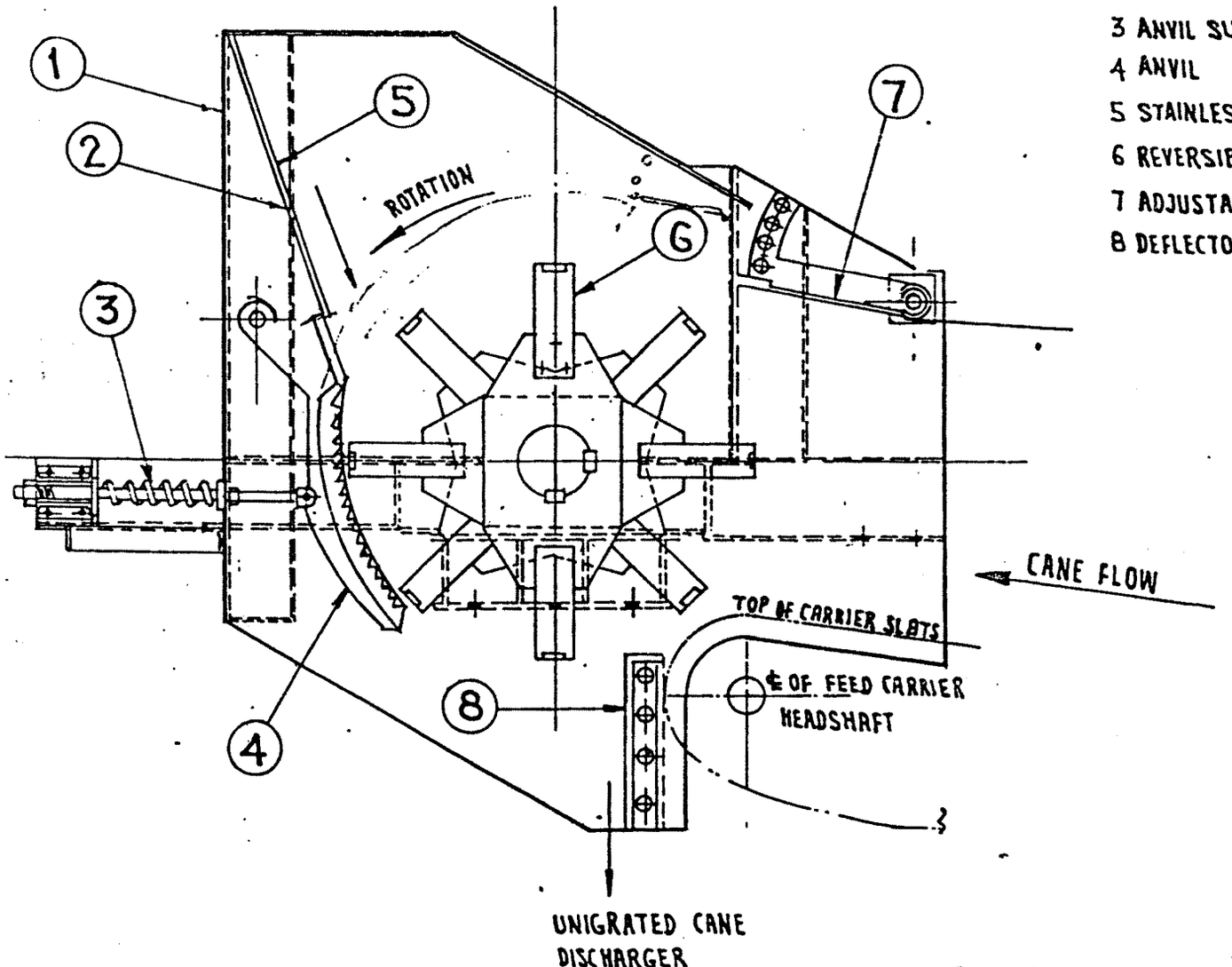
CHAPTER - III

~~Chart~~ Figure - No - 3.1

FIBRIZOR



1 REMOVABLE HOOD
2 REAR CHUTE
3 ANVIL SUSPENSION GEAR
4 ANVIL
5 STAINLESS STEEL LINING
6 REVERSIBLE HAMMERS
7 ADJUSTABLE COVER
8 DEFLECTOR PLATE

Fig-9

CHAPTER – III

DESCRIPTION OF PROCESSES IN MANUFACTURE OF SUGAR

INTRODUCTION

Sugar industry in India is fast expanding and modernising. The industry has reached production of sugar over 16 million tonnes and it is hoped that by close of the century the targeted production of 18 million tonnes will be achieved.

