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TESTS MADE BY THE WAIALUA AGRICULTURAL CO., LTD., TO DETERMINE THE CAPACITY OF THEIR "LILLIE" QUADRUPLE-EFFECT.

This evaporator was furnished by the Sugar Apparatus Manufacturing Co. of Philadelphia. Its rated capacity was originally 250,000 gallons diluted and clarified cane juice concentrated 75% in 24 hours to a syrup of 54° Brix density, using only exhaust steam to the first cell of 5 lbs. pressure per sq. in., and having 26 inch vacuum in the fourth cell. The apparatus was built with a tube area of 1,700 sq. ft. in each cell and 1700 × 4=6,800 sq. ft. total in all the four cells.

In 1902, the Waialua Agricultural Co. ordered an additional tube system from the Sugar Apparatus Manfg. Co., as the prevailing conditions demanded a greater capacity. This contract was based on a guaranted increase of 50% evaporation, or 375,000 gallons, but otherwise under the same general working conditions as stated above.

Mr. S. Morris Lillie instructed the Honolulu Iron Works Co. to build this increase but to give the apparatus 75% greater tube area, instead of 50% as contracted for, so as to dispel all doubts as to its final capacity, even under unfavorable working conditions. The original tube surface of 1,700 sq. ft. in each cell was, therefore, increased to 2975 sq. ft., or a total of 11,900 sq. ft. in all the four cells.

Monday, January 11th, and Saturday, January 16th, were selected for the tests being the first and last days of a continuous week's run, and the average work performed during these days should determine the result. The apparatus had prior to this been thoroughly overhauled by the mill management, and Mr. Lillie had personally inspected it and testified as to its good working condition.

The two following reports on these two days' tests were submitted to Mr. W. W. Goodale, manager of the Waialua Agricultural Co., Ltd., by Mr. Horace Johnson, the company's chemist, and form the basis for the following calculations:

TEST 1.

January 12th, 1904.

Mr. W. W. Goodale,

Manager, Waialua Agric. Co., Ltd., Waialua.

Dear Sir:—The test of the Lillie Evaporator which took place at the Waialua Mill January 11th., 1904, resulted as follows:

Duration of test—1 hour 53 minutes.

Total juice entering evaporator......26,842 gallons
Total syrup obtained................ 3,882 "
Water evaporated ....22,960 "
Or 85.54% by volume.

237.5 gallons of juice were evaporated 85.54% per minute. At this rate, 342,000 gallons would have been evaporated 85.54% or 390,144 gallons evaporated 75% during 24 hours.

The evaporator was run under the following conditions:

Steam Press.	Vacuum.				
1st Effect	2d Effect	3d Effect	4th Effect	~~On steam end~~ of 4th effect	At Vac P.
1.1 lbs.	4.9 ins.	9.5 ins.	15.45 ins.	24.4 ins.	25.40 ins

Density of juice entering evaporator....10.45° Brix
Density of syrup.......................58.4° "

Yours respectfully,

HORACE JOHNSON,

Chemist W. A. Co., Ltd.

TEST 2.

January 16th, 1904.

Mr. W. W. Goodale,

Manager, Waialua Agric. Co., Ltd., Waialua.

Dear Sir:—The second test of the Lillie evaporator at the Waialua Mill, taking place January 16th, 1904, resulted as follows:

Duration of test—2 hours 8 minutes.

Total juice entering the evaporator........ 29,522.5 gallons
Total syrup obtained .... 4,116.25 "
Water evaporated .... 25,406.25 "
Or, 86.06% by volume
Water evaporated per minute........... 198.486 "
Water evaporated per 24 hours...........285,820 "
Juice evaporated 86.06% per 24 hours......325,075 "
Juice evaporated 75% in 24 hours..........381,093 "

The evaporator was run under the following conditions:

Steam Press.	Vacuum.				
1st Effect	2d Effect	3d Effect	4th Effect	On Steam end of 4th Effect	At Vac. P.
1.5 lbs.	4.5 ins.	10.1 in.	16.25 in.	24.8 ins.	25.8 ins.

Density of juice entering the evaporator..11.17° Brix
Density of syrup........................61.06° "

Yours respectfully,
HORACE JOHNSON,
Chemist W. A. Co., Ltd.

If these reports be further analyzed so as to ascertain the effective evaporation performed by this apparatus during these tests, we find as follows:

TEST 1.

Water was evaporated at the rate of 75% from 390,144 gallons juice per 24 hours = 292,608 gallons of water. The guarantee was $\frac{375{,}000 \text{ galls.} \times 75}{100} = 281{,}250$ gallons of water, and the quantity evaporated in excess of the guarantee was therefore 11,358 gallons.

The efficiency was:

$$\frac{292{,}608 \text{ gallons} \times 8.34 \text{ lbs.}}{24 \text{ hours}} = 101{,}681 \text{ lbs. of water evaporated}$$

in one hour.

$$\frac{101{,}681 \text{ lbs.}}{2975 \text{ sq. ft.}} = 34.18 \text{ lbs. of water evaporated per sq. ft. per}$$

hour in *one* cell, and

$$\frac{34.18 \text{ lbs.}}{4} = 8.54 \text{ lbs. of water evaporated per sq. ft. per hour}$$

in the *four* cells.

The average pressure of the exhaust steam
to the first cell was ...... 1.1 lbs. at 216° temperature.
The average vacuum in the fourth cell,
.... 24.4 in. at 138.5° temperature.

Difference in temperature,............ 77.5°.

As stated above, the guarantee was based on:
5 lbs. pressure of exhaust steam to the
first cell of.........................228° temperature
26 inches vacuum in fourth cell of........126.3° "

Difference in temperature................101.7°
and was 101.7° — 77.5° = 24.2° less during the test.

If we take as approximately correct, the evaporation to be proportional to the difference in the temperature of steam to the first cell and the temperature of the vacuum to the last cell, the evaporation under the conditions called for in the guarantee would have been:

$$\frac{34.18 \text{ lbs. water} \times 101.7° \text{ difference}}{77.5° \text{ difference}} = 44.85 \text{ lbs. of water evap-}$$

orated per sq. ft. per hour in *one* cell, and,—

$$\frac{44.85}{4} = 11.21 \text{ lbs. water evaporated per sq. ft. per hour in the}$$

four cells.

As 292,608 gallons of water were evaporated in 24 hours at the rate of 8.54 lbs. per sq. ft. per hour (see above), the increased evaporation at the rate of 11.21 lbs. per sq. ft. per hour would have been:

$$\frac{292{,}608 \text{ galls.} \times 11.21 \text{ lbs.}}{8.54 \text{ lbs.}} = 384{,}091 \text{ gallons water per 24 hours,}$$

or 75% of 512,121 gallons of juice entering the apparatus in 24 hours, and would then have exceeded the rated guarantee at 50% increase of tube system:—

512,121 — 357,000 = 137,121 gallons

and with the 75% increase of tube system:—

512,121 — 437,500 = 74,621 gallons of juice per 24 hours.

TEST 2.

Water was evaporated at the rate of 75% from 381,093 gallons of juice per 24 hours = 285,820 gallons of water per 24 hours. The guarantee was

$$\frac{375{,}000 \text{ galls.} \times 75}{100} = 281{,}250 \text{ gal-}$$

lons of water, and there were therefore evaporated 4,570 gallons of water in excess of the guarantee.

The efficiency was:

$$\frac{285{,}820 \text{ gallons} \times 8.34 \text{ lbs.}}{24 \text{ hours}} = 99{,}322 \text{ lbs. of water evaporated in}$$

one hour.

$$\frac{99{,}322 \text{ lbs.}}{2975 \text{ sq. ft.}} = 33.38 \text{ lbs. of water evaporated per sq. ft. per}$$

hour in *one* cell, and

$$\frac{33.38 \text{ lbs.}}{4} = 8.34 \text{ lbs. water evaporated per sq. ft. per hour in}$$

the *four* cells.

The average pressure of the exhaust steam
to the first cell was.........1.5 lbs. of 217° temperature
The average vacuum in the fourth cell was
.........................24.8 in. of 136° temperature

Difference in temperature .... 81°

As stated above in Test 1, the guarantee was based on a difference in temperature of 101.7° and was during this test 101.7° — 81° = 20.7° less.

