capitalists in these islands that it would pay them to sink money in home sugar factories. If, however, the bounties can be abolished, there is no reason why factories in the country districts should not spring into existence, and a new and more paying crop be available for the cultivator of the land.

OCCURRENCE OF LIME-INCRUSTATIONS IN RUM STILLS.

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Molasses used for making rum contain varying quantities of lime-salts which are transformed into lime sulphate or gypsum by the action of sulphuric acid generally used in setting up the "wash." The addition of the acid is of great advantage in obtaining a good fermentation and a higher return in rum.

With ordinary pot-stills, where each charge of say 2,000 gallons wash is discharged after the rum has been distilled off, the gypsum in the wash is of no importance, but it is otherwise with continuous working stills, where an excess of lime compounds can cause heavy and exceedingly troublesome incrustations. In this case the interior divisions or shelves of the distilling column become incrusted with a coherent layer of crystalline or fibrous gypsum, varying in thickness from a thin film up to half an inch and more according to the length of time the still has been working. After some time the canals of circulation for wash and rum become choked so completely, that the still has to be dismantled, as hammer and chisel are now the only means of getting rid of the incrustations. These are often so coherent that regular casts of the "saucers" or "bells" in the stills can be knocked off.

The explanation of this unwelcome phenomenon is easier than its prevention. Although lime sulphate or gypsum is only sparingly soluble in water, one part of gypsum requiring about 400 parts of water for its solution, this solution deposits all gypsum in a very finely divided state as soon as it is mixed with alcohol. And this is precisely what takes place in a distilling column. Consequently the deposit will be strongest in those parts of the still where the wash first meets the rising vapours of the rum. With those stills in which by a violent circulation wash and alcohol mix freely most of the freshly precipitated

gypsum will be carried off mechanically and discharged in the lees or dunder, but in those apparatus where the wash has to fill one division or shelf first to a certain height, say 1½ inches, before it can overflow into the next compartment, a kind of pocket is formed in which some of the gypsum will settle and form at first a granular film and later a thick fibrous deposit. This will be especially the case when the distillation is interrupted and each of the shelves remains charged and undisturbed with a mixture of wash and alcohol for some time.

We have seen that it takes 400 parts water to dissolve one part gypsum, but a 15% sugar solution, as we may consider the unfermented wash to be, dissolves considerably more. According to Pellet, one part of gypsum requires only 160 parts of such a solution to become dissolved.* Moreover, acid liquids and certain salts, like ammonium sulphate which is often added to the wash, increase considerably its solubility and consequently the amount of gypsum in the wash can be very high, varying, of course, with the original lime-contents of the molasses. Carbonic acid, however, which is formed freely during fermentation does not increase the solubility of gypsum.

A sample of fermented wash analysed by me contained 4·3 lbs. gypsum per 100 gallons, or one part for every 233 parts wash. (The water used for setting up this molasses was very soft, 100,000 parts containing only 10 parts mineral matter.) As the sugar is converted into alcohol the solubility of the gypsum decreases and a part of it will be precipitated in the wash already. This can be proved by examining the very finely divided sediment thrown down by the "ripe" wash after a few hours subsiding, even if the sample is taken from the top of a vat after the greater part of the yeast has settled down to the bottom. A specimen of this sediment in an air-dried state was composed of 67·5% organic matter (mostly yeast-cells) and of 32·5% mineral matter with 16·1% gypsum. Including some phosphate and carbonate of lime, fully 58% of the mineral matter consisted of lime-compounds.

As to the quantity of lime-compounds present in the molasses, low grade molasses will contain more than those of a higher quality. Several samples, resulting from the manufacture of yellow crystals, and which had been reboiled twice for molasses-sugar contained from 4·50 to 7·50% ash (mineral matter), including 1·33 to 2·33% gypsum. The total lime compounds including some phosphate and carbonate,

* Some writers dispute this statement.

when calculated as sulphates, amounted from 2·12 to 3·72%. A wash set up with molasses of this description will contain from 3 to 7·75lbs. gypsum per 100 gallons.