Efficiency at all stages of processing is the only measure of survival through reduction of production cost to keep up the economic viability. Efficiency is also related to the skill of the managerial persons engaged in it.

PROCESS OF SUGAR MANUFACTURE

In a sugar factory, milling section handles the cane for extraction of juice from cane. This juice is sent to Boiling House for processing and production of sugar and the bugasse (i. e. remainder solid material of cane) is sent to Boiler Section to be used as fuel for boilers.

Milling section is divided in three sub sections. Those are (a) Cane Handling, (B) Cane Preparation and (C) Cane Milling. These sub sections (A) and (B) are briefly described as follows:

A) Cane Handling

1) Cane Weighment:

Cane is transported from to the factory with the help of (1) Bullock carts, (2) Trailers, (3) Trucks. These vehicles are directly taken on platform type weighting scales for measurement of weights. The difference between gross weight and tare weight gives the weight of cane.

The weighing scales are of three types (1) Lever type, (2) Dial type, (3) Electronic. In lever and dial type manual efforts and attention required more than the electronic type. Record keeping can be done automatically in case of electronic type and also computerisation is possible.

2) Cane unloading:

Cane unloading is done either (1) in the cane yard, (2) near the cane carrier or (3) directly in the cane carrier. Following are the methods for cane unloading.

a) Manual for feeding small bundles of cane directly to cane carrier.

b) Cranes – These are used for handling cane bundles wound by chain or wire rope sling for loose cane grab gripper or net unloaded is used. The types of canes are (1) Derrick Crane – revolving around a vertical axis and

covering circular area. (2) Traveling Crane – 2 motions or 3 motions which covers rectangular area. Hence mostly used in sugar factories. (3) Tipping Platforms: These are hydraulically operated hilling platforms. With the help of these vehicles are tilted to slide down the in cane carrier. (4) Self discharging vehicles – In this type the vehicle itself has arrangement for tilling the body, so as to dump cane in the cane carrier or at desired place. (5) Dragging Racks: These pull the cane from the vehicle.

3) Cane Feeding

Cane feeding to cane carrier is done by following methods.

1) Manually such as unloading of bullock cars directly in the cane carrier.

2) Direct unloading in cane carrier.

3) Feeder Tables – Unloading cranes place the cane bundles on feeder tables. With the help of dragging chain bellow the cane bundles. Cane is pushed towards to one end of table and falls in the cane carrier.

4) Cane Conveyors (Carriers): After unloading cane mills for crushing so also before crushing cane has to pass thro the preparatory devices. This is done by means of cane

carrier. These are either one or two in numbers. If two, the first one is known as main or 1st cane carrier and second one is known as mill feeding carrier or 2nd cane carrier.

The main carrier is always constructed of chain and salt type arrangement forming a moving apron and carrying cane alongwith it. The main can carrier is has two portions for identification. (1) Horizontal Portion: This portion is always out side the factory building and cane is feed here. (2) Inclined Portion: This portion has indignation of 18^0 and installations of cane preparatory devices over it. While the cane is carried along the apron, the same undergoes preparation. Fully or partly. The highest and portion of the main cane carrier is known as the 'head' of the carrier. Head of the main cane carrier either directly feeds the prepared cane to the mills or to another preparatory device for further preparation. In the later case; II cane carrier is employed to receive finally prepared cane and feed it to mills. This II cane carrier may be either slat type or rack type depending upon the availability of space.

B) Cane Preparation

1) The processes done on the cane before feeding to the mill are known as cane preparation. These processes are – 1) Lolling the cane in cane carrier, 2) Cutting, 3) Shredding or fibrizing.