Following the same calculation as in test 1, the evaporation under the conditions of the guarantee would have been:

$$\frac{33.38 \text{ lbs. water per sq. ft. per hour} \times 101.7^\circ \text{ difference}}{81^\circ \text{ difference}} = 41.9$$

lbs. water per sq. ft. per hour in *one* cell, and,—

$$\frac{41.9}{4} = 10.48 \text{ lbs. water per sq. ft. per hour in the } \textit{four} \text{ cells.}$$

As 285,820 gallons of water were evaporated in 24 hours at the rate of 8.34 lbs. per sq. ft. per hour (see above), the increased evaporating efficiency at the rate of 10.48 lbs. would have been:—

$$\frac{285{,}820 \text{ galls.} \times 10.48 \text{ lbs.}}{8.34 \text{ lbs.}} = 359{,}159 \text{ gallons of water per 24}$$

hours, or 75% of 478,878 gallons of juice entering the apparatus per 24 hours, and would have exceeded the rated guarantee with the 50% increase of tube system by 478,878 — 375,000 = 103,878 gallons, and with the 75% increase of tube system by 478,878 — 437,500 = 41,378 gallons of juice per 24 hours.

SUMMARY:

In accordance with the above calculations, the *average* evaporation performed during the first and last days' work of the week's run was:

385,618.5 gallons of juice evaporated 75% in 24 hours, which was 10,618.5 gallons in excess of the guaranteed capacity.

Or, 289,213 gallons of water evaporated in 24 hours at the rate of 8.44 lbs. water per sq. ft. of total tube surface per hour with exhaust steam to the first cell 1.3 lbs. pressure per sq. in. and 24.6 inches of vacuum on the fourth cell, giving an average difference of temperature of 79.25°.

Density of juice entering..............10.81° Brix
Density of syrup leaving..............59.73° "

NOTE: If the juice supply during these tests would have allowed a pressure of 5 lbs. of exhaust steam to the first cell, while the vacuum was maintained at 26 inches in the fourth cell, the actual capacity corresponding to the 75% enlargement would have been 495,500 gallons of juice per 24 hours, which would have been 58,000 gallons in excess of the rated capacity, or nearly 13¼%, and the efficiency would have been at the rate of 10.84 lbs. of water evaporated per sq. ft. of tube surface per hour. C. HEDEMANN.

Honolulu, 7th March, 1904.

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OILS.

By John M. Edgar.*

"I will not mention a class of oil, a dark cylinder oil, a light cylinder oil or an engine oil, which is not made by ten, twenty or thirty different houses. I have nothing to say in favor of any one class of oils. Of course, I am here to tell you how they are made, why they were manufactured and put on the market in the early days, the business of making different oils for different purposes and the demands of machinery, and in doing so I will give my views according to such experience as I have possibly gathered in the oil fields, in the refinery and in the laboratory.

"In the early days steam pressures ranged up to 80 lbs. and in locomotive work possibly a little higher, and the engineers used tallow, which was the only lubricant they then had. They used what is known as the 'tallow pot.' They would fill a pot full of lump tallow and keep it on the boiler of the engine, melt it and pour it in as they needed oil. Later on, when petroleum was discovered and they began to refine it to produce illuminating oil, they had a large amount of heavy oil left which they did not know what to do with; it was a biproduct. They began to introduce it on the market as a lubricant. They combined this petroleum with tallow, castor oil, grape-seed oil, neats-foot oil, palm oil and lard oil. In the course of time they found that in the cylinders, where they had moisture to contend with, the water would wash the mineral oil off the surface, and the adding of a little animal or vegetable oil would saponify with the water to a more or less extent and form an emulsion or soap; and this, in turn, would take up the mineral oil, or in other words, hold the mineral oil on the surface in the form of a film, which was needed to produce lubrication and keep the metal surface apart. Illu-

*Paper read before Honolulu Engineering Association.

minating oil being the main product and refining by fractional distillation, they would put the oil in a retort, apply heat, which would bring it up to certain gravities or temperatures and draw off the gasoline; then take off, at a higher temperature, the kerosene. There is no need of my giving you a lot figures on gravities and temperatures. Next we get an oil which is know as a neutral, a light neutral. It is too heavy to burn and too light to produce a lubricant; practically no body to it and no market for it. They have tried to mix it with paint oils and in many ways get rid of it as a substitute for other oils on the market. We next get what is known in the refineries as wax oils, which contain paraffine. We will take the wax oils as they handle them in the refineries. They place the wax oil in a freezing room, bringing the temperature down to 25° F., which congeals all of the paraffine into a mass. They draw the clear oil off the top, which is free from the paraffine, and pump this clear oil out into large pans from a foot to two feet in depth, 20 feet wide and 40 feet long, and leave it exposed for a week or ten days to the action of the weather or atmosphere. They do that for the purpose of deblooming the oil. They call the process deblooming, because it rids it of the bloom. Practically it gets rid of a percentage of kerosene, or lighter hydro-carbons, which cling to the oil or heavier hydro-carbons as a part of the chemical composition which is impossible to break up and drive away with additional heat, but in this manner gotten rid of by atmospheric exposure. These pans are exposed to the rain, sun, dirt, dust, etc. The oil is taken from them and filtered through bone-ash and after filtering one, two or three times, according to the viscosity and gravity we wish to reach, we then have our best engine oils; we have gotten rid of our paraffine, which is not a lubricant. Paraffine is used to wax floors, as it gives little resistance. It also coagulates into a mass when exposed to atmospheric action, gathers dirt, therefore a little paraffine in the oil is a resistance and necessitates a greater consumption of oil. If, at any time, you are buying an engine oil and it has that heavy bloom, it is an indication that it must be an inferior oil. The next suspicious test is to place a bottle of oil in a dish of ice and water, which gives it a temperature of 32° F.; if it is a paraffine oil it will become thick, which proves that the paraffine has been left in; if it is a light or heavy oil and does not cling to the glass, or if it does not form three or four divisions across the top and stay there when the sample bottle is shaken, it is a further test of paraffine oil being present. If you take a bottle of engine oil and shake it and it does not form a film across the top, it is filled with cheap paraffine oil and cheap neutral oil. On the other hand, if it has a very stringy nature, it must be a neutral filled up with pulp. In the oil field they make what is known as mineral axle oil, or wagon oil;

they take this neutral which they want to get rid of and add to it a percentage of what is known as pulp, which is made by saponifying some tallow with soda carbonate, producing a soap, and adding to that some alum, which gives you oleate of aluminium, which is a very sticky mass and has no lubricating properties whatever, but is simply as named, a pulp, and is used to thicken cheap oils. Paraffine is taken from the tanks, put into the press, the oil pressed out and the paraffine prepared for the market. The oil that drips from the filter press is red, dark in color, known and sold as paraffine oil. There is a large quantity of paraffine oil produced which is light colored. They take the color out of the cheap oils by adding sulphur. Sulphur destroys the color; it is a cheap method, but injurious in time to machinery. Another condition resorted to in the oil-refining business is as follows: They take the light neutral between the kerosene and the wax oils, then take all of the paraffine oil coming from the filter press and add these two oils to the good engine oil; then they filter and make one gallon of good oil carry two gallons of oil that is really no good, and that enables different oil concerns to produce very cheap oils. It is the same thing that we find in cloth; you can get any percentage of cotton you want with the wool. I am simply mentioning all these conditions as you will find them if you visit the refineries in Pennsylvania and Ohio. I do not refer to the California oils, because they are all of an asphaltum base and although they are trying to refine them for lubricating purposes, I do not believe they will ever be successful, for the reason that they will not be able to reach the high steam temperature, or be equal to the high duty demanded by our heavy bearings and rapid-running machinery, with any crude other than one of a paraffine base.