The temper-lime used in clarifying the cane juice and the molasses is not the only source of this large amount of lime-salts. A certain amount of lime-salts will be introduced into the cane juice by the use of acid phosphates during the process of clarification. These phosphates are often mere superphosphates, that is, the lime sulphate or gypsum formed by the action of strong sulphuric acid on tri-calcium phosphate has not been separated from the resulting soluble phosphate. There are some preparations in the market where this separation has been effected, but their relative high price is often a drawback to their more general use, the more so, as the gypsum accompanying the ordinary acid phosphates does not interfere seriously with the manufacture of the sugar, as long as no bone black is used.

It is surprising to find such a large quantity of sulphuric acid, in the form of sulphates, in the molasses, but this must be attributed to the sulphurous gas used for bleaching the cane juice when yellow sugar is made. Already, more than twenty years ago when sulphurous gas began to replace the expensive bone-black, the refiners soon found out that the gypsum in the ash of beetroot raw sugar had risen from 4·5 to 10%, as against 1 to 3½% formerly.

I am not aware whether the lime-contents of the molasses of the past crop are abnormally high compared with former years, or whether the lime-incrustations in rum stills have been noticed before. The quality of the canes worked up in 1901 was rather good, and the return in sugar very satisfactory.

The question arises now, how can these incrustations be prevented?

This is rather a difficult problem, and I am afraid it will be practically impossible, at least with the prevailing low prices for rum.

First of all, filtration of the fermented wash through bag filters, filter presses, or over gravel, might come under consideration, but this would remove only that part of the gypsum precipitated already in the wash during the course of the fermentation, and which is still kept suspended in the liquid.

To get rid of the dissolved gypsum we should require to precipitate it by means of chemicals. Sodium carbonate decomposes gypsum by forming insoluble lime carbonate, but a trial with diluted molasses on a small scale will show that the calculated amount of sodium

carbonate will precipitate only a small proportion of the gypsum present* Of course, the molasses has to be diluted previously to at least double its volume, and must be neutralised with caustic soda. Heating to boiling point will facilitate the precipitation of the lime, but this would interfere seriously with the setting up of the wash afterwards, when a temperature of 85° Fahrenheit ought not to be exceeded.

Another equally unfeasible plan would be the transformation of the gypsum into harmless calcium-chloride by means of barium-chloride. But in this case neither sulphuric acid nor ammonium sulphate could be used for promoting fermentation, otherwise gypsum would be regenerated. Muriatic acid might replace sulphuric acid, but it is doubtful whether with the same beneficial result.

As to the dissolving of the hard incrustations by means of chemicals, only prolonged boiling (for several hours) with muriatic acid, diluted with five times its volume of water, will be effective. Copper, gun-metal, and brass, provided the latter does not contain more than 50% of zinc, are not attacked by hot muriatic acid. Iron and zinc, however, would be speedily destroyed.

Another solvent for gypsum, although far less effective, is a concentrated solution (say 40%) of ammonium-sulphate, or of sodium hyposulphite, the "hypo" of the photographers. A solid piece of incrustation of $\frac{1}{8}$ inch thickness lost only 60% of its weight by boiling in a 40% solution of ammonium-sulphate during four hours.

The only practical means will be to scrape and chip off the hard incrustations. To this end those compartments or shelves of the still, where the wash comes first into contact with the alcoholic vapours, should be made as accessible as possible, perhaps by making them of larger dimensions than the remainder of the shelves. Mere arm holes of four inches diameter, as are provided in some rum stills, are utterly inadequate for this purpose.

We have to thank Messrs. James Buchanan & Son, Liverpool, and Messrs. A. & W. Smith & Co., Ltd., Glasgow, for copies of their sugar machinery catalogues. In each case they are tastefully got up and profusely illustrated, and we have no doubt that the would-be purchaser will benefit by a perusal of the same. It is obvious that when dealing with foreign customers, a complete explanatory catalogue saves needless delay and correspondence, and ensures a quicker delivery of any requisite article.

* Stammer found that even twice the equivalent amount of sodium carbonate precipitated only a certain quantity of the gypsum contained in diluted molasses.