneventful throughout the week, business in spot and nearby sugars being restricted, owing to the small quantities offered, and to refiners having fair supplies for their current wants. It is probable that an advance of 1-16c. would bring out some larger parcels from Cuba and from store, but, at the most, and if holders become free sellers, the quantity thus coming on the market for prompt shipment or immediate spot delivery could hardly exceed a week's meltings.

At the same time, refiners show no fear of experiencing difficulty in replenishing their stocks once the period arrives when they shall require to do so, and they prefer to wait and pay whatever price may then be ruling, rather than advance the market now in anticipation of later wants, the extent of which will be dependent on the demand they meet with for their refined product. There is every prospect that this demand will be large enough to call for meltings reaching from 400,000 to 450,000 tons in September and October.

A factor of much importance in determining the future of the market will be the duration of the revolt in Cuba. Should it not be repressed before October, the crop prospects will be less favorable, as labor will be disorganized in the disturbed districts and the supply for later harvesting requirements will be diminished. Up to the present time it cannot be said that the coming crop has been affected by the disturbances, but the longer restoration of order is delayed, the greater will be the risk of loss to the planters.

The European beet markets showed a gain at the beginning of the week, on further purchases for American account, and this has been fully maintained. The American purchases are understood to have been limited to about 10,000 tons present crop, for September shipment, at a price on the parity of 4c. for 96° Centrifugals. New crop, October shipment, has been offered at the equivalent of 3.96c. for Centrifugals. The weather is favorable for the ripening of the roots. Today's f. o. b. quotations are: August, 9s. 5¼d.; September, 9s. 5¼d.; new crop, October-December, 9s. 1¾d.; January-March, 9s. 2½d.

There are no Javas pressing on the market. One unsold steamer cargo afloat, and another for September shipment, are held for a price about 1-16c. above our present spot market. The first Java cargo of the new crop is included in this week's receipts and two additional cargoes have since reached port of call.

Willett & Gray in their "Weekly Statistical" of September 9, say:

Visible Supply.—Total stock of Europe and America, 1,866,434 tons, against 1,404,028 tons last year at the same uneven dates. The increase of stock is 462,406 tons, against an increase of 523,167 tons last week. Total stocks and afloats together, show a visible supply of 2,106,431 tons, against 1,784,028 tons last year, or an increase of 322,406 tons.

Raws—The supply of sugars remaining unsold of the Cuba crop has now reached a point so small that the offerings for sale have nearly ceased, creating a very dull and lifeless market for raw sugars. At the same time these conditions naturally produce a steady, firm tone to the market, which is held up also by the continued upward tendency of the European beet sugar markets, caused especially at the moment by the outlook in Cuba, which, owing to the insurrection, throws some doubt on to the coming crop of sugar.

As a matter of fact, it is entirely too early to borrow trouble over the next Cuban crop.

The insurrection may be nipped in the bud at any time, and for several months the cane fields are safe from burnings, which are the only dangers of important effect.

The affair is political, entirely; a dissatisfaction with present government administration. Concessions in this regard are quite likely to be made which will satisfy the disaffectants.

There is little or no talk of annexation as being a motive for the agitation.

In fact, annexation to the United States is an impossibility during the administration of President Roosevelt, who is committed to a "square deal" for Cuba, as elsewhere.

If the Cubans are not getting a "square deal," and if the Palma government are not inclined to give it to them, then the utmost that the United States can do will be to help the Cubans to a "square deal" in their independent state, and not through annexation. The Palma government, no doubt, understands the situation perfectly, and is abundantly able to deal with it satisfactorily without assistance from the United States, and so we look for an adjustment of the present troubles without any great interference with the brilliant prospects for the next Cuba sugar crop.

Locally the statistical position gained strength for the week.

The receipts were less than requirements and stock decreased 20,000 tons.

Prices remain unchanged for last week. The holidays came in the week, following which no special activity developed.

Cuba sugars are sparsely offered at 2⅝c. c. and f. for 95° test basis, equal to 4.02c. duty paid for 96° test. Javas are offered at 10s. 9d. c. and f., a price above present market values.

Beet sugars may be had as wanted at 9s. 10½d. c. and f., equal to 4c. for Centrifugals, 96° test.

Refiners generally have a good stock on hand so that no element of actual scarcity of supplies enters into the conditions and can hardly do so until developments not due until about December relating to new crops come into the consideration.

Preliminary estimate of the European beet crops are beginning to be made, but will not prove of especial value until a few weeks later. As far as now appears the statistical position of sugar taken altogether is favorable to steady firm markets at home and abroad with a further gradual improvement in values.

Our Java cable reports shipments to Europe and the United States of 61,000 tons by steam and 3,000 tons by sail, practically all of which has United States options. The East took 114,000 tons; making the total shipments for the month of August 178,000 tons, against 205,000 tons last year, and for the campaign thus far 369,000 tons, against 538,080 tons last year. The afloats to the United States from Java are now 105,000 tons, against 300,000 tons last year.

Mr. F. O. Licht in his "Monthly Report" of August 17, reviews the European situation and gives the following information:

The consumption in the various countries was as follows:

	In the month of July.		
	1906 Tons.	1905 Tons.	1904 Tons.
Germany	124,718	102,527	107,742
Austria	49,532	43,059	43,175
France	56,000*	45,645	53,357
Holland	8,979	7,954	6,062
Belgium	7,140	5,669	8,350
England	185,165	164,205	166,366
Total	431,534	369,059	385,052
America	202,887	155,000	160,747
Total	634,421	524,059	545,799

	In the 11 months Sept.-July.		
	1905/06 Tons.	1904/05 Tons.	1903/04 Tons.
Germany	1,020,069	885,134	1,026,261
Austria	477,701	409,052	454,590
France	597,215	557,822	722,077
Holland	90,459	81,701	88,902
Belgium	75,142	69,655	88,776
England	1,675,276	1,485,053	1,474,629
Total	3,935,862	3,488,417	3,855,235
America	1,729,992	1,619,880	1,617,506
Total	5,665,854	5,108,297	5,472,741

From this there results that in this July alone, when compared with the same month of the preceding year, 110,362 tons (21.1%), when compared 1904 88,622 tons (16.2%) more were consumed; while the increase for the period commencing with September 1st amounted to 557,557 tons (10.9%) and 193,113 tons (3.5%).

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* Estimation.

Our preliminary estimate of the European beet sugar production will compare with the preceding campaigns as follows:

	1905/06 Tons.	1904/05 Tons.	1903/04 Tons.	1902/03 Tons.
Germany	2,425,000	1,598,164	1,927,681	1,762,461
Austria	1,510,000	889,373	1,167,959	1,057,692
France	1,085,000	622,422	804,308	833,210
Belgium	330,000	176,466	209,811	224,090
Holland	210,000	136,551	123,551	102,411
Total	5,560,000	3,422,976	4,226,945	3,979,864
Russia	1,000,000	953,626	1,206,907	1,256,311
Other Countries	410,000	332,098	441,116	325,082
Total	6,970,000	4,708,758	5,881,333	5,561,257

According to this the campaign of 1905/06 may reckon on an increase of about 2,260,000 tons against its predecessor, meanwhile the figures already mentioned,—for 1905/06 are only for the time.

The general position of the article may be gathered from the following statistics for Europe and North America:

COLONIAL AND BEETROOT SUGAR IN EUROPE AND NORTH AMERICA.

In the first eleven months.	1905/06 Tons.	1904/05 Tons.	1903/04 Tons.	1902/03 Tons.
Production	5,533,603	3,407,481	4,228,845	3,950,190
Imports	3,902,712	3,450,281	3,503,640	3,538,593
Stocks on 1st Sept..	870,720	1,163,265	1,577,327	1,426,201
Total	10,307,035	8,021,027	9,309,812	8,914,984
Stocks end of July..	1,850,541	1,116,110	1,622,533	1,881,058
Deliveries	8,456,494	6,904,917	7,687,279	7,033,926
Exports	2,783,231	1,831,638	2,122,195	2,314,662
Consumption eleven months	5,673,263	5,073,279	5,565,084	4,719,264
Previous 1 month..	485,713	630,429	477,858	503,967
Consumption twelve months	6,158,976	5,703,708	6,042,942	5,223,231

The production of beet sugar during the first eleven months shows an increase of 2,126,000 tons, against the preceding year.

Imports show for Europe and North America together a surplus of 452,000 tons, for Europe alone a such of 286,000 tons, while the stocks on September 1st, in Europe and North America together, were 293,000 tons smaller, in Europe alone 350,000 tons smaller, than 12 months ago. From the sum of these 3 groups of figures, there results for Europe and North America together a more of 2,286,000 tons, and for Europe alone a such of 2,062,000 tons. At the end of July the stocks in Europe and North America together were 734,000 tons, in Europe alone 621,000 tons higher, than 12 months ago, and the consumption, taking into account an increase of 952,000 resp. 951,000 tons in the exports, showed during the 11 months an increase of 600,000 tons, for Europe alone a such of 490,000 tons. But for the twelve months ending end of July, there results for Europe and North America together a increase of 455,000 tons for Europe alone a such of 338,000 tons.

NOTES.

Louisiana Planters Importing Porto Ricans.—The sugar planters of Louisiana in their dire distress for labor have turned to Porto Rico for a supply of plantation hands and have apparently completed arrangements to obtain regular shipments.

This immigration is under the auspices of the Louisiana Immigration Association, which is an organization formed by the Louisiana sugar planters for immigration purposes. The Association has established in Porto Rico what they believe to be proper recruiting connections, and havė thus insured the shipment of only desirable laborers.

That the southern States with their large population of negro laborers and their easy accessibility to the great immigration depots in the East should have to go to Porto Rico to obtain field hands is a matter which naturally causes some surprise and comment. Even the sugar planters away off here in Hawaii—over 5,000 miles from New York—have been advised and urged by high government authority to get laborers at Ellis Island, and the feasability of such a course has been urged upon our planters. But Louisiana with higher wages paid and within easy rail connection with the Eastern ports must need look elsewhere, out of the United States for a labor supply. Why, we are told that there was admitted into the United States in 1905 over one million immigrants—of whom over two hundred and twenty thousand were Italians and over five thousand Portuguese, the people who are best suited for sugar plantation work, and the very class the sugar planters here have been advised to seek, and are now spending close to half a million dollars in efforts to obtain. At Ellis Island alone during the past five years there has been admitted nearly four million immigrants and if from this vast number it is impossible for the Louisiana planters to obtain laborers, we ask what are our chances? Undoubtedly the southern employers have not neglected their opportunities of obtaining labor at home, but the statistics of distribution of the multitude of immigrants who came into the United States in 1905 show that only five thousand went to Louisana and that but forty-six thousand—about four and one-half per cent.—were destined for the States south of the Mason and Dixon line.