Now we come to what is left in the retort, or the cylinder stock. In the early days they refined by direct heat, and consequently, in doing so they charred a great amount of the hydro-carbons. All pertroleum oils are hydro-carbons, and subjected to this severe heat, there is more or less hydro-carbon broken up and straight carbon left. This carbon was mainly grit and interfered with the lubricators. Furthermore, that high degree of heat caused a large amount of the oil to become like heavy residuum and consequently did not have a cold test; it was so thick it would not feed through the lubricators. They found, in the early days, that a little degras had the physical property of making this oil thin so it would flow; they used a percentage of degras and a percentage of tallow, which afterwards, in the barrels, separated and formed a heavy mass with the charred mineral oil and was very objectionable, and, at the same time, the different refineries began to filter the cylinder oil through bone-ash. They put it through the bone-ash three or four times until they produced a light, clear, filtered oil. In doing so they took out 35% of the original existing lubricating properties of the oil, and where they possibly could have taken the dark oil and lubricated an engine cylinder, the filtered oil would not lubricate; it had not body enough to hold without the use of some animal or vegetable oil. They further found that the use of lump tallow would separate and also had an action on the metal, so they sweetened their tallow and produced what is known as acidless tallow oil. In the last three or four years the acidless tallow oil has gone from 40 cents to 95 cents per gallon at the packing houses—it matters not who buys or how much, it is all the same price, and the better oil houses throughout the country are still using the same. Some oil concerns claim great knowledge and use grape-seed oil; palm-oil and neats-foot oil, but all these oils were dropped many years ago, as the friction test proved they were not one-half so valuable as tallow; furthermore, they would not take care of the moisture like tallow; and the mineral oil should do all of your lubricating to-day and the tallow should be used only to take care of moisture in the steam. Later on, as the steam temperatures began to get higher and we commenced to have water tube boilers and larger units, there was a demand for better oil, higher test oil to meet the present conditions, so they cleaned or filtered the crude first and then refined it in the retort by fractional distillation and the use of a vacuum pump. That was partly successful, and later on they took their crudes and filtered through strainers and burlap; filtered, you understand, before refining was begun, consequently all foreign matter was carefully taken out before the crude oil was pumped into the retort, and then, before applying the heat, the prepared steam coils were introduced into the retort and a constant flow of steam turned into the oil. This steam preserved the hydro-carbons, subdued the heat and prevented charring, breaking up, disintegration or other chemical changes. We were enabled to continue the fractional distillation up to a higher degree, and reach a higher flash point and a higher fire test, and, at the same time, give a little heavier gravity and a greater density, and when this cylinder stock was removed from the retort, after drawing the fires, or shutting off the steam, they had an oil that, although it was thick and dark, the minute you brought it up to 175° to 212° F., it would flow just as readily as a filtered oil, or a dark, unfiltered oil of a lower test, and would atomize and spread just as readily and quickly, and although it is as thin as the lower test oil, it maintains itself perfectly in the cylinder against the existing condition and a greater heat, because they have brought the flash test and fire test above the temperature existing in the steam in the cylinder; consequently, it could not burn or volatilize or be destroyed, and yet it is not a tar-like nature, nor does it contain any dirt. Therefore, we have been able to handle the high steam pressures of to-day and keep a perfect film on the surfaces of the cylinder and piston. The steam in the retort passes over with the kerosene and gasolene and has to be removed at an expense. It is easy enough to get rid of it in the engine oils, but we have to wash the kerosene with sulphuric acid, which is the cheapest and best method, also practical in getting rid of the water, which has an affinity for sulphuric acid and is taken up by it. This is an expense on which was once the main product and changes the main product to bi-product, making lubricating oils the main product, which is brought about by the necessity and the demand of the high units of your water tube boilers and compound and triple-expansion engines carrying 140-180-210 lbs. pressure. In vertical engines the piston weight is all on itself. In most cases vertical engines can run without oil, but on a horizontal engine, where we have the great weight of the piston to contend with, we must have an oil with body to hold enough heat units to reach a point higher than the heat in the cylinder. Of course if you take a horizontal engine with a tail rod carrying the weight off from the cylinder, possibly we could get along without oil."

Mr. Hedemann:—"What would you advise in the way of lubrication for our mills where there is great pressure on the rollers?"

Mr. Edgar:—"In surface lubrication where there is great pressure and slow-moving machinery, it has been found necessary to have a very heavy oil; if the rollers were turning over 300 to 1000 revolutions per minute, I would advise using a light oil with a viscosity of about 165, with a gravity of 31 and fire test of 460; such an oil would take care of the bearings. On slow moving, heavy machinery, however, a heavy oil has been found necessary and vegetable castor has been very successful on large, heavy rollers in paper mills and other factories, but castor oil or any vegetable or animal oil of the nature of a carbohydrate, readily congeals and becomes gummy, mixes with the dust and dirt, and that being the case it has been found better to use mineral oil; and in using the mineral oil it is very essential that we should use cylinder stock, so as to give a heavy enough body to enable us to carry a certain high flash and fire test to the corresponding gravity and viscosity. Such an oil would be capable of taking up the latent heat fast enough and would be thick enough to keep clinging to the surfaces and enable us to get proper lubrication and keep the bearings down to a proper temperature. I think that if there is any addition to be made to the straight mineral cylinder oil of the highest flash and fire test you could obtain, it would be the adding of a little lard oil. Lard oil has a physical action we cannot explain chemically. We can take a little lard and soda and saponify it, add a little paraffine and make a grease which we can put on red hot metal and it will not burn ,melt or run off. I believe that a little lard oil added to cylinder stock might be of some benefit."

Mr. Hedemann:—"Experiments should be made to find out what is the extreme limit of pressure that can be maintained on roller bearings."

Mr. Edgar:—How many pounds are carried or are trying to be carried on the new mills?

Mr. Hedemann:—"About 420 to 425 tons on the top rollers of the last mills,—bearings 15½" dia., 20" long—enormous pressure."

Mr. Edgar:—I believe that class of lubrication can still be bettered to a great extent; I shall work out a formula to cover same.

I might say that in testing oils we take the flash and fire test. We want the flash test when the oil begins to break apart and then we want the fire test to know at what point the oil is absolutely destroyed. Place the oil in the cup, put a very small flame under it and allow the oil to warm not more than 10° to 15° per minute; after reaching a point of 400 on cylinder oil and 150 on engine oil, watch the thermometer hanging in the oil and pass a little flame across the surface; at first you will get a flicker; do not pay any attention to the flicker, because when you get a flash it will be a distinct flash across the entire cup which will go out. That is your flash test; take the reading of your thermometer. Do not heat the oil too rapidly, as this would not give you an equal temperature throughout the body of the oil; very soon the oil will take fire and remain on fire, and that is your burning test; take the reading of your thermometer instantly. In making this test do not stand too closely and do not allow your breath to pass over the surface. If an oil man wanted to make the test for you and you were watching it, he would keep his breath across the top and that would necessitate a great deal of the volatile parts lost before you get your flash; he would heat the oil up very slowly so as not to give you your test too quickly. In the viscosity test, cylinder oil is warmed up to 212° F. in the viscosmeter, and when you have the entire body of oil at 212°, according to the thermometer, you open your valve and start your stop watch at the same time and have a little test tube of 50 cubic centimeters; some tests are made at 100, but 50 is right; when you come back to the 50 mark you stop your watch and multiply this by two, and that gives you the accepted viscosity of the oil. The reason we do not use 100, is due to the fact that in the early days 100 was patented by a certin oil company, so the others simply changed this to 50 and beat the patent by multiplying by two. The viscosity is for the purpose of determining the absolutely true body of the oil.

I might have a very thick, pulpy mass of oil with a high fire test, but no body when warmed up to 212°; it would not stand the heat without getting as thin as water.

Practically there are no rules you could go by in books up to date. The tables covering present demands are very plain, but not printed. We have found that a good oil for certain purposes should have a flash and fire test and an approximate set viscosity and gravity. Now, the gravity might be all right and your flash and fire test would not be right. Asphaltum oil might give a flash and fire test as wanted, but we might have too high a viscosity and too high a gravity, due to asphaltum heavy base, and our cold test would be so light, also indicating heavy base. The tests are all relatively dependent upon one another.

Engine oils are tested in the viscosmeter at 70°, cylinder oils at 212°. A cylinder oil or engine oil tested for its gravity should be warmed from 80° to 100° F., especially cylinder oil ought to be at least 100° so the hydrometer can hang buoyantly; then take the reading of the thermometer in the hydrometer, also take the reading of the hydrometer; then refer to your accepted book of tables and it will give you the true gravity taken at 60° F. If it is such a reading at 100 it would be the table reading at 60, accepted by all chemists.

Mr. Fuller:—"Why is it that all cylinder oils cost more than engine oils?"

Mr. Edgar:—There is really no reason why they should cost more, except the fact that there is considerable more of the lighter oils than the heavier. That is not so of the Ohio oils, but in the early days people were willing to pay more for the cylinder oils; they were afraid of the cylinder because they could not see inside of it, while they could see the bearings. A man is not half so afraid of a thing if he can see it; he is very much like a horse in this respect.

Mr. Goodale:—"On the nine-roller mills we use very hot water for macerating and the result is, with continuous grinding, the top roller of the third mill is heated to a high point; is that sufficient to require a special oil for lubricating?"

Mr. Edgar:—The large rollers with the heavy pressure warrant one in using on the mills the highest test oils that can be obtained, at an economical or reasonable figure. The heat of the hot water is transmitted through the metal to the bearings.

Mr. Goodale:—"The temperature of the whole mass and rollers is very high on the third mill."

Mr. Edgar:—And that heat is added to the heat from friction of the bearings, which brings the temperature very high on the journals. I did not realize or know, up to the present trip, the extreme demand for a very high flash and fire test oil, not only a thick oil, but high in flash and fire test, on these roller mills. It is quite interesting to see the conditions existing in these new mills with greater pressures, also those of the paper mills East. They require pretty large rollers and very heavy crushers in our paper mills throughout the States, which are handled successfully with heavy gravity prepared oils.

Mr. Gartley:—"Why is it necessary for us to have a special oil for marine service?"