2) Necessity of cane preparation

Cane sticks consist of different portions along the length separated by hard mass known as nodes. Outer cover consists of densely situated fibres forming hard skin known as 'rind'. And the pulp portion consists of fibrous material which is embedded with pith and juice cells which is comparatively soft.

During cane preparation the cane structure is to be destructed into small pieces and separation of fibres is effective juice extraction in milling so also power requirement of mills is considerably reduced in case of finally prepared cane.

3) Cane Preparatory Devices

1. Cane kicker on equaliser
2. Knives sets i. e. chopper, leveller, cutter
3. Hammer sets i. e. shredder, fibrizor
4. Combination sets i. e. miner

All these devices are rotary equipment running at different speeds (rpm) with varying input power. These devices consists of a centrally mounted steel shaft between two bearing at the ends and driven by coupling to a suitable drive. Such as electric motor or steam turbine, directly or through gear box depending upon the requirement of speed and power.

Cane Kicker or equaliser:

This is used to level the angled cane in the cane carrier so as to effect uniform feeding tot he next preparatory device.

This consists of fabricated arms welded on the pipe shaft and swinging backward to push the excessive cane in gaps of levels following cane.

Cane Cutting Knives Sets

The working principle of these is cutting combing the cane by sharp edges of revolving knives set. The knife at both ends and keyed to the shaft forming helix and covering the width of the cane carrier. Installation of knives sets is such that the axis of rotation is along the width of the carrier. The knives used are either curved or straight type, sharpened and sterilized to reduces wear of edges. Strait knives sharpened at both sides and tips are used so that the same can be reversed and reused.

The three types of knives sets are (1) Chopper, (2) Leveller, (3) Cutter out of these; leveller and cutter combination or only leveller with shredder/fibrizer are used. Along the travel of cane with the apron of the carrier leveller is first normally, followed by either cutter or fibrizor or both respectively. The leveller carries lesser number of knives (24 nos.) than cutter. The distance between the lowest tip of knife and apron of cane carrier is known as clearance. Which are about 200 mm

in case of leveller and about 100 mm in case of cutter. These are rotated at a seep of about 585 rpm.

3) Hammer Sets

These consist of hammers, pinned to the thick, discs or bolted to hub ends which are mounted on the central shaft. The rotating hammers on their circular way pass over the anvil placed and adjusted with small clearances. The pieces of cane entrapped in the clearance gets blows of hammers thus structure of the cane gets disintegrated and juice cells are opened out.

The hammers are either 'straight' or 'T' types. In both the cases the wearing portions of the hammers are coated by deposition of hard material. This deposition of material is normally done by electric are welding process and is in such a fashion that the surfaces are made rough.

The anvil plates over which the hammers pass are having 'wrap angles' ranging from 90 to 180^0. These are of two types depending upon the internal fabricated structure – 1) Serrated, 2) Pocketed; roughened to achieve higher degree of disintegration.

The hammer sets are of two types – 1) Shredder, 2) Fibrizer. The shredder is located below the head of 1st cane carrier to receive the cane and discharge the finally prepared cane into and cane carrier. The fibrizor is located just in front of the head of the 1st cane carrier and the direction of rotation of fibrizor is so that the pieces of the cane are

lifted above in the head and get entrapped between the hammer and anvil plate.

4) Index of preparation (I. P.) or Preparatory Index (P. I.)

The degree of achievement of preparation or the stat of disintegration of cane is expressed by the percentage of pol in the open cell or preparatory index. (P. S.). It is measures in laboratory by taking average sample of prepared cane two parts of the measured samples are (1) leached (2) disintegrated or digested in measured samples of water and respective pol reading are noted. Thus P. S. is given by the ratio –

$$\text{Percentage of P. I.} = \frac{\text{Pol extracted by leaching}}{\text{Pol extracted by disintegration}} \times 100$$

5) The sugarcane is received by bullock carts, trucks and trolleys at factory site. After weighment of cane it is subjected to heavy duty mills for extraction of juice, residue left behind is called 'bagasse".

6) This bagasse goes to boilers as fuel for generation of steam. The steam generated is mainly utilised in power. Turbine and mill driving turbines.