The south needs more laborers and to obtain these the employers are organizing and are seeking the coöperation of such Immigration Bureaus as exist in some of the States. The problems they are about to handle, and the difficulties they will encounter, are problems and difficulties with which the sugar men of Hawaii have struggled for years. The Louisana planters will conduct their operations under many advantages that do not exist in favor of Hawaii, but even so and profiting as they will by the experiences of others, the importation in large numbers of ignorant laborers will under any circumstances be attended with many difficulties.

So far as Porto Ricans are concerned, the experience of the Hawaian sugar planters has been both bad and good. When the Porto Ricans arrived here they gave the least promise as laborers, of any immigrants that ever landed in the Islands. Much of this can be laid to careless recruiting; very few of them were in a condition to do any work; the laboring population of Porto Rico at that time was sufferng from starvation and disease and no laborers were ever nursed along and fed into condition as were these people during the year following their arrival. Many never left the plantation hospitals, and they all had to be taught how to care for themselves and to live in their new surroundings.

A fair number of these people have met the situation with credit to themselves and are acquiring habits of industry that they never would have gained in their own country. There are approximately two thousand Porto Ricans now on the plantations and those now employing them would be glad to have more of the same kind. The criminal element has been weeded out of the plantations and those remaining form a body of efficient laborers who are apparently well satisfied with their conditions.

If our Louisiana friends exercise a careful supervision of the recruiting of Porto Ricans, and see to it that they are properly housed and cared for in the beginning, keep out the criminal and idle element, and exercise care in the selection of such interpreters as they may need, we believe that they will not be sorry for having opened this source of supply.

Losses Occasioned by Destructive Insects and Plant Diseases.—Probably there is no country in the world where greater losses result to agricultural products from destructive insects and plant diseases, than in the United States. In the latest year-book of the Department of Agriculture there is an appendix showing the prevalence of plant diseases and the estimated losses arising therefrom. Severe as are these losses, it is said that the depredations of insects on plant products of the soil and on live stock result in losses which annually exceed the entire expenditures of the National Government, including the pension roll and the maintenance of the army and the navy.

The value of all agricultural products of the farms of the United States for years past has exceeded $5,000,000,000, and an annual shrinkage of ten per cent. due to direct loss by insects is considered the minimum. In addition to these direct losses there is the annual expenditure devoted to the efforts to control the pests.

In 1904 the amount of loss chargeable to insect pests was figured at the enormous sum of $795,100,000, divided among the various crops as follows:

Product.	Value.	Percentage of loss.	Amount of loss.
Cereals	$2,000,000,000	10	$200,000,000
Hay	530,000,000	10	53,000,000
Cotton	600,000,000	10	60,000,000
Tobacco	53,000,000	10	5,300,000
Truck crops	265,000,000	20	53,000,000
Sugars	50,000,000	10	5,000,000
Fruits	135,000,000	20	27,000,000
Farm forests	110,000,000	10	11,000,000
Miscellaneous crops	58,000,000	10	5,800,000
Animal products	1,750,000,000	10	175,000,000
Total	$5,551,000,000		$595,100,000
Natural forest and forest products			100,000,000
Products in storage			100,000,000
Grand total			$795,100,000

The experience of the Hawaiian sugar plantations with insect pests and plant diseases of sugar cane, the losses suffered and the expenditures made in endeavoring to control them, incline us to believe that twenty per cent. would be nearer the mark so far as Hawaii is concerned than the estimate of the statistician of the Department of Agriculture. The losses from leaf hopper during the years 1901-1904, we think amounted to fully ten per cent. of each crop, to which may be added the losses from borer, rind and pineapple disease and the various root diseases, and the expenditures made to control the insects and diseases.

Enormous as is the annual loss which may now be fairly charged to insects, it would undoubtedly be vastly greater if such pests were left absolutely unchecked and no effort made to limit their operations. Were it not for the methods of controlling insect pests and the practice of these measures by progressive farmers and fruit growers the losses from insects would be greatly increased. Familiar illustrations of savings from insect losses will occur to any one familiar with the work in economic or applied entomology in this country. The cotton worm, before it was studied and the method of controlling it by the use of arsenicals was made common knowledge, levied in bad years a tax of $30,000,000 on the cotton crop. The prevention of loss from the Hessian fly, due to the knowledge of proper seasons for planting wheat and other direct and cultural methods, results in the saving of wheat on the farm value of from $100,000,000 to $200,000,000 annually. Careful statistics show that the damage from the codling moth to the apple is limited two-thirds by the adoption of the arsenical spray, banding and other methods of control, representing a saving of from $15,000,000 to $20,000,000 in the value of this fruit product alone. The existence and progress of the citrus industry of California were made possible by the introduction from Australia of a natural enemy of the white scale, an insect pest which was rapidly destroying the orange and lemon orchards, this introduction representing a saving to the people of that state of many million dollars every year. The rotation of corn with oats or other crops saves the corn crop from the attacks of the root worm to the extent of perhaps $100,000,000 annually in the chief corn producing regions of the Mississippi Valley. The cultural system of controlling the boll weavil is already saving the farmers of Texas many millions of dollars, and in fact, making the continuance of cotton growing possible.

Likewise has the control of the leaf hopper saved the day for the Hawaiian sugar planter; for had this pest gone unchecked the losses resulting in a short time would have made the profitable production of sugar in these islands an impossibility. Our planters realize to a very great degree the value of entomological work in connection with insect pests, and the debt they owe to scientific research as applied to cultivation of sugar cane.

A bulletin on "Hawaiian Waste Molasses," written by Mr. S. S. Peck, is printed in full in this number of the Planters' Monlhly and will be found replete with interesting data concerning the composition of the final molasses from Hawaiian Mills. Mr. Peck endeavors to show that the exhaustion of our molasses is governed chiefly by the viscosity of the product arising from the contained gums, and that the Java theory, which places the ratio of Glucose to Ash as a limiting factor in the recovery of sucrose, is not tenable in Hawaii. Instructive tables are presented giving the detailed analyses of many samples of this exhausted material obtained from various localities in the different islands.

CORRESPONDENCE.

WATER-DRIVEN AND BELT-DRIVEN CENTRIFUGALS.

To the Editor of the Hawaiian Planters' Monthly:

"The Comparative Test of Water-driven and Belt-driven Centrifugals at Ewa Mill," published in your June number was in some of the results so different from my experience here at Makaweli, that on October 5th and 6th, 1906, we made a similar test which, though not quite as extensive as the Ewa one, may also be of interest to those who work with both kinds of machines.

I do not believe that there was any prejudice one way or the other on the part of those who made the test at Ewa and think it is rather commendable if they—in the interest of the Plantation—wanted to find out which kind of the machines in use in their mill gives the best results. Their report shows that the belt-driven machines dried more sugar, used less fuel in a given time, dried the sugar better and discharged a molasses of lower purity than the water-driven machines. A molasses 3% lower in purity may be discharged from the Ewa water-driven machines, but in our experience here, we find no such difference. Some time ago we made a short test of only two hours duration, just to find out the difference in molasses purity. We have a double mixer, one side furnishes the massecuite to the belt-driven machines and gates on the opposite side empty into the water-driven machines, so—especially as only a few cars were used from the same strike—the quality of the massecuite was the same. The molasses purity of the water-driven machines was 33.48, that of the belt-driven ones 33.06—showing only a difference of 42%.

In the test on October 5th and 6th the third massecuite was taken out of a stone cistern holding about forty cars. Twenty cars were used altogether for both tests, the first car was emptied into the mixer, the next one put aside and so on. Quite unintentionally and rather through lack of forethought the belt-driven machines in this way received a less viscous massecuite as the material in the stone tank was slightly warm, while the water-driven machines had the cooled-off massecuite and therefore a more sticky material to work with, which fact was soon noticed when we began drying on October 6th. There is no doubt that the result of the water-driven machines, as far as sugar output and consumption of fuel is concerned, would have been better had we allowed all the cars to cool off for a few days. The figures show a difference in purity of molasses and polarization of sugar but it is small; the difference in sugar polarization is very possible as not all the machines dry the sugar alike and it is difficult to get average samples of such low polarizing sugars.

Table A—Oct. 5th, 30" Belt-Driven: Duration of test, 9 hours; motive power, 16x42 Putnam Engine; boiler pressure, 65 lbs.; coal used, lbs., 5,130.

Oct. 6th, 40" Water-Driven: Duration of test, 9 hours; motive power, 18x10x12 Duplex Pump with direct steam; boiler pressure, 70 lbs.; coal used, lbs., 3,700.

Table B—Oct. 5th, 30" Belt-Driven: No. of Centrifugals, 16; R. P. M. of Centrifugals, 1,100; size of screen, 00; lbs. sugar dried per 10 lbs. coal used, 23.88.

Oct. 6th, 40" Water-Driven: No. of Centrifugals, 6; water pressure at pump, 180 lbs.; R. P. M. of Centrifugals, 1,000; size of screen, 00; lbs. sugar dried per 10 lbs. coal used, 22.98.

Table C—Oct. 5th, 30" Belt-Driven: Purity massecuite, 46.48; purity molasses, 36.99; lbs. molasses, 46,954; lbs. sugar, 12,250; rec. of sugar%, 20.69; polarization of sugar, 81.8.

Oct. 6th, 40" Water-Driven: Purity massecuite, 46.48; purity molasses, 37.59; lbs. molasses, 35,720; lbs. sugar, 8,500; rec. of sugar %, 19.22; polarization of sugar, 82.4.

The tests at Ewa and Makaweli compared would show the following in favor of Belt-Driven Centrifugals:

Ewa.—Lower purity of molasses, 2½-3½%; larger % of recovery, 5.7; increase in polarization, 1.1½%; increase in sugar dried per gal. oil (10 lbs. coal) consumed, 30 lbs.. The capacity of one machine per hour would be: For Belt-Driven, 49.61 lbs. sugar; for Water-Driven, 75.85 lbs. sugar; or the proportion of Water-Driven to Belt-Driven machines would be: 1:1.53.