Mr. Edgar:—In the early days marine engineers used lard oil exclusively on their engines. Lard oil saponifies very readily with water, and this fact is also true that in cylinder oil experiments, where lard oil should not be used, it washes off. In surface lubrication on marine engines in the pit where there is water, lard oil saponifies very readily with the water and is also a very good lubricant on all metal surfaces exposed to water. Later on, the marine engineers began to mix a good mineral oil with the lard oil in proportions of 65 parts mineral and 35 lard oil, and they had great deal better results. The co-efficient of friction averages 125 on mineral oil, 156 on lard oil, 160 on linseed oil and 140 on tallow oil, making the mineral oil a greater lubricant.

Mr. Gartley:—"It is customary sometimes to use mineral oil exclusively, except when the parts get warm; it seems to have the desired effect."

Mr. Edgar:—As a lubricant, taking up latent heat and cooling, lard oil is far ahead of mineral oil, but as a lubricant exposed to the atmospheric action, it thickens and gathers dirt much more readily and also saponifies to a great extent with the water, so a good mineral oil is the best.

Mr. Fuller:—"Has castor oil the same quality?"

Mr. Edgar:—Yes, to a great extent, but does not saponify with the water. It gathers dust and makes a sticky condition much quicker than lard oil.

"If there are no more questions I will close, trusting I have not overlooked any points of interest. I thank you for your kind attention."

WORK OF THE EXPERIMENT STATION AND LABORATORIES.

(Charles F. Eckart, Director and Chief Chemist.)

(Continued from Page 131, March Number.)

FERTILIZATION WITH 150 POUNDS OF THE ELEMENTS.

(Blouin's Experiments.)

These experiments, comprising eight plats in all, were started in June, 1901, and harvested in April, 1903.

The plats may be designated as follows:

Plat 1. Unfertilized. (Lahaina Cane.)

Plat 2. Unfertilized. (Rose Bamboo Cane.)
(The same unfertilized plats were used as a basis in all series of experiments.)

Plat 3. 150 lb. Nitrogen, ⅓ as Nitrate of Soda, ⅔ as Sulphate of Ammonia.
150 lbs. of Phosphoric Acid as Double Superphosphate.
150 lbs. of Potash as sulphate. (Lahaina Cane.)

Plat 4. Fertilization as in Plat No. 3. (Rose Bamboo Cane.)

Plat 5. 150 lbs. of Nitrogen, ⅓ as Nitrate of Soda, ⅔ as Sulphate of Ammonia.
150 lbs. of Potash as Sulphate. (Lahaina Cane.)

Plat 6. Fertilization as in Plat No. 5. (Rose Bamboo Cane.)

Plat 7. 150 lbs. Nitrogen, ⅓ as Nitrate of Soda, ⅔ as Sulphate of Ammonia.
150 lbs. of Phosphoric Acid as Double Superphosphate. (Lahaina Cane.)

Plat 8. Fertilization as in Plat No. 7. (Rose Bamboo Cane.)

The yields of cane and sugar and the quality of the juices are shown in the following tables:

WEIGHT OF CANE PER ACRE.

Plat	Lahaina, Lbs.	Plat	Rose Bamboo, Lbs.	Average, Lbs.
1	112,559	2	111,688	112,123
3	126,226	4	115,695	120,960
5	149,614	6	117,612	133,613
7	166,748	8	127,195	146,971

ANALYSIS OF JUICES.

Plat	Density by Brix	Sucrose in Juice Per Cent.	Glucose in Juice Per Cent.	Purity of Juice
1	19.11	17.40	.298	91.05
2	19.44	18.00	.123	92.59
3	18.74	16.95	.464	90.44
4	19.57	18.25	.192	93.25
5	18.26	16.70	.505	91.45
6	18.87	17.55	.284	93.00
7	17.46	15.80	.548	90.49
8	17.37	15.70	.373	90.38

SUGAR PER ACRE.

Plat	Lahaina, Lbs	Plat	Rose Bamboo, Lbs.	Average, Lbs.
1	17,525	2	17,993	17,759
3	19,155	4	18,893	19,524
5	22,367	6	18,465	20,416
7	23,578	8	17,871	20,724

The largest weight of cane per acre for both varieties was obtained where nitrogen and phosphoric acid were applied, potash being omitted. This plat also gave the highest yield of sugar per acre with Lahaina cane, while Plat No. 4 of Rose Bamboo, receiving nitrogen, phosphoric acid and potash, gave the greatest yield of sugar with that variety. The percentage of sucrose in the juice of Plat No. 4 (Rose Bamboo) was 12.25, while in Plat No. 8, receiving only nitrogen and phosphoric acid, the percentage of sucrose was 15.70. This difference in the quality of the juices of the two Rose Bamboo plats gave the complete fertilizer test the superior yield.

It will be noted that the Lahaina cane responded better to this high fertilization than the Rose Bamboo. The greatest gain in sugar with Lahaina cane was 6,053 pounds (Plat 7); with Rose Bamboo the greatest gain was only 900 lbs. (Plat 4). With the fertilization that gave Lahaina cane its highest output of sugar, there was a loss of 122 pounds with Rose Bamboo. It will be very interesting, on this account, to study the relative manner in which the same fertilization affected the two varieties with regard to the amounts of solid matter produced.

SOLID MATTER PRODUCED PER ACRE.

LAHAINA.

Plat	Solid Matter in Cane Lbs.	Solid Matter in Leaves Lbs.	Total Solid Matter Lbs.	Sugar Lbs.
1	31,066	39,073	70,139	17,525
3	34,433	52,602	87,035	19,155
5	40,156	50,525	90,681	22,367
7	43,554	52,199	95,753	23,578

ROSE BAMBOO.

Plat	Solid Matter in Cane Lbs.	Solid Matter in Leaves Lbs.	otal Solid Matter Lbs.	Sugar Lbs.
2	31,161	39,657	70,818	17,993
4	31,839	51,333	83,172	18,893
6	32,214	45,981	78,195	18,465
8	33,134	52,178	85,312	17,871

AVERAGE OF LAHAINA AND ROSE BAMBOO.

Plats	Solid Matter in Cane Lbs.	Solid Matter in Leaves Lbs.	Total Solid Matter Lbs.	Sugar Lbs.
1 and 2	31,113	39,365	70,478	17,759
3 and 4	33,136	51,967	87,103	19,024
5 and 6	36,185	48,253	84,438	20,416
7 and 8	38,344	52,188	90,532	20,724

PERCENTAGE OF SOLID MATTER IN THE CANE AND LEAVES.

Lahaina			Rose Bamboo		
Plat	Solid Matter in Cane Per Cent.	Solid Matter in Leaves Per Cent.	Plat	Solid Matter in Cane Per Cent.	Solid Matter in Leaves Per Cent.
1	44.3	55.7	2	44.0	56.0
3	39.6	60.4	4	38.3	61.7
5	44.3	55.7	6	41.2	58.8
7	45.5	54.6	8	38.8	61.2

GAIN OR LOSS FROM FERTILIZATION.

Lahaina.

Plat	Gain or Loss in Solid Matter in Cane	Gain or Loss in Solid Matter in Leaves	Gain or Loss in Total Solid Matter	Gain or Loss in Sugar
1	....	....	....	....
3	+ 3,367	+13,529	+16,896	+1,630
5	+ 9,090	+11,452	+20,542	+4,842
7	+12,488	+13,126	+25,614	+6,053

Rose Bamboo.

Plat	Gain or Loss in Solid Matter in Cane	Gain or Loss in Solid Matter in Leaves	Gain or Loss in Total Solid Matter	Gain or Loss in Sugar
2	....	....	....	......
4	+ 678	+11,676	+12,354	+900
6	+1,053	+ 6,324	+ 7,377	+472
8	+1,973	+12,521	+14,494	−122

Average of Lahaina and Rose Bamboo.

Plats	Gain or Loss in Solid Matter in Cane	Gain or Loss in Solid Matter in Leaves	Gain or Loss in Total Solid Matter	Gain or Loss in Sugar
1 and 2	....	....	....	....
3 and 4	+2,022	+12,602	+14,624	+1,265
5 and 6	+5,071	+ 8,888	+13,959	+2,675
7 and 8	+7,230	+12,823	+20,053	+2,965

The results presented in the foregoing tables are very interesting, as they show that while the gains from fertilization in the solid matter of the cane were very large with Lahaina, ranging from 3,367 pounds to 12,488 pounds, with Rose Bamboo they were relatively small, ranging from 678 pounds to 1,973 pounds. With regard to the gain in solid matter of the leaves, Lahaina ranged from 11,452 pounds to 13,529 pounds, and Rose Bamboo varied from 6,324 pounds to 12,521 pounds. Fertilization with 150 pounds of the elements stimulated the leafy growth of the Rose Bamboo to a very pronounced extent as compared to the extra amount of solid matter produced in the cane. With Rose Bamboo the greatest gain in total solid matter was 14,494 pounds, *86 per cent.* of such gain being in the leaves. The largest gain in total solid matter with Lahaina was 25,614 pounds, of which amount *51 per cent.* was in the leaves. Dead canes are included under "leaves" in these statements of data, and there were somewhat more among the Rose Bamboo than the Lahaina, although the difference was not enough to materially affect the results. The heading "leaves" should more properly be "leaves, tops and dead canes."

