In the Paris Exhibition of 1900 a cane-crushing, mill was shown with three rollers 32 in. in diameter by 60 in. long. It is driven by a powerful engine through triple gearing of 42 to 1, and speeded to have a surface velocity of rollers of 15 ft. 9 in. per minute. This mill is guaranteed to crush thoroughly and efficiently from 250 to 300 tons of canes in 24 hours. In Louisiana two mills, set one behind the other, each with three rollers 32 in. in diameter by 78 in. long, and driven by one engine through gearing of 15 to I, are speeded to have a surface velocity of rollers of 25 ft. 6 in. per minute (or 60% more than that of the French mill described above), and they are efficiently crushing 900 to 1200 tons of canes in 24 hours. In Australia, Demerara, Cuba, Java and Peru *double crushing and maceration* (first used on a commercial scale in Demerara by the late Hon. William Russell) have been generally adopted; and in many places, especially in the Hawaiian Islands, *triple crushing (i.e.* passing the canes through three consecutive sets of rollers, in order to extract everything possible of extraction by pressure) is employed. In the south of Spain, in some favoured spots where sugar-canes can be grown, they are submitted even to four successive crashings.

It has been found in practice advantageous to prepare the canes for crashing in the mills, as above described, by passing them through a pair of preparing rolls which are grooved or indented in such manner as to draw in and flatten down the canes, no matter in which way they are thrown or heaped upon the cane­carrier, and thus prepare them for feeding the first mill of the series; thus the work of crushing is carried on uninterruptedly and without constant stoppages from the mills choking, as is often the case when the feed is heavy and the canes are not prepared.

Although it cannot be said that any one system of extraction is the best for all places, yet the following considerations are of general application :—

*a.* Whatever pressure be brought to bear upon it, the vegetable or woody fibre of crashed sugar-canes will hold and retain *for the moment* a quantity of moisture equal to its own weight, and in practice 10% more than its own weight; or in other words, 100 lb of the best crushed megass will consist of 47∙62 lb of fibre and 52∙38 lb of moisture—that is, water with sugar in solution, or juice.

*b.* Canes vary very much in respect of the quality and also as to the quantity of the juice they contain. The quantity of the juice is the test to which recourse must be had in judging the effi­ciency of the extraction, while the quality is the main factor to be taken into account with regard to the results of subsequent manufacture.

For the application of the foregoing considerations to practice, the subjoined table has been prepared. It shows the greatest quantity of juice that may be expressed from canes, according to the different proportions of fibre they contain, but without employing maceration or imbibition, to which processes reference is made hereafter. The percentages are percentages of the original weight of the uncrushed canes.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Per Cent. | Per Cent. | Per Cent. | Per  Cent. | Per Cent. | Per Cent. |
| Percentage of fibre in canes . | **1O** | **11** | 12 | 13 | 14 | 15 |
| Percentage of juice in canes . | 90 | 89 | 88 | 87 | 86 | 85 |
| Percentage of juice retained in me­gass .... | **10** | **11** | 12 | 13 | 14 | 15 |
| Percentage of maxi­mum expression. | 80 | 78 | 76 | 74 | 72 | 70 |
| Percentage of best average expres­sion, in practice.  Percentage of juice left in megass, in practice . | 79 | 76∙9 | 74∙9 | 72∙9 | 70∙6 | 68∙5 |
| **11** | **12∙1** | 13∙2 | 14∙3 | 15∙4 | 16∙5 |

Thc British Guiana Planters’ Association appointed a sub-com­mittee to report to the West India Commission on the manufacture of sugar, who stated the following:—

With canes containing 12% fibre the following percentages of sugar are extracted from the canes in the form of juice:—

Single crashing 76%

Double crushing 85 %

Double crushing with 12% dilution 88%

Triple crushing with 10% dilution 90%

Diffusion with 25 % dilution 94 %

These results are equivalent to 66∙88 % extraction for single crashing. 74∙80% ,, „ double crushing.

77∙44% ,, „ double crushing with 12% dilution.