Makaweli.—Lower purity of molasses, .60%; larger % of recovery, 1.47; loss in polarization, .60; increase in sugar dried per gal. oil (10 lbs. coal) consumed, .90 lbs. The capacity of one machine per hour would be: For Belt-Driven, 85.07 lbs.; for machine per hours would be: For belt-driven, 85.07 lubs. sugar; for water-driven, 157.41 lbs. sugar; or the proportion of water-driven to belt-driven machines would be: 1:1.85.

Belt-Driven—In the Makaweli test 10 pounds of coal were needed to dry 23.88 pounds of sugar; or 1 ton of sugar would require 837.660 lbs. of coal; and 2.12 hours and 3.37 men, or an expense of 48.73 cts.; cost of coal, 209.40 cts.; total cost, 258.13 cents.

Water-Driven—In the Makaweli test 10 pounds of coal were needed to dry 22.98 pounds of sugar; or 1 ton of sugar would require 870.60 lbs. of coal; and 2.12 hours and 2.00 men; or an expense of 28.92 cts.; cost of coal, 217.65 cts.; total cost, 246.57 cents.

Difference in favor of Water-Driven per ton sugar, 11.56 cts.

Against this we ought to put the decrease in sugar recovery of 1.47% and the Belt-Driven Centrifugals would by far be the more economical machines. But I do not consider the Makaweli test conclusive; it was the first test of the kind and we have learned by the experience and will know better the next time. We had some difficulty in measuring the molasses and, as I said before, the belt-driven machines had the advantage in getting warmer massecuite to work with. We start our 40" water-driven machines empty, run them for about ten seconds and then fill them with massecuite and we get up full speed in 2¼ to 2½ minutes. If the screens are in perfect condition I see no reason why more grain should go through with the water-driven centrifugals, than with the belt-driven centrifugals.

Yours very truly,

A. FRIES,
Chemist Hawaiian Sugar Company.

HAWAIIAN WASTE MOLASSES.

By S. S. PECK,

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No product of the sugar mill presents more interesting or perplexing problems than the final or waste-molasses. It is not, of course, entirely without value, for it still has its uses as horsefeed, fuel, fertilizer, or for conversion into alcohol, but as far as the making of sugar is concerned, it is a waste-product. The bulk of the difficulties of the boiling-house is concentrated in the handling of these low-grade products, and by their success or failure in this respect is the true measure of the skill of the sugar-boiler to be estimated. In the mills of Hawaii, to each ton of sugar manufactured, there are produced from 15 to 23 gallons of molasses of a sucrose content averaging 35%. It is, therefore, of the greatest importance to be able to decide correctly whether or not the attenuation of the molasses is complete, within economic limits, and likewise to keep the amount of it down to a minimum.

The practical sugar-boiler, with a correct understanding of the behavior of his pans and the limitations of his house, can usually be relied upon to properly decide when the economical working of a molasses ceases. It has assumed a stickiness or consistency which his experience teaches him will not allow proper boiling, precluding the possibility of the separation of any more grain. The question of what causes this stickiness or to what is the loss of crystallizing power due, is a subject of much discussion. It has been variously ascribed to ash, glucose, gums, and combinations of two or all three of these. A brief resume of different opinions collected from many sources is given herewith.

We read, then, that

"Ash is supposed to be the most deleterious element, as it de-"stroys or prevents the crystallization of three to five times its "weight of sugar," (1)

"Salts act either by their invertive action or by a specific ef-"fect, differing for each salt, whereby they retain the sugar in "solution without altering its chemical composition," (2) and

"The solubility of sugar is increased by the large presence of "bodies other than sugars, notably the organic salts of potash, "while the salts of soda and inorganic salts of potash increase the "solubility of the sucrose only slightly; certain salts, as sulphate "of soda, chloride of calcium, and sulphate of magnesia even "cause crystallization of a considerable portion of sugar," (3)

Marschall, Geerligs, and other investigators have likewise studied the melassigenic actions of various salts liable to be found in the juices of the cane and beets, or introduced during the process of manufacture. As will be seen from the analyses of the ashes of Hawaiian molasses given later, their composition varies so extremely that no precise conclusion can be drawn as to the effect of each component part of the ash on the sugar content.

From those who ascribe the non-crystallization of the sucrose to the action of invert-sugar wholly or in part, we quote:

(1) Planters' Monthly, 1887.
(2) Ibid. 1888.
(3) Deutsche Zuckerindustrie, 1897.

"Invert sugar as an agent preventative of crystallization is "second only to the salts of the ash" (1);

"It is well understood that * * * * each part of invert sugar "or glucose prevents an equal amount of sucrose from crys- "stallizing" (2)

"On the hypothesis that glucose is the only impurity in our "cane juices which materially affects crystallization." (3)

Regarding the role played by the gums, we read that:

"One pound of gum prevents two pounds of sugar from "crystallizing" (4)

"As the result of superheat clarification and the freeness of the "juices from gums, it was found that the molasses were also "freer of the so-called gums, and it was found possible to gain "sugar in the pan out of molasses whose purity did not permit it "the year previous."

The restraining influence of the salts on the separation of the sucrose has been thoroughly studied, especially in connection with the beet industry. The methods used to counteract this influence could not be applied economically to cane products, as the molasses not only contains a smaller percentage of ash, but also a more or less large proportion of invert sugar, which is found only in traces, if at all, in the beet products.

Regarding the influence of glucose *per se,* many experiences in Louisiana, where the juices themselves already contain a high percentage of this element, show that even where it is present in large quantities in the molasses, sucrose can still be recovered. The statement found in Tucker that

"The lowest molasses of commerce from which all sugar has "been crystallized that it is practicable to get, will retain from "25 to 30% cane sugar, to about an equal amount of invert "sugar"

is scarcely in accord with the following working experiences:

"A molasses containing 33.2% sucrose and 33.74% glucose "gave a massecuite which grained excellently in the wagons, " 'swinging' out well in the centrifugals, and yielded 12.06 pounds "of commercial sugar per ton of cane."

Edson in the La. Planter of 1893, states:

"I have seen a whole crop of thirds with an average purity of "39.10 and a glucose ratio of 73.19, single polarization, produce "sugar of approximately 80 degrees test, leaving a molasses of "13.95 purity, and a glucose ratio of 253.44. There were in this "crop single lots which gave a molasses with a glucose ratio of "297.0. As the molasses gave this result, crystallization must "have taken place in a material which was just below this ratio."

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(1) Planters' Monthly, 1887.
(2) Ibid, 1888.
(3) From a La. Mill Report, 1889.
(4) Scientific American, 1880.

Another, writing about the same time, is forced to the conclusion that:

"But little reliance can be put in the method of estimating the "available sugar by deducting 1 1-2 times the glucose from the "sucrose."

In an exhaustive study of the final molasses in the factories of Java, extending over many years, Mr. Prinsen Geerligs has concluded that it is by the ratio existing between the invert sugar and salts that the extent of the solubility of the sucrose in the water of the molasses is established; a low solubility coinciding with a high quotent between the glucose and the ash, within, of course, certain limits. In support of this hypothesis he presents the analyses of a great number of final molasses, in which this correspondence of sucrose per hundred water, and glucose-ash ratio, is fairly constant.

With the object of ascertaining whether or not this measure of the complete attenuation of molasses could be applied to the products of Hawaiian mills, a number of them were analyzed during the past two seasons, and the results are presented herewith. In attempting a comparison of these, several facts must be borne in mind. It is true that as far as the methods of clarification of the juices are concerned, they are fairly comparable, all of them being defecated with lime alone, the molasses from the mills employing sulphurous-oxide not being represented. But they originate in juices of varying purities, are clarified with lime some to neutrality, others to alkalinity, and not a few are allowed to remain slightly acid; some are clarified in open clarifiers, others by the Deming superheater; some are boiled according to the Java process, and producing but two grades of sugars; others are boiled to produce four grades, the lower being remelted and remade into first sugars, or drawn directly into the pan, being partially remelted in the thick syrup which is drawn in on them, and acting as a nucleus for the new grain; in some mills the low grades are handled in crystallizers, with others they are boiled to string proof, placed in wagons, in small tanks of various dimensions and constructions and material, or in large wooden tanks, where they are allowed to remain sometimes a few weeks, and again several months. With some the "ash" represents the original ash of the juice and the lime used in clarification, less the precipitated phosphates, etc., removed in the scums, the depositions, as scale, in the effects, and the settlings in the blow-up tanks; with others, Solvay soda is added to correct the acidity of the molasses and its frothing when boiled, thus affecting the soda percentage in the ash, slightly, it is true, but vitiating any attempts at accurate comparison of the action of the inorganic constituents. The composition of the ash is further complicated by the environment of the cane itself, as will be pointed out later. Again, these molasses are accepted as the final products of the mills which sent them. In some instances false grain could be discerned, thus raising the "sucrose per 100 water" above what is actually held in solution in the water. Lastly, it is not improbable that what represents an exhausted molasses in one mill might in another with different pan construction, or perhaps simply with a larger capacity for low grade boilings, give a further and profitable crop of crystals.

In Table I the molasses are arranged according to the sucrose contained per 100 water. In addition to the necessary data, are given the true and apparent purity of each molasses, these being the usual methods by which the sugar-boiler adjudges them, and as showing that none of these molasses differ greatly in their composition from the average of these Islands.

TABLE I.