FERTILIZATION WITH 200 POUNDS OF NITROGEN, PHOSPHORIC ACID AND POTASH.

(BLOUIN'S EXPERIMENTS.)

These tests were started by my predecessor, with the object of noting the effect of different forms of the various fertilizing ingredients when applied in large quantities, two hundred pounds per acre being used in each instance. The tests were started in June, 1901, and concluded in April 1903, the plats, with the corresponding fertilization, being as follows:

Plats 1 and 2.	No Fertilizer.
Plats 3 and 4.	200 lbs. Nitrogen in Tankage 200 lbs. Phos. Acid in Tankage and Double Superphosphate. 200 lbs. Potash as Sulphate.
Plats 5 and 6.	200 lbs. Nitrogen as Fish Scrap. 200 lbs. Phos. Acid in Fish Scrap and Double Superphosphate. 200 lbs. Potash as Sulphate.
Plats 7 and 8.	200 lbs. Phos. Acid in Ground Bone. 200 lbs. Nitrogen in Ground Bone, and Nitrate of Soda. 200 lbs. Potash as Sulphate.

Plats 9 and 10. 200 lbs. Phosphoric Acid as Acid Phosphate.
200 lbs. Potash as Sulphate.

Plats 11 and 12. 200 lbs. Phosphoric Acid as Ground Phosphate Rock.
200 lbs. Potash as Sulphate.

The weights of cane and sugar yielded per acre in the various plats, together with the quality of the juices, were as follows:

WEIGHT OF CANE PER ACRE AND QUALITY OF JUICES.

LAHAINA.

Plat	Cane per Acre	Analysis of Juices			
		Brix	Sucrose	Glucose	Purity
1	112,559	19.11	17.4	.298	91.05
3	115,928	16.7	15.0	.606	89.82
5	113,546	17.87	16.3	.465	91.21
7	137,185	18.8	17.2	.395	91.49
9	112,559	19.0	17.3	.35	91.05
11	120,748	19.45	18.0	.301	92.54

ROSE BAMBOO.

Plat	Cane per Acre	Analysis of Juices			
		Brix	Sucrose	Glucose	Purity
2	111,688	19.44	18.0	.123	92.59
4	122,955	17.8	16.2	.291	91.01
6	132,887	18.14	16.8	.276	92.61
8	133,700	19.0	17.65	.247	92.89
10	115,579	19.25	17.85	.199	92.72
12	116,276	19.7	18.4	.22	93.40

AVERAGE OF LAHAINA AND ROSE BAMBOO.

Plat	Cane per Acre	Analysis of Juices			
		Brix	Sucrose	Glucose	Purity
1 & 2	112,123	19.22	17.70	.210	91.82
3 & 4	119,441	17.20	15.60	.448	90.41
5 & 6	123,216	18.00	16.50	.370	91.91
7 & 8	135,442	18.90	17.42	.321	92.19
9 & 10	114,069	19.12	17.57	.274	91.88
11 & 12	118,512	19.57	18.20	.260	92.97

The gain or loss of sugar (based on the yields of the unfertilized plats)are next given:

SUGAR PER ACRE.

LAHAINA.

Plat	Sugar per Acre. Pounds.	Gain or Loss. Pounds.	Gain or Loss. Percent.
1	17,525	....	....
3	15,558	−1,697	− 11.2
5	16,566	− 959	− 5.4
7	21,113	+3,588	+ 20.4
9	17,424	− 101	− .5
11	19,453	+1,928	+ 11.0

ROSE BAMBOO.

Plat	Sugar per Acre. Pounds.	Gain or Loss. Pounds.	Gain or Loss. Percent.
2	17,993	....	....
4	17,828	− 165	− .9
6	19,986	+1,993	+ 11.0
8	21,125	+3,132	+ 17.4
10	18,458	+ 465	+ 2.5
12	19,151	+1,558	+ 6.4

AVERAGE FOR LAHAINA AND ROSE BAMBOO.

Plats	Sugar per Acre. Pounds.	Gain or Loss. Pounds.	Gain or Loss. Percent.
1 and 2	17,759	....	....
3 and 4	16,693	−1,066	− 6.00
5 and 6	18,276	+ 517	+ 2.91
7 and 8	21,119	+3,360	+18.92
9 and 10	17,941	+ 182	+ 1.02
11 and 12	19,302	+1,542	+ 8.68

These figures show most conculsively the risk which is entailed through excessive fertilization. With Lahaina cane there was a material gain in two plats and a loss in three. Rose Bamboo showed a loss in one plat and a gain in four. The largest gain with both varieties was obtained where 200 pounds of phosphoric acid in ground bone, 200 pounds of nitrogen in ground bone and nitrate of soda, and 200 pounds of potash as sulphate were applied per acre. The average gain for the two varieties with this fertilization was 3,360 pounds of sugar. Where *100 pounds* of each element were applied, the nitrogen in the form of nitrate of soda, the phosphoric acid as double superphosphate, and the potash as sulphate, the average gain for the two varieties was *4,289 pounds* of sugar. With other plats the loss from heavy fertilization is even more striking; for instance, Lahaina cane responded as follows to fertilization with phosphoric acid and potash, nitrogen being omitted:

LAHAINA CANE.

Quantity of Potash and Phos. Acid (Acid Phosphate) Applied per Acre	Gain or Loss in Sugar
100 pounds	+ 3,135 pounds
200 "	— 101 pounds

With Rose Bamboo cane, the difference in yields is almost as great.

ROSE BAMBOO.

Quantity of Potash and Phos. Acid (Acid Phosphate) Applied per Acre.	Gain in Sugar
100 pounds	3,135 pounds
200 "	465 pounds

It is interesting to note the difference in yields between Plats 9 and 10 and Plats 11 and 12, both tests receiving 200 pounds of phosphoric acid and 200 pounds of potash, the difference in fertilization being in the form of phosphoric acid applied. The averages of the two varieties may be brought together as follows:

	Fertilization.	Gain in Sugar.
Plats 9 and 10—	200 lbs. Phos. Acid as Acid Phos. 200 lbs. Potash as Sulphate.....	364 pounds
Plats 11 and 12—	200 lbs. Phos. Acid as Ground Phosphate Rock 200 lbs. Potash as Sulphate......	1,543 pounds

This difference in yields is doubtless due to a more insoluble form of phosphoric acid causing less injury to the roots of cane than a soluble (and also acid) form when applied in excessive quantities. This point was touched upon in the report of the Committee on Fertilization for 1903.

The effect of this heavy fertilization on the amounts of solid matter produced by the cane of the two varieties is shown in the following series of tables:

SOLID MATTER PRODUCED PER ACRE.

LAHAINA.

Plat	Solid Matter in Cane. Pounds.	Solid Matter in Leaves. Pounds.	Total Solid Matter. Pounds.	Sugar Pounds
1	31,066	39,073	70,139	17,525
3	29,503	48,064	77,567	15,558
5	30,078	53,754	83,832	16,566
7	37,479	52,343	89,822	21,113
9	30,954	44,143	75,097	17,424
11	33,701	43,875	77,576	19,453

ROSE BAMBOO.

Plat	Solid Matter in Cane. Lbs,	Solid Matter in Leaves. Lbs.	Total Solid Matter. Pounds.	Sugar Pounds
2	31,161	39,657	70,818	17,993
4	32,497	53,052	85,549	17,828
6	35,521	54,216	89,737	19,986
8	36,767	46,899	83,666	21,125
10	32,050	47,679	79,729	18,458
12	32,708	41,437	74,145	19,151

AVERAGE OF LAHAINA AND ROSE BAMBOO.

Plats	Solid Matter in Cane. Lbs.	Solid Matter in Leaves. Lbs.	Total Solid Matter. Lbs.	Sugar Pounds
1 and 2	31,113	39,365	70,478	17,759
3 and 4	31,000	50,558	81,558	16,693
5 and 6	32,799	53,985	86,784	18,276
7 and 8	37,123	49,621	86,744	21,119
9 and 10	31,502	45,911	77,413	17,941
11 and 12	33,204	42,656	75,860	19,302

PERCENTAGE OF SOLID MATTER IN THE CANE AND LEAVES.

Lahaina			Rose Bamboo		
Plat	Solid Matter in Cane Per Cent.	Solid Matter in Leaves Per Cent.	Plat	Solid Matter in Cane Per Cent.	Solid Matter in Leaves Per Cent.
1	44.3	55.7	2	44.0	56.0
3	38.0	62.0	4	38.0	62.0
5	35.9	64.1	6	39.6	60.4
7	41.7	58.3	8	43.9	56.1
9	41.2	58.8	10	40.2	59.8
11	43.4	56.6	12	44.1	55.9

GAIN OR LOSS FROM FERTILIZATION.