79∙20% „ „ triple „ „ 10% „

82∙72% „ ,, diffusion with 25% „

To prevent the serious loss of juice left in the megass by even thc best double and triple crushing, maceration or imbibition was introduced. the megass coming from the first mill was saturated with steam and water, in weight equal to between 20% and 30% and up to 40% of the original weight of the uncrashed canes. Consequently, after the last crashing the mixture retained by the residual megass was not juice, as was the case when crushing was employed without maceration, but juice mixed with water; and it was found that the loss in juice was reduced by one-half. A further saving of juice was sometimes possible if the market prices of sugar were such as to compensate for the cost of evaporating an increased quantity of added water, but a limit was imposed by the fact that water might be used in excess. Hence in the latest designs for large factories it has been proposed that as much normal juice as can be extracted by double crashing only shall be treated by itself, and that the megass shall then be soused with twice, as much water as there is juice remaining in it; after which, on being subjected to a third crushing, it will yield a degraded juice, which would also be treated by itself. It is found that in reducing the juice of these two qualities to syrup, fit to pass to the vacuum pans for cooking to crystals, the total amount of evaporation from the degraded juice is about half that required from the normal juice produced by double crashing.

Great improvements have been made in the means of feeding the mills with canes by doing away with hand labour and substituting mechanical feeders or rakes, which by means of a simple steam-driven mechanism will rake the canes from the cane waggons on to the cane-carriers. By the adoption of this system in one large plantation in the West Indies, crushing upwards of 1200 tons of canes per day, the labour of sixty-four hands was dispensed with, and was thus made available for employment in the fields. In Louisiana the use of mechanical feeders is almost universal.

With a view of safeguarding themselves from breakdowns caused by the inequality of feeding, or by the action of malicious persons introducing foreign substances, such as crowbars, bolts, &c., among the canes, and so into the mills, many planters have adopted so- called hydraulic attachments, applied either to the megass roll or the top roll bearings. These attachments, first invented by Jeremiah Howard, and described in the *United States Patent Journal* in 1858, are simply hydraulic rams fitted into the side or top caps of the mill, and pressing against the side or top brasses in such a manner as to allow the side or top roll to move away from the other rolls, while an accumulator, weighted to any desired extent, keeps a constant pressure on each of the rams. An objection to the top cap arrangement is, that if the volume or feed is large enough to lift the top roll from the cane roll, it will simultaneously lift it from the megass roll, so that the megass will not be as well pressed as it ought to be; and an objection to the side cap arrangement on the megass roll as well as to the top cap arrangement is, that in case more canes are fed in at one end of the rolls than at the other, the roll will be pushed out farther at one end than at the other; and though it may thus avoid a breakdown of the rolls, it is apt, in so doing, to break the ends off the teeth of the crown wheels by putting them out of line with one another. The toggle-joint attachment, which is an extremely ingenious way of attaining the same end as the hydraulic attachments, is open to the same objections.

Extraction of cane juice by diffusion (a process more fully de­scribed under the head of beetroot sugar manufacture) is adopted in a few plantations in Java and Cuba, in Louisiana and the Hawaiian Islands, and in one or two factories in Egypt; but hitherto, except under exceptional conditions (as at Aska, in the Madras Presidency, where the local price for sugar is three or four times the London price), it would not seem to offer any substantial advantage over double or triple crushing. With the latter system practically as much sugar is obtained from the canes as by diffusion, and the resulting megass furnishes, in a well-appointed factory, sufficient fuel for the crop. With diffusion, however, in addition to. the strict scientific control necessary to secure the benefits of the process, fuel—that is, coal or wood—has to be provided for the working off of the crop, since the spent chips or slices from the diffusers are useless for this purpose; although it is true that in some plantations the spent chips have to a certain extent been utilized as fuel by mixing them with a portion of the molasses, which otherwise would have been sold or converted into ram. The best results from extraction by diffusion have been obtained in Java, where there is an abundance of clear, good water; but in the Hawaiian Islands, and in Cuba and Demerara, diffusion has been abandoned on several well mounted estates and replaced by double and triple crashing; and it is not likely to be resorted to again, as the extra cost of working is not compensated by the slight increase of sugar produced. In Louisiana diffusion is successfully worked on two or three large estates; but the general body of planters are shy of using it, although there is no lack of water, the Mississippi being near at hand.

*Purification.—*The second operation is the coagulation of the albumen, and the separation of it with other impurities from the