No.	Water	Sucrose	Glucose	Ash	Sucrose per 100 Water	Glucose; Ash	Apparent Purity	Real Purity
19	16.20	36.57	7.55	14.93	225.7	.51	35.99	43.73
24	16.45	36.63	20.83	11.28	222.6	1.84	32.94	43.84
13	17.43	38.29	18.00	13.43	219.7	1.34	33.85	46.37
11	18.34	40.04	15.01	11.36	218.3	1.32	.....	49.03
1043	18.39	39.00	12.64	10.70	212.1	1.19	44.77	47.40
8	18.20	37.45	17.31	11.47	205.8	1.51	38.02	45.78
23	19.35	39.81	6.74	13.57	205.7	.50	42.59	49.36
12	18.20	36.30	13.33	14.52	199.4	.90	34.61	44.37
16	21.75	42.95	6.67	10.59	197.5	.63	46.33	54.89
1102	19.09	36.81	12.37	13.18	192.8	.84	34.90	45.50
18	19.00	36.60	13.97	11.99	192.6	1.17	37.18	45.18
25	17.08	32.71	18.38	13.02	191.5	1.41	28.92	39.45
21	17.75	33.49	18.90	8.95	188.7	2.11	27.65	40.72
15	19.73	36.45	19.61	13.02	184.8	1.50	33.79	45.41
3	18.11	33.20	11.16	11.76	183.3	.95	31.62	40.54
20	19.15	35.00	14.51	10.21	182.8	1.42	33.00	43.29
1044	20.48	37.20	10.00	10.27	181.6	.97	42.44	46.80
9	19.15	34.20	11.36	11.24	178.6	1.01	27.22	42.83
6	20.94	36.95	8.84	13.25	176.4	.67	37.34	46.61
17	22.85	39.64	14.37	12.15	173.5	1.20	40.61	51.38
1036	19.80	34.23	20.08	7.97	173.0	2.52	34.54	.....
2	21.31	36.72	8.92	8.32	172.3	1.07	36.86	46.60
14	20.46	35.17	21.18	10.50	171.9	2.08	35.40	44.22
26	19.05	32.77	8.90	10.13	172.0	.88	35.14	40.48
10	20.64	35.15	14.12	13.44	170.3	1.05	35.22	44.29
1121	21.99	36.65	18.62	8.68	166.7	2.15	35.10	47.00
27	23.74	38.44	14.71	9.06	161.9	1.62	40.50	50.40
7	24.94	39.74	12.54	8.21	159.4	1.53	44.28	52.94
1	24.91	39.12	6.04	8.41	157.0	.72	43.07	52.09
22	23.57	36.69	10.00	11.45	155.6	.88	40.59	48.00
4	24.66	35.23	15.82	7.89	142.8	2.00	37.70	46.76
5	24.66	34.58	21.55	8.46	140.2	2.55	39.02	45.90
1130	28.60	34.20	8.23	8.35	119.6	.98	42.50	47.90
1123	26.74	16.34	29.24	7.49	61.0	3.90	7.34	22.26

It is evident that the glucose-ash ratio is not a reliable criterion by which to judge the exhaustion of the molasses of these Islands.

Sample 1123, with the lowest sucrose per 100 water, does indeed contain glucose and ash in amounts forming the highest ratio; but the question arises in instances like this, does this measure the successful elimination of sucrose, or a destructive inversion of a part of it? The sum of the sucrose and glucose in this sample amounts to 45.58%, or 170.4 parts per 100 water. That of sample 1130 is only 42.43% or 148.3 per 100 water, with a low glucose-ash ratio of .98, while sample 1, with a still lower ratio of .72 contains 45.16%, or 181.3 per 100 water, which is but a little higher than 1123. If we take molasses No. 1 and suppose that inversion is allowed to take place to such an extent that 22% of the sucrose is changed, it would then analyze: sucrose, 17.12%; glucose, 29.2%, containing 68.8 parts sucrose per 100 water, and having a glucose-ash ratio of 3.47. It is not intimated that sample 1123 attained its composition through inversion; as a mater of fact, we have cause to believe quite otherwise. But this example is given as illustrating the fact that with our molasses a higher glucose-ash ratio could as readily be a sign of great inversion having taken place, as a standard of its successful exhaustion. Thus we could start with any molasses, and by gradually inverting the sucrose derive a table in which the descending sucrose per 100 water will be constantly accompanied by an ascending glucose-ash ratio.

The inapplicability of this standard to our molasses is doubtless largely due to the fact that in many cases the quantity of salts is equal to or greater than that of the glucose; of the 34 samples, only 12 showing a ratio greater than 1.50, and 12 being less than one. Respecting such a condition, Mr. Prinsen Geerligs modifies his theory in the statement:

"These constituents (i. e. salts) increase the solubility of the "sucrose, just as is the case with beet molasses, which likewise "contain a large quantity of salts, but little or no glucose." (On Cane Sugar and the Process of Its Manufacture in Java.) However, in spite of the reversal of the proportions of glucose and ash, no great difference exists between the average amounts of sucrose retained in solution. In 12 samples where the mineral matter exceeds the glucose, there are 180.5 parts of sucrose in 100 water; in 21 samples, where the glucose is greater, and excluding 1123, which is an extreme case, the average amount of sucrose held in 100 water is 182.3. Even including 1123, the average is but little lower than with the ash in excess, viz: 176.8 parts sucrose per 100 water.

In the same treatise, the author says that the effects of placing a foot of water over a low massecuite is two-fold:

"The massecuite takes up a little water and becomes less sticky, "while a portion of the viscous salts diffuses into the water, "whereby the quotient between the glucose and ash rises, and ac"cordingly the amount of crystallizing sugar is increased."

Another way of effecting this second condition, without affecting the viscosity, would be to add glucose to the molasses, and three such experiments were carried out on molasses 1 and 6, both selected on account of their low glucose-ash ratio. A pure invert sugar solution, containing 68% invert sugar, and .05% ash, was prepared from white cane sugar. The two molasses were slightly diluted with hot water in order to dissolve any false grain that might be present, enough normal sodium carbonate solution added to neutralize the acidity, which had been previously determined in separate samples, and a sufficient quantity of glucose (1) syrup added to considerably modify the ratio of glucose to ash, in number 1 in the proportion of 30 to 100 molasses, and in number 6, 18 to 158, and 15 to 100. These were concentrated under a vacuum of 26 inches, the temperature not being allowed to exceed 160 degrees. A check sample of each molasses was treated exactly in the same manner, with the exception of the addition of the glucose, and concentrated to about the same density. The following table presents the analyses of the resulting concentrates, along with those of the original molasses for comparison:

TABLE II.

MOLASSES NO. 1.

	Original Molasses	Concentrated Molasses	Glucose Added
Total Solids	75.08	82.60	81.7
Sucrose	39.12	42.76	33.45
True Purity	52.09	51.77	40.94
Glucose	6.04	6.98	21.38
Glucose Ratio	15.44	16.32	63.91
Ash	8.41	9.36	7.13
Glucose: Ash	.72	.75	3.00
Sucrose per 100 Water	157.0	245.7	182.8

MOLASSES NO. 6.

	Original Molasses	Concentrated Molasses	Glucose Added	Glucose Added
Total Solids	79.06	81.24	77.23	80.32
Sucrose	36.95	37.69	33.17	35.50
True Purity	46.61	46.39	42.95	44.20
Glucose	8.84	9.30	14.87	17.25
Glucose Ratio	23.92	24.67	44.83	48.59
Ash	13.25	13.68	11.90	12.00
Glucose: Ash	.67	.68	1.25	1.44
Sucrose per 100 Water	176.4	200.9	145.7	180.4

(1) Throughout this bulletin, the term "glucose" is used interchangeably with "invert-sugar," as is the custom in most mills having chemical control.

The resulting concentrates were allowed to stand three months, but in no instance was there any sign of crystallization. The masses, it is true, cooled very rapidly and at rest, and the amounts treated were small, in no case exceeding one litre, as this laboratory is not equipped to handle such experiments otherwise. At the same time, the entire absence of even the slightest crystallization in every experiment compels us to the conclusion that an increase of the glucose-ash ratio, accomplished in this manner, will not force out any sucrose from its solution.

The other effect produced by the application of water to the surface of an obstinate massecuite, as mentioned above, is the absorption of some of the water and the consequent lessening of the stickiness of the massecuite. This is an expedient frequently employed by the sugar-boilers of our mills. Many a contrary low-grade massecuite which gave no signs of crystal growth, has by the addition and admixture of water been forced to yield a crop which was dried easily in the machines, presenting the phenomenon as a mass giving up sucrose when its density was decreased, and also the sucrose per 100 water; in other words, a dilution instead of a cencentration. The addition of the water in no ways disturbed the relations of the solid matters of the massecuite to each other. The sole effect was the decrease of its viscosity, allowing freer movements of its molecules and the consequent aggregation of the sucrose. It apparently points to the evidence that the causative principle of molasses is that part or parts of it creating stickiness or gumminess. For the purpose of studying the probable relation of the impurities other than glucose and ash to the retention of sucrose, twenty-seven of the molasses were subjected to a more thorough analysis, and the results are given in Table III. It might be well at this point to indicate the methods of analysis used in making these determinations.

Moisture and Total Solids. A weighed portion of molasses was diluted to a definite volume, and after shaking well, an aliquot part placed in a platinum boat containing a coil of filter paper, all of which had been dried in an oven at 100 degrees and weighed. This was placed in a Habermann and Zulowsky drying apparatus, the heat supplied by boiling alcohol, and a vacuum maintained at about twenty-six inches. Occasionally the vacuum was stopped and dry air drawn over the boat, removing the vapor and condensed moisture from the tube, and considerably shortening the time necessary to thoroughly dry the sample.

The operation was considered complete when constant weight was obtained; the time consumed to attain this varied from four to six hours. The boat and contents were weighed in a weighing tube, and the increase in weight termed "total solids." The difference between this and a hundred, is, of course, "water."

Sucrose. The molasses was diluted with four times its weight of water (1), and the brix determined. The normal weight in a 100 cc. flask clarified with subacetate of lead gave the sucrose by direct polarization. The amount of subacetate of lead necessary to effect perfect clarification was determined in a separate sample, so that no excess of this reagent was used. A few drops of acetic acid were added to minimize the danger of the formation of levulosate of lead. In the filtrate, the sucrose was determined by the method of Clerget, the formula

$$\frac{100\,(P-P')}{142.66-1/2\,t}$$ being used.

Glucose. The molasses was clarified with the requisite amount of subacetate of lead, the acetic acid added as with the sucrose, and filtered. In an aliquot portion the lead was removed by a solution of neutral oxalate of potassium (2), and an aliquot portion of the filtrate from this taken for the glucose determinations, which were made by the Soxhlet method, occasionally duplicated by the gravimetric method, using Allihn's tables.

Levulose and Dextrose. These were taken from the reading of the inverted clarified solution at a low and high temperature, according to the method of Wiley (3). The method, as performed here, is not claimed to be an exact one, but was carried out in precisely the same way on each sample, so that the results are certainly comparable and most probably approximate very closely to the true percentages.