LAHAINA.

Plat	Gain or Loss in Solid Matter in Cane	Gain or Loss in Solid Matter in Leaves	Gain or Loss in Total Solid Matter	Gain or Loss in Sugar
1	....	....	....	
3	— 1,563	+ 8,991	+ 7,428	— 1,967
5	— 988	+ 14,681	+ 13,693	— 959
7	+ 6,413	+ 13,270	+ 29,683	+ 3,588
9	— 112	+ 5,070	+ 4,958	— 101
11	+ 2,635	+ 4.802	+ 7,437	+ 1,928

ROSE BAMBOO.

Plat	Gain or Loss in Solid Matter in Cane	Gain or Loss in Solid Matter in Leaves	Gain or Loss in Total Solid Matter	Gain or Loss in Sugar
2	....	....	....	....
4	+ 1,336	+ 13,395	+ 14,731	− 165
6	+ 4,360	+ 14,559	+ 18,919	+ 1,993
8	+ 5,606	+ 7,242	+ 12,848	+ 3,132
10	+ 889	+ 8,022	+ 8,911	+ 465
12	+ 1,547	+ 1,780	+ 3,327	+ 1,158

AVERAGE OF LAHAINA AND ROSE BAMBOO.

Plat	Gain or Loss in Solid Matter in Cane	Gain or Loss in Solid Matter in Leaves	Gain or Loss in Total Solid Matter	Gain or Loss in Sugar
1 & 2	..... .	... .	....	....
3 & 4	− 113	+ 11,193	+ 11,080	− 1,066
5 & 6	+ 1,686	+ 14,620	+ 16,306	+ 517
7 & 8	+ 6,009	+ 10,256	+ 16,265	+ 3,360
9 & 10	+ 388	+ 6,546	+ 6,934	+ 182
11 & 12	+ 2,091	+ 3,291	+ 5,382	+ 1,543

CULTIVATION OF CANE AT REUNION.

BY M. LEON COLSON,

President Chamber of Agriculture, St. Denis, Reunion.

(From "T e Cultivation of Sugar Cane in Hawaii.")

Irrigation.

Irrigation in Reunion has made little progress of late, as many of the ditches have been neglected and much water allowed to escape. On the lower slopes which have been cleared the water sinks into the soil and continues its journey toward the sea, although deprived of the dampness of the upper forest regions.

We have surface streams and underground streams, a little water everywhere, and an abundant supply for a great part of the year. After the period of heavy winter rains, the beds of our streams hold but little water, so that, in the dry season when it is most needed, water is often lacking. But under the strata of permeable sand and pebbles which form the beds of our rivers, there flow inexhaustible streams, often of considerable importance. We should make use of this water.

We can apply all the methods of irrigation used in the Hawaiian Islands, cisterns, reservoirs, pumps, ditches (either dug or tunneled), and the management of running water in low as well as high altitudes. Each of these problems demands special study, as to the nature and permeability of the soil, the quantity and distribution of the rain, et cetera. And care must be taken to find how the gains of the increased output will compare with the cost of installing and maintaining a pumping plant. If the motive power of the numerous waterfalls of Reunion could be converted into electricity, the question of fuel would be easily settled.

Plowing.

Much land in Reunion is never touched by plows, on account of the great numbers of rocks and stones. There is, however, more arable land than is generally supposed. On many estates plowing is very extensive, but in some places it is little used. The general type of plow is the Brabant, drawn by six or eight oxen and working to a depth of 14 to 28 inches. In the first plowing of about 19 inches, two days of ten hours each are allowed for a single plow to an acre; the second plowing of about 30 inches takes about one and one-half days.

Plowing was at first unsatisfactory, owing probably to the fact that it was little understood and badly executed. One complaint was that plowing left the cane too little support against the cyclones which are always to be feared in our latitude; another, that it allowed the earth to wash away more easily under the action of the heavy rains. Land on which the plow has been used for many years under my own supervision, as well as information from Hawaii, leave no ground for these complaints. Account must be taken, however, of the depth of the soil, and the greatest depth to be used in plowing as well as the inadvisability of mingling good soil with the subsoil, which is often of inferior quality. This last may be managed with rakes which sift the soil without going too deep.

Our plowing could often be done by steam plows, or, better still, by electricity furnished by our waterfalls. Here also some association between neighboring planters would be of service. On some plantations weeding and plowing are done by ox-plows. It would be well if this method were more universally employed, as much for the reduction of hand labor as for the increase which would result in the crops.

Transportation.

On some estates small railways are used for the transportation of cane, fertilizers, wood, etc., but many plantations still employ bullock carts.

Labor.

Hand labor is furnished by the working classes of Reunion, by the month or day, and by foreigners bound by contracts for from one to three years. The difficulties met in recruiting laborers outside of Reunion, the exodus of creoles to Madagascar, military enrollment, rapid decrease in the numbers of those engaged, owing to the death of the old men, and the irregularity of the day laborer make in Reunion as serious a labor problem as in Hawaii. Its solution is not only urgent, but simple, if the home government would only remove the restraint placed on recruiting in Comores by the almost prohibitive decree of February, 1902, and authorize again recruiting in English India. Sixty-four thousand, seven hundred and thirty-three immigrants in 1859 diminished in 1881 to 41,045, and in 1902 to 13, 578.

Summary.

After comparing our conditions with those in Hawaii, I have come to these conclusions in regard to the improvement possible in our cultivation. The direct conclusions are these:

1. The speedy introduction of modern methods.
2. The giving of better care to the preparation and preservation of manure and composts.
3. The ascertaining of the proper amount of fertilizer for each particular composition of soil and condition of climate.
4. The extention of irrigation, where wise.
5. The use of deeper plowing wherever possible and the employment of better plows.
6. The introduction of more railroads for the transportation of cane.

The other conclusions are these, indirect, but equally important:

7. The keeping of agricultural statistics.
8. The establishment of an experiment station, subsidized by the colony, but organized and maintained by the planters, and under the management of chemists versed in tropical agriculture.
9. The sending out of men competent to study tropical industries.
10 The organization of a mutual agricultural trust, syndicates, and co-operative societies.

11. The diffusion of agricultural information, especially in certain schools.

We have really great resources, but instead of being guided by circumstances, let us look ahead and bear in mind our old saying, "To remain stationary in any industry is to recede," else others will step into our places and benefit by our efforts. First of all it would be wise to establish a planters' association similar to those in Hawaii, Louisiana, Queensland, and Java. This would be the means of an exchange of ideas on the measures to be taken; the wisdom of having a central mill; the search for new methods; the possible installation of a refinery; the best system of cultivation; the sending out of competent men to study the utility and value of inventions connected with the handling of sugar cane; the gathering of satistics and all questions of similar import.

This brief account of conditions in Reunion has been written with the aid of twelve years of practical experience. It is the hope of the author that it will be of some use in arousing a greater spirit of enterprise than has hitherto been shown in the colony.

THE JAVA PROCESS.

By George Stade.

Introduction:

The practical experiences gained during the last few years in the most modern sugar houses working with up-to-date machinery, have led to the fact generally acknowledged by all experts that the making of low-products (i. e. second and third sugars from the runnings or molasses-sugar as it is termed in some countries) is not only usually a financial draw-back, but also leads to a considerable loss in sugar. The object of a modern progressive mode of manufacture, is therefore to construct sugar houses where:

First sugar and completely exhausted final refuse molasses are made in one operation only.

The apparatus and processes introduced by Dr. Bock, Huch, Manoury and others, all endeavor to produce this result (more or less successfully). The cane-sugar industry is moreover greatly interested in the attainment of this end. Here to a greater degree than is the case with beet, the contents of Glycose and acids are as a rule extremely high and cause, without exception, serious losses in crystallizable sugar by reboiling and manufacturing low-products. Scientific researches having clearly proved, that the most indifferent sugar-boiler cannot close his eyes to the advantages of making first sugar only if a high class refined raw sugar is demanded.

For some time the working with mass-cuites has been brought to great perfection in Java and all modern sugar houses there are now making "first sugar and final molasses in one operation."

This success is chiefly due to the results attained by the eminent sugar expert, Dr. H. Winter, and his assistants and collaborators as is well known from the "Archief voor de Java Suikerindustrie." Dr. Winter has been working out his process for ten years, continuously making improvements and simplifying the same until it has reached the perfection and high standard of the present day, yielding completely exhausted molasses with a purity as low as 28 to 32%.

Our firm have great pleasure in acquainting our friends and the Sugar Industry generally, after Dr. Winter, this well-known authority on sugar cane matters, left Java, we succeeded in securing the services of the learned doctor as consulting expert for exploiting the newest improvements in his process "First Sugar and Refuse Molasses," i. e. "The Java Process." Dr. H. Winter has placed his long years of experience in this most successful process entirely at our dispoal and now superintends the construction of all our machinery, gives working instructions as well as the various important details necessary for "The Java Process."

Description of Machinery Required:

We can therefore guarantee to any sugar factory the same splendid results generally obtained in Java if the machinery we recommend is erected with proper superintendence and our directions strictly followed. In order to get the same excellent results as in Java, the vital point on which everything depends is of course successive co-operation of all stages of the process in the sugar-house, from the filtered juice-tanks down to the molasses separating reservoirs. Generally speaking the machinery required is not novel—but the accessories and devices in connection with this machinery are of great importance and we cannot therefore undertake any guarantee unless our working instructions are strictly followed. In this connection it may be stated:

1. The syrup or concentrated juice should be of the purest quality, no suspended matter which may surround the growing crystals (separating saccharose-crystal and mother liquor) may be present in the boiling liquor. A rapid and free crystallization is the essential feature on which everything depends and especially the exhaustion of the molasses. A series of "Standard Sand Filters" is, therefore, necessary to make the liquor as bright and clear as practicable. This can be effected without inversion by means of sand only.

2. The boiling liquor circulates in a vacuum pan of special construction fitted with Dr. Winter's patent injection system for syrup, steam and air. The heating surface and the capacity of the pan must be properly proportioned and the syrup introduced must be especially prepared.

3. The cooling down of the masse-cuite and the complete exhaustion take place in malaxeurs of special construction. The complete exhaustion of the mother-lye (the molasses) occupies about 35 hours including the time used for boiling in the pan.

4. The centrifugals are so designed that there is no difficulty in separating crystals and molasses. Masse-cuites yielding syrup of less than 30% purity can be readily treated whilst for high class sugars, provision is made to avoid an eventual washing of the sugar having any influence on the resulting low purity of the molasses.

5. A special system for the classification of the runnings is also required, i. e., a system of tanks the contents of which are under continuous control of the chemist, who carefully supervises the results of all previous operations.

Advantages of "The Java Process":

The important advantages obtained by the process "First Sugar and final Molasses" are obvious to any sugar refiner, and are as follows:

1. A considerable saving in wages.

2. Clean and convenient operation in the whole sugar department.

3. Dispensing with all storage tanks for second and third masse-cuite.

4. Considerable simplification of the whole plant.

5. No chemical losses by inversion.

6. No mechanical losses, no waste in tanks, gutters and pipes.

The chief advantage, however, of "The Java Process" from a financial point of view is the higher prices realized and obtained for the sugar sold. By comparing the work done with and without the Java Process in two sugar houses, the results obtained will speak for themselves: While personally introducing his process in the sugar works, Bogokidoel (Kediri) and in Poh-Djedjer (Soerabaia) and superintending the work done there, the following clearances were made by Dr. Winter—(For all details see Achief voor die Java Suikerindustrie, Volume V. page 23.)

Usine Bogokidoel: In the crop of 1896 with the old process—per 100 tons obtainable sugar, the yield of commercial sugar was valued at £ 756.

In the crop of 1897—with "The Java Process," the yield amounted to £832.

This means on the total crop of 4400 tons obtainable sugar a clearance of £3300 or $16558.

Usine Poh-Djedjer: Made at the same time on a crop of 4700 tons sugar a clearance of £3400.

This surplus was obtained although both the above mentioned factories were working previous to 1897 with the best known systems, the most intelligent superintendence and full chemical control.

Calculation:

In order to enable the sugar manufacturer to calculate for his particular requirment how much profit may be gained in a sugar factory by adopting the improved methods of working down the masse-cuite in one operation, the following schedule has been drawn up. The local figures, must of course be substituted to give the corrresponding favorable financial results for the respective locality.

Comparison of Plants:

For a 70000 metric tons Sugar House (700 tons per day).

A. Old Process:

Close mixers and tank-system combined—

GROUND FLOOR PLAN
Old System Low Product Sugar House
working with storage tanks,
700 tons Raw Material per day
Scale = 1 : 400.

The complete estimate for a comparatively new "Low Product Sugar House" is given as follows:

1 Vacuum pan, 1 Condenser, 1 Vacuum Pump, 2 Malaxeurs, 4 Centrifugals, 1 Vacuum Pan, 1 Condenser, 1 Vacuum Pump, 1 Masse-Cuite Pump, 3 Centrifugals, 1 Pug-Mill, 6 Closed Malaxeurs, 18 Storage Tanks of 1000 tons capacity, Piping, Gutters, Sluices, Shafting, etc.

To this should be added the staging and the complete building covering more or less 500 square meters=5400 sq. ft.

B. Java Process System:

Complete Arrangement of modern sugar house for Low Products—

New
Java Process Plan
as above 700 tons
Scale=1 : 400.

This embodies: 2 Patent Pans, 1 Condenser, 2 Vacuum Pumps, 4 Standard Filter and clarifying tanks, 5 Malaxeurs, 12 Centrifugals, Shafting, etc., and Molasses separating tanks.

To this has to be added the staging and the complete building—but this to cover only 1-5 of the old plant, i. e., 112 square meters=1200 sq. ft.

Per 1000 tons of first masse-cuite at a polarization of say 82%.

I. Old Process.

Worked according to the most modern methods with storage tanks. (See Geo. Stade, "On the Working of a Cane Sugar Factory and Refinery," the Sugar Cane, Vol. XXII, page 131), will yield:

First sugar: 60% from 1000 tons masse-cuite I=600 tons at £10 or $48,7=£6000 or $29,220.

Second sugar: 33% from 360 tons masse-cuite II—=118,8 tons at £8 or $39,0=£950 or $4633.

Third sugar: 22% from 217 tons Masse-Cuite III=47,7 tons at £7 or $34,0=£334 or $1622.

Total: 766,5 tons =£7,284 or $35,475.

II. "The Java Process"

Making first sugar of 96,5% polarisation only:

First sugar minimum 80% from 1000 tons masse-cuite at £10 or $48,7=£8000 or $38,960.

Net profit per 1000 tons of masse-cuite=£716 or $3,487 in favor of "The Java Process."

For an average size factory grinding say 50,000 tons canes and yielding say 15% first masse-cuite or say 7500 tons masse-cuite per crop this means:

1. A profit in sugar alone of about £5,370 or $26,152.
2. To this should be added: (a) Saving in labor; (b) saving in fuel; (c) saving in interest.

TEST WITH AND WITHOUT SUPERHEATED STEAM

In the early part of this year one of the boilers at the Spring Creek Pumping Station of the Brooklyn Water Works was equipped with a Foster Superheater, the idea being to determine the amount of saving due to superheating the steam, by comparative tests.

The Spring Creek Pumping Station is one of a number of small stations which secure their supply from driven wells and deliver into a conduit which carries the water to the Ridgewood Pumping Station. From there it is delivered to the reservoir by more economical engines of larger size and power.

The equipment of the Spring Creek Pumping Station consists of two horizontal return tubular boilers, each 60 inches in diameter by 15 feet long, having sixty-six 3″ tubes and 914 square feet of heating surface. Each boiler has 25 square feet of grate and natural draft. The fuel burned was large size, white ash anthracite.

The pumping plant consists of two Knowles compound condensing direct-acting duplex pumps, size 6½ and 11½ × 16 × 24 inches, and one Davidson triple-condensing, direct-acting simplex pump, size 8 & 14 & 24 × 24 × 24. These three pumps are equipped with independent jet condensers, the exhaust steam from which is used to heat the feed water to the boilers. These pumps get their water through a common suction pipe from the driven wells and deliver it through separate delivery pipes into the conduit, the total head against which they work being in the neighborhood of 30 feet. On its way to the conduit the water flows over a Weir, making it easy to check the plunger displacement. One of the boilers was equipped with a Foster Superheater. The superheater was connected up to the old steam main, making it possible to run a test on each boiler under the same conditions.

It was decided to run two tests—one using the boiler containing the Foster Superheater and a second using the boiler without the superheater. In both tests the main object was to determine the amount of work which could be developed per 100 pounds of coal. It was decided to base the results on the Weir measurement and careful measurements were taken and checked by plunger displacements. In the first test the "slip" was 22.3%, in the second 22.2%—checking very closely. That these figures are so high is explained by the fact that the water as it comes from the wells contains a very large quantity of air, and further, that the pumps did not make full stroke. The coal and feed water supplied to the boiler during both tests were carefully weighed. The station was in charge of the regular crew and no attempt was made to direct their handling of the plant during either test.

The first test was made using the boiler containing the Foster Superheater and lasted 24 hours, starting at noon, February 8th and ending noon February 9th. The boiler without the superheater was then cut in and the other shut down. After running a few days to get properly warmed up, a 24-hour test was started, using the boiler without the superheater, starting at 11 a. m. February 11th and ending 11 a. m. February 12th.