Ash. The sulphate ash was determined in the usual manner. Under the column "ash" is given the carbonated ash; that is, the ash obtained by charring the molasses at a low red heat in a muffle-oven, then thoroughly leaching with hot water, drying and incinerating the residue, evaporating the filtrate down to a small bulk, and adding it to the incinerated ash, and then evaporating the two together in a tared platinum dish, with the addition of ammonia and ammonium carbonate, drying at a low red heat, cooling and weighing. This was repeated, with fresh additions of ammonia and ammonium carbonate, until constant weight was attained.

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(1) Method of H. E. Sawyer, Journal of the American Chemical Society, June, 1905.

(2) Journal of the American Chemical Society, Dec., 1904.

(3) Methods of Agricultural Analyses, Vol. III.

TABLE III.

	1	2	3	4	5	6	7
Total Solids	75.08	78.69	81.89	75.34	75.34	79.06	75.06
Sucrose (Clerget)	39.12	36.72	33.20	35.23	34.58	36.95	39.74
Real Purity	52.09	46.60	40.54	46.76	45.90	46.61	52.94
Glucose	6.04	8.92	11.16	15.82	21.55	8.84	12.54
Dextrose	3.00	4.97	5.70	7.21	11.05	4.60	6.20
Levulose	3.04	3.95	5.46	8.61	10.50	4.24	5.82
Ash (Sulphate)	8.36	8.36	11.17	8.39	9.21	13.99	8.47
Ash	8.41	8.32	11.76	7.89	8.46	13.25	8.22
Gums	8.91	9.64	12.63	6.68	4.89	9.09	7.89
Total Nitrogen	.933	.364	.756	.421	.274	.600	.373
Albumenoid Nitrogen	.080	.057	.078	.039	.045	.092	.046
Ammonia Nitrogen	.026	.006	.032	.007	.006	.008	.004
Acidity 10/N Soda	2.7	1.5	3.0	1.7	1.4	2.4	1.1
Chlorine	1.23	.64	2.14	2.15	2.37	3.12	2.20

	8	9	10	11	12	13	14
Total Solids	81.80	80.85	79.36	81.66	81.80	82.57	79.54
Sucrose (Clerget)	37.45	34.20	35.15	40.04	36.30	38.29	35.17
Real Purity	45.78	42.83	44.29	49.03	44.37	46.37	44.22
Glucose	17.31	11.36	14.12	15.01	13.33	18.00	21.18
Dextrose	8.30	5.60	6.22	7.46	....	7.80	9.09
Levulose	9.01	5.76	7.90	7.55	....	10.20	12.09
Ash (Sulphate)	10.47	10.73	15.14	....	13.18	11.44	10.90
Ash	11.47	11.24	13.44	11.36	14.52	13.43	10.50
Gums	8.98	11.51	8.44	12.21	8.55	8.82	7.59
Total Nitrogen	.440	.765	.529	.320	.413	.336	.353
Albumenoid Nitrogen	.041	.062	.049	.030	.042	.046	.045
Ammonia Nitrogen	.008	.029	.011	.002	.007	.007	.004
Acidity 10/N Soda	2.21	3.30	2.60	2.00	1.04	2.10	1.40
Chlorine	2.47	1.98	2.70	2.49	2.99	3.28	2.41

	15	16	17	18	19	20	21
Total Solids	80.27	78.25	77.15	81.80	83.80	80.85	82.25
Sucrose (Clerget)	36.45	42.90	39.64	36.60	36.57	35.00	33.49
Real Purity	45.41	54.89	51.38	45.18	43.73	43.29	40.72
Glucose	19.61	6.67	14.37	13.97	7.55	14.51	18.90
Dextrose	...	3.42	8.01	7.02	3.70	6.97	9.40
Levulose	...	3.25	6.36	6.95	3.85	7.54	9.50
Ash (Sulphate)	11.26	10.03	11.63	11.57	14.97	9.56	9.31
Ash	13.02	10.59	12.15	11.99	14.93	10.21	8.95
Gums	7.46	10.54	7.06	9.97	9.06	6.77	8.93
Total Nitrogen	.425	.570	.361	.473	.996	1.000	.911
Albumenoid Nitrogen	.041	.042	.038	.041	.095	.108	.095
Ammonia Nitrogen	.008	.007	.006	.008	.011	.033	.030
Acidity 10/N Soda	1.60	3.40	2.20	2.10	2.70	3.60	3.60
Chlorine	2.38	2.03	2.23	2.31	2.99	1.53	1.53

	22	23	24	25	26	27
Total Solids	76.43	80.65	83.55	82.92	80.95	76.26
Sucrose (Clerget)	36.69	39.81	36.63	32.71	32.77	38.44
Real Purity	48.00	49.36	43.84	39.45	40.48	50.40
Glucose	10.08	6.74	20.83	18.38	8.90	14.71
Dextrose	5.76	3.87	10.18	9.42	3.78	6.70
Levulose	4.32	2.87	10.65	8.96	5.12	8.01
Ash (Sulphate)	10.95	13.19	11.94	12.97	11.28	9.40
Ash	11.43	13.57	11.28	13.02	10.13	9.06
Gums	7.62	9.70	8.90	8.53	7.51	7.42
Total Nitrogen	.332	.457	.332	.483	1.001	.486
Albumenoid Nitrogen	.038	.027	.029	.041	.050	.042
Ammonia Nitrogen	.006	.011	.008	.011	.006	.003
Acidity 10/N Soda	3.60	3.80	3.40	3.60	4.08	3.80
Chlorine	2.20	2.67	2.12	2.15	.93	1.65

Gums. By this term is indicated all the impurities precipitated by subacetate of lead, and includes, naturally, a great many substances other than true gums, such as glucinic, melassinic and succinic acids, and perhaps partially aspartic acid. The precipitate, produced as in the sucrose and glucose determinations, with an exactly sufficient amount of the lead-solution, and the addition of a few drops of acetic acid, was thoroughly washed first by decantation and then on the filter, until the washings gave no test for sugars with alpha-naphthol. The precipitate was then suspended in water and decomposed with sulphuretted hydrogen, filtered, concentrated, and weighed in a platinum dish. This was then ignited, and the weight of the ash deducted.

Acidity. This was determined by titrating with tenth normal soda solution, using phenolphthalein as indicator. The usual difficulties attending this determination were encountered, and the results represent the means of several titrations.

Nitrogen. Total nitrogen was determined by the Kjeldahl method, sometimes modified, when the molasses was particularly refractory, by the addition of about ten grammes of sulphate of potash. Distillation was conducted as usual, fifth normal reagents being used. The albumenoid nitrogen was estimated with Stulzer's reagent, and the ammonia nitrogen by distillation with barium carbonate, tenth normal reagents being used in these instances.

A considerable difference exists between the molasses as regards their consistencies, as may be seen by reference to the percentage of total solids. Some were so stiff that it was with considerable difficulty that they were removed from their containers; others were extremely liquid, and appeared as if water or steam had been added, after leaving the centrifugals, or that the sugar in the machines was washed and the water allowed to mix with the discharged molasses. This would account for some of the higher sucrose contents found in molasses of low solids, which can be better seen by reference to the purity column. The lowest purity is in sample 25, being 39.45, and total solids in the same, 82.92%, whilst the highest purity is found in sample 16, 54.89, where the total solids are only 78.25%. This may have been caused as indicated above, may mean inferior pan work, or may simply indicate that the economical limit of the exhaustion of the molasses has been found to be higher in the latter instance, due to a variety of circumstances, such as less storage tanks for low-grade products, lack of steam, or shortage of drying conveniences.

The sucrose percentage is fairly constant, ranging from 32.71% in number 25 to 42.95% in number 16, with an average for all of 36.40%. But with the glucose, a wider difference is found, the lowest showing 6.04%, whilst the highest gives 21.55%, the average of the twenty-seven being 13.76%. This difference cannot be exactly explained, but from the fact that, with but few exceptions, those molasses giving the highest glucose originate in mills handling juices of lowest average purity, we can safely presume that it is to the higher glucose ratio of the original juices that these higher glucose contents of the molasses are mainly due.

No deductions can be drawn from the nitrogen columns, as there is not only a great variation amongst the molasses from different mills, ranging from .27 to 1.001% but also, in one instance, in samples from the same mill, taken at different times, due, of course, to the different degrees of maturity of the canes from which derived, or different conditions of growth of the cane. Thus samples 2 and 26, though from the same mill, vary from .36 to 1.001%. The difference between the total and the albumenoid and ammonia nitrogen is principally amido nitrogen in the form of amido-acid. This amido body was isolated by precipitation with mercuric nitrate, separation from the mercury, crystallization, and purification with 60% alcohol. The resulting product consisted of thin, white needles, soluble in water, and with no action on polarized light either in neutral, acid, or alkaline solutions. The nitrogen content was found to be 10.68%, which would approximate very closely to the formula of Aspartic Acid, viz: $C_2H_3(NH_2)(COOH)_2$. This compound very probably originates with the Asparagine of the cane-juice, the long continued boilings and re-boilings of the molasses effecting the transformation into what appears to be inactive aspartic acid.

With ash, as with nitrogen, considerable differences are manifested, molasses 4, containing but 7.89% of mineral matter, while number 12 has an ash content of 14.52%. Conditions affecting the amount of ash are so diverse and complicated, that any explanation of these differences which, again, as with nitrogen, occur in molasses from the same mills, is most unsatisfactory. Together with different degrees of maturity of the cane, the ash of the juice is affected in the field by amounts and qualities of fertilizer applied, weather conditions after fertilization, nature of the soil and irrigation water where applied, and different requirements of various kinds of cane for the various soluble ingredients in the soil waters. Then on entering the mills, the amount of lime used in clarification varies in different mills, and sometimes in the same mill, changing with the variety of cane being crushed. For example, on Hawaii, it is the opinion of some of the sugar-boilers that Yellow Caledonia cane should always be boiled slightly under-limed or acid, while Rose Bamboo, to give good work, must be neutral or even slightly alkaline to litmus. In most instances, the results of the sulphate ash accord closely with the carbonated, but in several there are wide differences. In all these cases, the work was carefully repeated, but the differences still obtained.

By "gums," as has been previously explained, is meant all the impurities, other than ash, precipitated by subacetate of lead, and no effort has been made to segregate them. The gums of the cane molasses have been divided by one authority as follows: (1)

"The different gums which we have identified may be "divided into three classes: 1. Those derived naturally "from the cane, such a xylan, araban, and galactan; 2. Those "resulting from fermentation changes in the juice, syrup, or "molasses, such as dextran, mannan, and cellulan; 3. Those "produced by the action of the clarifying agents during the "process of manufacture."

In Table IV, given below, will be found the molasses arranged as before, according to the sucrose per 100 water, and also the gums per 100 water. With the exceptions of samples 2, 3, and 9, it will be seen that the fall in gum content of the water fairly regularly accompanies a fall in the sugar content. The viscid nature of the molasses is due mainly to these gums, and the greater their proportion in the water, the less mobile becomes the molasses, and crystallization of the sugar is materially hindered. The viscosity is affected by other agents than the gums. Temperature plays an important part, while certain salts, as for instance the chloride and nitrate of potash, "diminish in an exceptional way the viscosity of pure saturated solution; as a general rule for the same acids, salts "of soda increase the viscosity more than salts of potash, and

(1) C. A. Browne, La. Planter and Sugar Manufacturer, April, 1905.

"salts of lime more than salts of soda" (1)
By reference to the analyses of the ashes given later on, it will be seen that a large part of the ashes of these molasses consists of chloride of potassium, thus already presenting the most favorable condition for the diminution of viscosity. The sole precaution we can urge is that liming should be carefully carried on, no more or less than actually needed used, thus both avoiding the introduction of an undesirable ash constituent, and the creation of the third class of gums as defined in a previous paragraph. (2)

TABLE IV.

Number	Water	Sucrose	Gums	Sucrose per 100 Water	Gums per 100 Water
19	16.20	36.57	9.06	225.7	56.0
24	16.45	36.63	8.90	222.6	54.1
13	17.43	38.29	8.82	219.7	50.6
11	18.34	40.04	12.21	218.3	66.5
8	18.20	37.45	8.98	205.8	49.3
23	19.35	39.81	9.70	205.7	50.1
12	18.20	36.30	8.55	199.4	47.0
16	21.75	42.95	10.54	197.5	48.5
18	19.00	36.60	9.97	192.6	52.5
25	17.08	32.71	8.53	191.5	49.9
21	17.75	33.49	8.93	188.7	50.3
15	19.73	36.45	7.46	184.8	37.8
3	18.11	33.20	12.63	183.3	69.7
20	19.15	35.00	6.77	182.8	35.4
9	19.15	34.20	11.51	178.6	60.1
6	20.94	36.95	9.09	176.4	43.4
17	22.85	39.64	7.06	173.5	30.9
2	21.31	36.72	9.64	172.3	45.2
14	20.46	35.17	7.50	171.9	36.7
26	19.05	32.77	7.51	172.0	39.4
10	20.64	35.15	8.44	170.3	40.9
27	23.74	38.44	7.42	161.9	31.2
7	24.94	39.74	7.89	159.4	31.6
1	24.91	39.12	8.91	157.0	35.8
22	23.57	36.69	7.62	155.6	32.3
4	24.66	35.23	6.68	142.8	27.1
5	24.66	34.58	4.89	140.2	19.8

(1) International Sugar Journal, June, 1903.

(2) "The amount of available sugar depends not only on the solubility in the water contained in the molasses, which is dependent "on the quantity of glucose and ashes, but also practically on the "viscosity of the molasses. Whenever the molasses are very sticky, "whether this be caused by gums, by lime salts of products of "decomposition of glucose, or by constituents resulting from the "action of prolonged high temperatures, the quantity of sugar which "cannot remain will crystallize out at any rate, but in this case it "will take place in such minute crystals, that they are practically "lost."
(H. C. Prinsen Geerligs in "International Sugar Journal," Nov., 1901.)

To rid ourselvevs of the gums, then, would seem to be one method of making possible the recovery of more sugar. We have many agents at hand for this purpose, but unfortunately the use of them is prohibitive either on account of their poisonous nature or great cost. Dr. Maxwell effected this in Louisiana by precipitation of both the gums and amido bodies by mercuric nitrate and the subsequent removal of the mercury by electricity, whereby he recovered 53.5% of the sugar present in the molasses. (1)

The possibility of the recovery of sugar from sorghum by the precipitation of the gummy impurities by alcohol has already been demonstrated by the U. S. Department of Agriculture. The practice of this method on the large scale has hitherto been interdicted by the high price of the alcohol, and the impossibility of preventing some loss. With the passage of the act enabling the manufacture of denaturized spirit, this objection has been overcome, and we have, further, the material at hand for the manufacture of the alcohol. It may not be out of place to suggest here that this same fact opens up a profitable field for the use of our molasses, and it is possible that it will prove more advantageous to convert all our lower grades into spirit than to strive for such thorough exhaustion of them.

To learn the effects of alcohol on our molasses, sample number 1 was treated with alcohol in the proportion of two of 95% alcohol to one of molasses. After decanting the clear liquid from the copious precipitate, it was evaporated under vacuum. The resulting massecuite analyzed as follows, it being tabulated with the original molasses for convenience of comparison:

	Total Solids	Sucrose Clerget	Real Purity	Glucose
Molasses	75.08	39.12	52.10	6.04
Massecuite	77.00	41.75	54.2	6.25

The difference in purity is not great, yet after standing ten days, a splendid crystallization resulted. A study of the nature of the gums removed by the alcohol, showed that in a general way they are similar to those eliminated by subacetate of lead. Thus, any process which can economically remove or reduce the amount of the gummy impurities, will increase the amount of recoverable sugar. An opportunity is presented for accomplishing this in part when the molasses is steamed for

(1) Bulletin No. 38, La. Sugar Experiment Station.

the purpose of dissolving false grain and facilitating handling. The heavy scum or froth which rises to the surface is usually of a much less purity than the molasses which is under it. We have been able to examine three such scums and the molasses from which they originate, and their purities compare as follows:

	A	B	C
Scum	35.40	37.1	18.2
Molasses	36.37	39.4	25.6

Thus there is possible a more or less considerable improvement of the molasses at this point of manufacture, provided the scum is removed. It is strongly recommended that this mass of impurties be discarded and not again passed through the process of boiling, as is unfortunately frequently the case.

No other method of removing the gathered impurities in the molasses by means of chemical agents suggest themselves, at this time.

Most of the new processes have for an object the removal of the impurities in the juice before concentration, by precipitation, decolorization, oxidation or reduction. None of these methods are in vogue on these Islands, and as far as we can learn, but few of them bear out in practice the advantages claimed for them. The clarifying compounds suggested are legion,—amongst them being baryta, strontia, salts of zinc, tin, ozone, hydrogen dioxide, chlorine, ammonia, sulphurous oxide, calcium chloride and carbonate, alumina, cork, asbestos, and sand, while extensive experiments have been carried on with the idea of using electricity as the clarifying agent. In the last analysis, however, only lime, sulphurous oxide, phosphoric acid, and carbonic oxide remain, and of these, the sole agents used, as far as we can learn, on these Islands are lime and sulphurous oxide.*

There are other methods, the principle of which is the precipitation of the sucrose with some agent as lime or strontia, and its subsequent separation and recovery, such as the Steffen's process, but thus far the difficulties attending their manipulation render them unprofitable for material of the composition of our cane molasses.

* The molasses from mills using sulphurous oxide are not represented in this bulletin.

TABLE V.*

No.	Silica	Iron and Alumina	Lime	Magnesia	Potash	Soda	Sulphuric Anhydride	Phosphoric Anhydride	Chlorine	Carbon Dioxide	Total	Less Oxygen= Chlorine	Total
1	.24	....	15.56	9.13	28.90	1.44	11.90	2.88	14.58	18.93	103.56	3.28	100.28
2	1.24	1.90	21.95	11.85	14.62	1.39	11.90	2.88	14.58	18.93	103.56	3.28	100.05
26	3.44	1.86	24.26	7.85	16.45	1.62	14.88	2.18	9.13	19.50	101.17	2.05	99.12
3	1.49	3.31	9.31	9.97	29.63	.90	15.36	3.30	16.21	14.31	103.79	3.65	100.14
9	1.76	2.91	9.70	9.04	31.59	2.01	15.67	3.57	16.16	11.02	103.43	3.62	99.81
16	1.04	1.64	12.70	6.62	32.41	2.02	11.73	1.52	19.16	16.07	104.91	4.31	100.60
20	3.62	3.53	6.46	9.75	32.40	1.90	17.81	3.86	14.96	9.78	104.07	3.37	100.70
21	3.71	2.04	9.68	7.30	34.59	1.86	13.37	2.51	17.11	12.14	104.31	3.85	100.46
27	3.28	4.95	3.21	4.66	41.53	1.98	7.84	7.37	18.25	10.13	103.20	4.10	99.10
7	.54	.91	9.96	7.03	36.24	3.30	4.29	1.02	26.86	15.87	106.02	6.04	99.98
23	.85	.88	17.32	3.91	31.93	2.22	10.68	.79	19.67	15.70	103.95	4.42	99.53
19	1.25	1.63	8.75	9.27	34.78	1.53	12.50	1.17	20.03	14.05	104.96	4.51	100.45
25	2.12	1.25	10.50	6.71	36.06	1.80	12.03	1.25	16.51	15.37	103.60	3.71	99.89
4	2.54	1.47	3.68	5.58	42.19	3.30	5.20	1.87	27.29	12.76	105.88	6.14	99.74
11	1.60	.60	8.33	2.38	47.21	3.29	4.46	1.03	21.96	13.82	104.68	4.95	99.73
24	2.21	2.00	6.24	3.74	45.13	1.80	8.85	2.02	18.80	13.09	103.88	4.23	99.65
6	1.43	.98	9.68	4.67	39.66	1.69	10.25	1.30	23.56	12.22	105.44	5.30	100.14
22	1.71	1.10	10.52	3.77	41.79	2.00	10.33	1.13	19.25	13.30	104.90	4.33	100.57
5	2.00	1.32	6.97	5.93	39.10	2.75	7.82	1.68	26.65	11.81	106.03	6.00	100.03
18	3.66	1.91	11.74	7.83	32.05	1.95	13.14	1.23	19.25	11.86	104.62	4.33	100.29
8	.86	1.05	7.52	6.75	37.09	3.73	12.91	1.05	21.50	12.88	105.34	4.84	100.50
13	2.04	.85	9.39	6.01	34.64	3.19	11.87	.77	24.40	12.54	105.70	5.49	100.21
14	3.57	.42	7.38	8.70	33.85	2.94	12.48	1.05	22.98	11.15	104.52	5.17	99.35
10	1.16	.81	6.52	6.10	39.98	2.89	13.04	1.10	20.06	12.92	104.58	4.51	100.09
17	2.50	.67	11.42	4.94	36.19	1.90	12.43	1.00	18.37	14.50	103.92	4.13	99.79
12	1.75	1.70	7.09	3.53	42.46	2.35	10.82	2.08	20.57	12.24	104.59	4.63	99.96
15	1.90	3.17	8.55	4.57	40.08	1.13	9.77	2.54	18.25	14.59	104.55	4.11	100.44

* The first nine molasses are from Hawaii, the next four from Kauai, the next five from Maui, and the balance from Oahu.