The results obtained on the two tests were figured back to the same basis for comparison, that is, the foot pounds of work done by the pumps (as measured by the Weir and the total head pumped against) per 100 pounds of coal and per 1000 pounds of steam, termed duty of the pump. It was shown by this comparison that 25½% more work was developed from 100 pounds of coal and 30.2% more work was developed from 1000 pounds of steam when superheated about 200 degrees than was developed when the steam was saturated. Also that the same amount of work was accomplished with a saving in coal of 20.2% and a saving in feed water of 23.2%.

Since making the above test a five days' run was made with an equally long run without the superheater, and the station records show that during the five days without the superheater the station pumped 21,956,400 gallons of water with 31,780 pounds of coal, and that with the superheater the station pumped 22,337,500 gallons of water and burned 23,730 pounds of coal, showing a saving of about 25%. Following are the figures obtained during the two 24-hour runs:

	With Superheater Date Feb. 8 and 9	Without Superheater Date Feb. 11 and 12
Time start	12 N. 8th	11 a.m.11th
Time finish	12 N. 9th	11 a.m. 12th
Hours run	24	24
Av. Steam Pressure lbs.	79.3	79.4
Av. Water Pressure Del'y Triple	.99'	1.05'
Av. Water Pressure, Comp'd	7.10	7.10
Av. Vacuum Suc. Trip. and Comp'd.	22.90"	23.21"
Total Head Triple	29.05'	29.46'
Total Head, Comp'd	33.04'	33.39'
Total counts Triple	30557	34114
Total counts Comp'd	35395	32158
G. pumped pl. disp. Triple	2854023	3186247
G. pumped pl. disp. Comp'd	2930706	2662682
Total G. pumped pl. disp.	5784729.8	5848930
Total G. pumped by Weir	4492680	4549480
%Slip	22.3	22.2
Foot lbs. work=both pumps Pl. Disp.	1497832458	1523115162
Foot lbs. work Weir	1163815819	1184983596
Total coal consumed, lbs	5015	6410
% Refuse	23.7	18.7
Total refuse	1188	1203
Total feed water	38399	50960
Duty per 100 lbs. coal	23206696	18486483
Duty per 1000 lbs steam	30308498	23253213

% Increase of work per 100 lbs. coal............ 25.5 coal
% Increase of work per 1000 lbs steam.......... 30.2 steam
% Saving in coal per foot pound work.......... 20.2 coal
% Saving in feed water per foot pound work...... 23.2 steam
Av. Temp. steam leaving superheater..........527.4°
Av. Temp. steam entering superheater.........320.1°
Av. Deg. F. superheat.......................207.3°

These tests are particularly interesting as showing the value of superheated steam in a plant which is of ordinary low-duty type and has been in operation for several years on regular city service. No special arrangements were made for the introduction of superheated steam and no special oil or stuffing box packing nor steam pipe gaskets were used. The plant is in the same condition as it has been running for years past. The percentages of saving by superheating may appear to be high, but experience has shown that a greater gain in economy is to be obtained in a low duty than in a high-duty plant. Mr. Dean remarked in a recent address before the New England Water Works Association that one of the most promising fields for increasing the duty of steam pumping engines, and in fact about the only remaining correction or radical improvement, was using superheated steam in place of saturated steam. The results obtained in Brooklyn would seem to bear out this opinion with greater positiveness.—[Power Specialty Co.]

Editor of Hawaiian Planters' Monthly. At the meeting of the Hawaiian Sugar Chemists' Association held October, 1903, a provisional method for the determination of sucrose in bagasse was adopted according to the formula.

$$\text{Sucrose per cent. Bagasse} = \frac{\dfrac{\text{Polaris. Reading}}{3.8} \times \text{Diffused Liquor} \times 100.}{\text{gr. bagasse used.}}$$

Enclosed find table (50 gr. of bagasse taken as a basis) which give per cent sucrose in bagasse having given weight and Polaris. Reading of the Diffused Liquor.

I send you the table thinking it might be of interest or of use to the readers of the Hawaiian Planters' Monthly who are interested in the chemical work of sugar manufacture.

Yours truly,

G. GIACOMETTI.

POLARISCOPIC READING.

Weight of Bagasse and Diffused Liquor.	.5	.6	.7	.8	.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2 2	2.3	2.4	2.5
450	1.11	1.33	1.56	1.78	2.01	2.23	2.45	2 68	2.90	3.12	3.35	3.57	3.79	4 01	4.24	4.46	4.68	4.91	5.13	5,35	5.58
455	1.12	1.35	1 58	1.80	2.03	2.26	2.48	2.71	2.93	3.16	3.39	3.61	3.83	4.06	4.29	4.51	4.74	4.97	5.19	5.41	5.64
460	1.14	1.36	1.60	1.82	2.06	2.28	2.51	2 74	2.97	3.19	3.43	3.65	3.88	4.10	4.34	4.56	4.79	5 02	5 25	5.48	5.71
465	1.15	1.38	1.61	1.84	2.08	2.31	2.54	2.77	3.00	3.23	3.47	3.70	3.92	4.15	4.39	4.62	4.85	5.08	5.31	5.54	5.78
470	1.16	1.39	1.63	1.86	2.10	2 33	2.57	2.80	3.04	3.27	3 51	3.74	3.97	4.20	4.44	4 67	4.90	5.14	5.37	5.60	5.84
475	1.18	1.41	1.65	1.88	2.13	2.36	2.59	2.83	3.07	3.30	3.55	3.78	4.01	4.25	4.49	4.72	4 96	5.20	5.43	5 67	5.91
480	1 19	1.42	1.67	1.90	2.15	2.39	2.62	2.86	3.10	3.34	3.59	3.83	4 06	4.29	4.54	4.78	5 00	5.26	5.49	5.73	5.97
485	1.20	1.44	1.69	1.93	2 17	2.41	2.65	2.90	3.14	3.38	3.63	3 86	4.10	4 34	4.59	4.83	5.06	5.31	5 55	5.79	6.04
490	1.21	1.46	1.70	1 95	2.20	2.44	2 68	2.93	3.17	3.41	3.67	3.91	4.15	4.39	4.64	4.88	5.11	5.37	5 61	5.85	6.11
495	1 23	1.47	1.72	1.97	2.22	2.47	2 71	2.96	3.21	3.45	3.70	3.95	4.19	4.44	4.69	4,93	5.17	5.43	5.67	5.92	6.17
500	1.24	1.49	1.74	1.99	2 25	2.49	2.74	2.99	3.24	3.49	3.74	3.99	4.24	4.48	4.74	4.99	5.23	5.49	5.73	5.98	6.24
505	1.25	1.50	1 76	2.01	2.27	2.52	2 77	3.03	3.28	3.52	3.78	4.05	4.28	4.53	4.79	5.04	5.29	5.55	5.79	6.04	6.30
510	1.26	1.52	1.78	2.03	2.29	2.54	2.80	3.06	3.31	3 56	3.82	4.07	4.33	4.58	4.84	5.09	5.34	5.60	5.85	6.11	6.37
515	1.28	1.53	1.80	2.05	2.32	2.57	2 83	3.09	3.34	3 60	3.86	4.12	4.37	4.62	4.89	5.14	5 40	5.66	5.91	6.17	6.43
520	1.29	1.55	1.82	2.07	2.34	2 60	2.85	3.12	3.38	3.64	3.90	4.16	4.42	4.67	4 94	5.20	5.45	5.72	5.97	6.23	6.50
525	1 30	1.56	1.84	2.09	2.36	2 62	2.88	3.15	3.41	3.67	3.94	4.20	4.46	4.72	4.99	5.25	5.51	5.78	6.03	6.30	6.57
530	1.32	1.58	1.85	2.11	2 39	2.65	2.91	3.18	3.44	3.71	3.98	4.24	4.51	4.77	5 04	5.30	5.56	5.84	6.09	6.36	6.63
535	1.33	1.60	1.87	2.13	2.41	2.67	2.94	3.21	3.48	3.75	4.02	4.28	4.56	4.81	5.09	5.36	5.62	5.89	6.15	6.42	6.70
540	1.34	1.61	1.89	2.15	2.43	2.70	2.97	3.24	3.51	3.78	4.06	4.32	4.60	4.86	5.14	5.41	5.67	5.95	6.21	6 48	6.76
545	1 35	1.62	1.91	2 17	2.45	2.73	3.00	3.27	3.54	3.82	4.10	4 36	4.64	4.91	5.19	5.46	5.72	6.01	6.27	6.55	6.83
550	1.37	1.64	1.93	2.19	2.48	2.75	3.03	3.30	3.58	3.84	4.14	4.40	4.69	4.95	5.24	5.51	5.78	6.07	6.33	6.61	6.90

1. This table has 50 gr bagasse as a basis.