TABLE VI.

No.	Silica	Iron and Alumina	Lime	Magnesia	Potash	Soda	Sulphuric Anhydride	Phosphoric Anhydride	Chlorine	Carbon Dioxide (in Ash)
1	.020	....	1.309	.768	2.430	.121	1.001	.242	1.226	1.592
2	.103	1.58	1.826	.986	1.216	.116	1.115	.158	.644	2.116
26	.349	.188	2.458	.795	1.666	.164	1.507	.221	.925	1.975
3	.175	.389	1.095	1.172	3.484	.106	1.807	.388	2.137	1.683
9	.198	.327	1.090	1.016	3.551	.226	1.761	.401	1.983	1.239
16	.110	.174	1.344	.701	3.432	.214	1.242	.161	2.030	1.702
20	.370	.360	.660	.995	3.308	.194	1.818	.394	1.527	.999
21	.332	.183	.886	.653	3.100	.166	1.197	.225	1.531	1.087
27	.297	.448	.291	.422	3.763	.179	.710	.668	1.654	.918
7	.044	.075	.819	.578	2.979	.271	.353	.084	2.200	1.305
23	.115	.119	2.340	.531	4.333	.301	1.479	.107	2.670	2.130
19	.187	.243	1.306	1.384	5.193	.228	1.866	.175	2.991	2.098
25	.276	.163	1.367	.874	4.695	.234	1.566	.163	2.150	2.001
4	.200	.116	.290	.440	3.329	.266	.410	.146	2.153	1.007
11	.182	.116	.946	.270	5.360	.370	.500	.117	2.490	1.560
24	.249	.226	.704	.422	5.091	.203	.998	.228	2.120	1.477
6	.189	.130	1.283	.619	5.255	.224	1.358	.172	3.120	1.619
22	.195	.126	1.202	.431	4.777	.229	1.181	.129	2.200	1.520
5	.169	.112	.590	.502	3.308	.190	.577	.142	2.369	1.000
18	.439	.229	1.408	.939	3.842	.234	1.575	.147	2.308	1.413
8	.099	.120	.863	.774	4.254	.428	1.481	.120	2.465	1.477
13	.274	.114	1.261	.807	4.652	.428	1.594	.103	3.277	1.684
14	.375	.044	.775	.914	3.554	.309	1.310	.110	2.413	1.171
10	.156	.109	.876	.820	5.373	.388	1.753	.188	2.702	1.736
17	.304	.081	1.388	.600	4.397	.231	1.510	.122	2.232	1.762
12	.254	.247	1.029	.513	6.163	.341	1.571	.302	2.986	1.777
15	.248	.413	1.113	.595	5.218	.147	1.272	.331	2.376	1.900

In TABLE V will be found the analyses of the ashes of the molasses. They are arranged according to the Islands whence they came, and those bracketed are from the same mill. In TABLE VI the ash constituents are given in per cent. of the molasses. The silica and iron and alumina are mainly accidental components of the ashes, depending on the condition of the cane when coming to the mill, the method of clarification, the time given for the settling of the scums, and the impurities present in the lime used in clarification.

The lime is found to be naturally greatly affected by the amount used in clarification. For the purpose of comparison, we append the lime percentage of the ashes of several samples, placed in comparison with the pounds of lime used per ton of juice:

	Lime % Ash	Lime % Molasses	Lbs. Lime per Ton Juice
2 and 26	22.0	1.642	1.93
17	11.42	1.388	1.77
16	12.70	1.344	1.73
11	8.33	.946	1.66
18	11.74	1.408	1.17
21	9.68	.866	1.12
22	10.52	1.202	.90
13	9.39	1.261	.89
20	6.46	.660	.76

A considerable portion of the lime which enters with the clarified juice is removed during the concentration of the juice to syrup as scale in the effects, either as sulphate or phosphate. Where sufficient lime has been used, sedimentation been good and no clarophos or other phosphoric acid compound used as a clarifying medium, the amount of lime phosphate formed on the coils should not be great. Again, later in the course of manufacture, a considerable sediment is formed in the blown-up molasses, which consists principally of sulphate of calcium and organic matter. One of the mills has perfected a process whereby a considerable portion of the gummy matter and ash of the molasses is eliminated by a purely mechanical contrivance. This matter consists of

Moisture	27.89%
Ash	27.60%
Organic Matter (including sugars)	44.51%

An analysis of this ash is given below, together with those of a molasses deposit and scale from a triple effect. The two latter are from a mill situated on a different island from the first, and yet a close resemblance exists between them. It should be stated that all molasses was first washed from the residue, so that these analyses represent only that part insoluble in water.

	Molasses Gum	Molasses Deposit	Scale
Silica	1.42	2.11	.17
Iron and Alumina Oxides	1.03	(1)	(1)
Lime	35.38	41.65	42.87
Magnesia	8.01	.25	.60
Phosphoric Anhydride	1.80	4.00	9.48
Sulphuric Anhydride	52.33	49.55	41.76

The potash content of the ashes varies from 8.22% to 47.21%, and of the molasses from 1.216% to 6.163%. As will be seen in TABLE VII, this variation follows very closely that of the chlorine, resembling in this respect the molasses of Java, of which Mr. Prinsen Geerligs says:

"A high chlorine content always coincides with a high "amount of potash, while the amount of soda is always in-"significant, although the chlorine had originally occurred in "combination with that element." (2)

TABLE VII.

Number	Potash	Chlorine	Soda
2	1.216	.644	.116
26	1.666	.925	.164
1	2.430	1.226	.121
7	2.979	2.200	.271
21	3.100	1.531	.166
20	3.308	1.527	.194
5	3.308	2.369	.190
4	3.329	2.153	.266
16	3.432	2.030	.214
3	3.484	2.137	.106
9	3.551	1.983	.226
14	3.554	2.413	.309
27	3.763	1.654	.179
18	3.842	2.308	.234
8	4.254	2.465	.428
23	4.333	2.670	.301
17	4.397	2.232	.231
13	4.652	3.277	.428
25	4.695	2.150	.234
22	4.777	2.200	.229
24	5.091	2.120	.203
19	5.193	2.991	.228
15	5.218	2.376	.147
6	5.255	3.120	.224
11	5.360	2.490	.370
10	5.373	2.702	.388
12	6.163	2.986	.341

The chlorine content is in a general way an indication of the source of the molasses. It varies from .644% to 3.277% in the

(1) Not determined.
(2) International Sugar Journal, December, 1905.

different samples, but those from the same mills do not show such extensive variations in this element as are found in the others. A low chlorine content indicates that the molasses originates from canes grown with natural rainfall, and of these, the highest are those from plantations having their lands near the coast, and receiving more or less the spray of the ocean during the heavy trades. Those with a high chlorine percentage are generally from lands under irrigation, and the more brackish the water used for that purpose, the more chlorine will be found in the juices and consequently in the molasses. The effect of varying quantities of salt in the irrigation water on the juices was demonstrated in experiments at this Station, with results as follows: (1)

Salt per Gallon of Irrigation Water	Chlorine Per Cent. Juice	Chlorine Grains per Gallon Juice
50 grains	.0520	30.212
100 "	.0758	44.040
150 "	.0778	45.086
200 "	.1010	58.681

There is considerable difference in the amounts of sulphuric anhydride present, due doubtless to the varying amounts of sulphate fertilizers applied, and to the different varieties of cane represented, as also the amounts of sulphuric oxide compounds existing in the soils. The ash of the cane itself may contain all the way from 2.61% to 10.55% of this element, so we should naturally expect to find considerable differences in the juices and molasses.

The figures given under carbon dioxide do not mean that those amounts of this matter are in the molasses, but are calculated from the percentages in the carbonated ash. Naturally, with an acid liquid, no carbonates could be present. The amounts of carbon dioxide as given can be taken as representing the quantities of organic acids existing in the molasses, in combination with the various bases.

SUMMARY.

(1) The ratio of glucose to ash does not serve as an indication of the exhaustion of the Hawaiian molasses.

(2) The limit of the further recovery of sugar is established principally by the viscosity of the molasses.

(3) The viscosity of the molasses originates with the gums, and any method reducing the quantity of gums or their stickiness, makes for the possibility of further recovery of sugar.

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(1) Bulletin No. 9, Division of Agriculture and Chemistry, H. S. P. A.

(4) The ashes of molasses and the composition of the ashes vary with the conditions of growth of the cane and the amounts of lime used in the clarification of the juices.

(5) A high salt content in the irrigation water increases the potash and chlorine in the ash, but not to an appreciable extent the soda with which the chlorine was originally combined.

In conclusion, the writer begs to extend his thanks to Mr. C. F. Eckart, Director of this Division, for much helpful advice and many valuable suggestions; also to the managers of the various mills who supplied the samples of molasses.

DENATURED ALCOHOL.

We have already published in this journal the act passed at the last session of Congress permitting the use of alcohol in the arts and indutsries free of tax. This act goes into effect January first next, and interest in this matter is steadily increasing. Regulations for denaturing are in course of preparation by the Treasury department, and officers of the government are investigating the conditions under which the work is carried on in foreign countries.

Denatured alcohol has been manufactured and used in European countries for many years and inquiry is naturally directed to them for information in regard to the methods of manufacture and the regulations under which the product is distributed.

The Department of Commerce and Labor has meanwhile issued a number of Consular reports largely devoted to reports from their consular officers in connection with denatured alcohol.

From Germany, Consul General Thackara reports that the distillation of alcohol from potatoes is one of the most important branches of agriculture, which alone, in some cases, renders farming pursuits possible in regions situated at a distance from business centers and possessing light soil, and many farms owe their existence to distilleries. In 1904-1905 there were 72,172 alcohol distilleries in operation, of which 6,048 farm distilleries and 21 industrial distilleries used potatoes; 7,620 farm distilleries and 780 industrial distilleries used grain; 39 distilleries used other materials; 29 used molasses, and 57,635 small farm distilleries used fruit, wine, etc. It has been impossible to obtain in Germany satisfatcory data regarding the cost of the production of alcohol from the different materials, it depending so much upon different conditions, etc.

Consul General Mason of Paris, makes an interesting report in which he states:

The alcohol which is used in France for various industrial purposes is manufactured mainly from the beet root, the material being either the refuse molasses from sugar factories or beets, which by reason of unfavorable weather, inferior soil, or other cause contain only a small proportion—4 to 6 per cent.—of sugar. Potatoes and grain are also used to some extent for distilling purposes, but to a relatively much less extent than in Germany, where the potato is the great dominating source of industrial alcohol.

Unlike the German system, which permits several methods of denaturation, according to the special purpose for which the spirit is to be subsequently employed, the French statute provides but one general process, which is applied indiscriminately to all alcohol to be employed tax free in manufactures and for burning or lighting purposes. The statute provides that all alcohol to be denaturized shall contain not more than 1 per cent. of fusel oil and shall be of exactly 90° purity. If of a higher grade the spirit must be reduced; if lower it must be strengthened to 90° before it can be denaturized.

STANDARD MIXTURE.

The process, which must be carried out in presence of a government official, consists in the addition to each hectoliter (100 liters, equal to 26.42 gallons) of the following standard denaturizing mixture and cost:

	Francs
15 liters of methyline (wood alcohol)	19.50
½ liter heavy benzine	30
1 gram Malachite green	06
Total cost of denaturants for 26.42 gallons	19.86
Equal to	$3.70

The market value of crude alcohol fluctuates slightly in France, as elsewhere, but a fair average price is $5.21 per hectoliter, or 20 cents per gallon. Add to this the foregoing cost of denaturants and we have a total cost of $8.91 for 115½ liters—or about 30 gallons—of denaturized spirit. This would mean 30 cents per gallons as the net cost in ordinary times of industrial alcohol in France.

EXTENT OF CONSUMPTION.

The total consumption of denatured alcohol varies from 250,000 to 300,000 hectoliter (6,600,000 to 7,926,000 gallons) and the quantity used does not fluctuate beyond these limits, although the French government has endeavored in various ways to encourage the manufacture and use of spirits for heating, power, illuminating, and other industrial purposes.

Meanwhile repeated efforts have been made to provide a cheaper and more effective method of denâturation, for experience soon proved that alcohol denatured by the methyline-benzine-malachite-green process could be restored by purification so as to be available for many purposes not contemplated by the law. Experiments were made with pyridin (a nitrogenous base distilled from bone oil or coal tar) as well as with wool grease and other substances, but none have proven sufficiently superior to supersede wood alcohol, which here (as well as in Great Britain) is considered the essential basic element of a standard denaturant.

GOVERNMENTAL EFFORTS TO EXTEND CONSUMPTION.

The French government, like that of Germany, was attracted by the idea that if the manufacture and use of denatured alcohol could be sufficiently stimulated and extended there would be not only added an important product to home agriculture, but the country would be provided in case of war with a native-grown fuel for military vehicles and other important purposes which would not be imperiled by the interruption of an imported supply of petroleum products. Accordingly, the ministers of commerce and agriculture organized a special exposition and offered prizes for the most effective types of alcohol motors, both stationary and portable, for motor vehicles and agricultural machinery, as well as alcohol lamps, stoves, and other fixtures for domestic use.

So far as can be ascertained the success of this movement has been, on the whole, disappointing, so that, as already stated, the consumption of denatured spirits for such purposes has not increased to any important degree. The motor-car builders admitted, as a result of their experiments, that alcohol was, chemically considered, a purer and more economical fuel for France than petroleum, but it required for highest efficiency a motor specially constructed for burning alcohol, the vapor of which explodes more suddenly and powerfully than that of petroleum essence. Moreover, the gases generated by the combustion of alcohol vapor attack steel and iron, so that the cylinders and valves proved difficult to keep bright and in order. A mixture of 20 to 30 per cent. of benzine with the alcohol was tried and showed some advantage, but according to report the alcohol and benzine volatilize at different temperatures, so that one ingredient would be exhausted more rapidly than the other, and the experiment fell short of the anticipated success.

For the same reason the alcohol denatured with wood alcohol and benzine proved only partially successful in lamps. Such of these as were tested required half a minute or more to light, and unless burned in a cold room the light diminished gradually to about 50 per cent. of its original brilliancy until extinguished and refilled, so that after a more or less unsatisfactory trial, most of the users of alcohol lamps returned to the use of petroleum or colzaoils. It is not asserted that these unsatisfactory results with denatured spirits were unavoidable or might not have been averted by improved and more scientific apparatus, but this is substantially what occurred.

Consul Dunning of Milan, gives in detail the denaturing processes in vogue in Italy and comparisons with the French system.

FRENCH AND ITALIAN SYSTEM.

Readers specially interested in the details of the subject may like to have some more complete description of the Italian process of denaturization as it is practiced by general chemists. In the manufacture of alcohol denaturization is effected by the addition of 15 per cent. of vinegar at 7° and by dilution with water and wine to secure a product containing 14 per cent. of alcohol.

Alcohol destined to be used in the manufacture of ether is denaturized by adding 10 per cent. of sulphuric acid at a strength of 66° Baumé and with 20 per cent. of acid at 54°, and carrying the temperature of the mixture to 80°. When alcohol is used for the preparation of iodoform acetone is added.

The French government system is much in favor here also among private chemists, that rule indicating as a denaturant for alcohol (methyl) a mixture of 65 per cent. of pure methyl alcohol and not less than 35 per cent. of foreign substances, among which acetone should figure at from 20 to 25 per cent. Under the French rule of January, 1894, alcohol presented for denaturization in France must contain not more than 1 per cent. of essential oils, the usual substances found in a certain proportion in all industrial alcohols. It must have a strength of 90° at a temperature of 15° without corrections; it being understood, however, that alcohols to be used in the manufacture of paints or chemical products be presented for denaturization at a grade superior to 90°. To 100 quarts of alcohol at 90° would be added 15 quarts of methyl of the grade known as "No. 2," adding also 1 pint of unrefined benzine, having the characteristic odor of the gross products of the distillation of coal, and boiling between 150° and 200°. Finally there was formerly added 1 gram of green malachite per 100 quarts.

In alcohol intended for the manufacture of paints, the benzine would have to be replaced with 4 4/5 pounds of resin or gum resin, which ever should be chosen by the manufacturer, dissolved in the presence of the revenue agents. The methyl used as standard by the French and accepted equally in Milan, I am informed, corresponds to the formula C_2H_4O, has a density of

0.814 at zero, boils at 65.5, and has a power of heat the low degree of which has led to some local discussion as to the method of its application in mixtures intended for use in lamps and heaters. In Italy the addition of 10 per cent. of methyl to industrial alcohol augments the price of the finished mixture about $2 per 100 quarts. Its average price in Italy is about $20 per 100 quarts.

USE OF MALACHITE DISCONTINUED.

The high and increasing cost of methyl and the fact that its use as a denaturant is believed to reduce the heating power of the finished mixture to too great a degree, has led the French to submit the whole problem of denaturization to a special commission appointed to study it. This commission fixed the proportion of methyl as 1 to 100 for industrial alcohol, cut out the green malachite on account of the serious inconveniences which it presented, and fixed at 1 to 100 the quantity of gross benzine (distilled at 180°), to be added to complete the denaturization. The commission finally fixed on a mixture of 97 parts of alcohol at 95°, 1 volume of methyl, 1 of animal oil distilled at 100°, and 1 of benzine. It is understood here that the French, in consequence of the report of the commission, have definitely abandoned the use of green malachite. The benzine recommended in this mixture is a special type, derived from coal tar distilled at a temperature of from 150° to 200° and differing essentially from pure benzine, which indicates a density of 0.88 at 15° and boils at 80.4°.

The activity of the French in experimentation along this line to secure a better fluid for both heat and power has given them a dominant position in Europe. For that reason, and the fact that the Italian chemists have found is considerably successful, the French system generally obtains in this country, with some unimportant modifications. The Italians have done next to nothing in such experiments.

NOTES ON SUGAR INDUSTRY OF CUBA.

Consul Max J. Baehr, of Cienfuegos, furnishes an interesting and comprehensive report from which the following is taken:

The large sugar plantations surrounding Cinefuegos have not only made heavy purchases of machinery for their mills in order to increase their capacity, but idle and new land has been brought under cultivation to yield sugar cane. This has caused a demand for plows and other agricultural implements, which since January 1, 1905, has exceeded the supply. A like situation may be said to have obtained with regard to machetés for agricultural purposes, the factory of Collins & Co., of Hartford, Conn., not being able to keep up with their orders.

Of entirely new enterprises in the sugar-producing industry is the Jatibonico plantation, between Sancti Spiritus and Ciego de Avila, the land being under cultivation and the machinery installed. It is an American company. Other plantations are being put in order.

The sugar shipments to this port at the close of the 1906 crop will be increased by about 200,000 bags of 325 pounds each. This increase will result from the completion of a branch of the Cuban Central Railroad and by the building of another line into the Cardenas district, which will bring the sugar to this market instead of going elsewhere, as heretofore. Part of these additional shipments will be accommodated in a large warehouse in course of construction by the owner of one of the large plantations.

IMMIGRATION INVITED.

In his recent message to the Cuban Congress, President Palma recommended legislation to encourage immigration to the island. He said:

The sugar industry and tobacco planting being the rich fountains whence spring the many enterprises that yearly engage attention in this island, giving life in various ways to the economic being of the nation, it is but reasonable that the State render as much assistance thereto as may be compatible with other public interests that can not be neglected. One of the measures indicated as an aid to agriculture is the promulgation without delay of an immigration law, promoting on the one hand the immigration of laborers in number proportionate to the needs of the country, and on the other hand stimulating the increase of the rural population by the immigration of foreign families, to whom sufficient facilities and advantages to induce them to make homes in and adopt Cuba as their country should be offered. Any amount that might be applied from the treasury surplus for either purpose, particularly the latter, would be an investment bound to be abundantly productive. With the aid given by such a law it is not to be doubted that a constant current of labor immigration will be assured, if it be borne in mind that during the last year 54,219 immigrants arrived upon their own initiative, without other inducement than the certainty of finding work at good wages.