7) The juice after weightment is chemically treated with a new to purify or clarify it for further crystallisation process. The juice contains sugar associated with dissolved salts and some

suspended solids. The purpose of purification or clarification is to remove the salts called 'non sugars' as much as possible so as to facilitate proper crystallisation of sugar as well as to reduce the colour present in the cane juice. This colour if not removed, affects the colour of the white sugar produced.

8) The clarified juice is evaporated by the application of heat to obtain thicker juice called unusual syrup.

9) The unusual syrup is bleached by SO_2 gas before crystallisation to obtain white sugar.

10) The supplied syrup is further concentrated in vacuum pans to the extent that the crystallisation of sugar takes place.

11) From the crystallised mass sugar crystals are separated. The remaining portion of the mass called 'Molasses" also gets separated.

12) The separated sugar crystals are washed dried and bagged as commercial white sugar.

13) The molasses obtained by separating sugar crystal is further desugarised step by step, by reboiling it.

In reboiling a stage is reached when further crystallisation of sugar is no longer practically and economically feasible and such molasses is called 'final molasses'.

First of all we are concerned with the sugar present in the cane. If we know the proportion of sugar present in the unit weight of cane and if we know the total weight of cane received. We can easily calculate the total amount of sugar that has been imported into the factory. Therefore, the first takes is to weigh sugarcane received of course, this weight must be absolutely correct. Next takes is to find out proportion of sugar that is present in sugarcane. Sugar in any material can be determined by an analytical method. The details of which we shall discuss later.

After weighing the cane is fed into the mills whereby juice present in the cane is extracted and fibrous portion of sugarcane called 'Bagasse is conveyed to the boilers. The juice goes to Boiling House for purification, evaporation, crystallisation etc.

The juice contains sugar we must know how much sugar has been extracted in the juice from that present in the sugarcane. Some sugar which does not get extracted is present in the bagasse. We must know how much sugar is being lost in the bagasse. The sugar present in the juice can be found out by recording the weight of juice and determining the proportion of sugar present in unit weight of juice by analysis. Similarly the weight of sugar present in bagasse can be found out by finding out the weight of bagasse and analysing the bagasse for sugar content.

The juice passes through several stages of processing. The treated juice is salted and the settled mud is filtered. In spite of washing the mud with water, some sugar is still left in it and is lost. The supplied syrup is concentrated to the extent that crystallisation takes place. Inspite of multiple system of crystallisation, some sugar is still left in final molasses and is lost. During processing some sugar also gets lost due to overheating. Uncontrolled chemical reactions, spillage, leakage entrainment etc.

All these losses have to be estimated and balance sheets are prepared as follows –

A)	**Sugar present in sugarcane**		**100 say**
	Balance Sheet of Mill House		
	i)	Sugar present in juice	95.00
	ii)	Sugar present in bagasse	4.00
	iii)	Sugar lost due to bacterial action Of spillage of juice	1.00
		Total	100.00 say
B)	**Sugar present in juice Balance Sheet of Boiling House**		
	i)	Sugar lost in filter cake	1.00
	ii)	Sugar lost in final molasses	10.00
	iii)	Sugar recovered as crystal sugar	87.00
	iv)	Sugar lost in handling, spillage, chemical reaction etc.	2.00
		Total	100.00

This with the help of chemical control we can obtain data from which can be calculated the distribution of sugar in various products and that unavoidably lost. This is called "Accounting Control".

Basic Concepts of Sugar Evaluation

The significances of some of the basic concepts are important to understand with a view to evaluate the concentrations of sugar at various stages. These are – 1) Brix, 2) Pol and 3) Purity

Brix is defined as the total solid matter present in the solution. That is to say if 20 gms of sugar is dissolved in 80 gms of water to make 100 gms of sugar solution, the Brix of the solution would be 20 deg. Again if we take 20 gms of sugar and gms of common salt and 75 gms of water to get a sugar salt solution of 100 gms. The Brix of the solution would be 25.

In sugar factory we always come across sugar solutions which are almost associated with some other substances in dissolved state which was called it as 'Non Sugar".

If we evaporate such a solution to dryness some solid matter will result. The percentage by weight of this solid matter is represented by the term "Brix" of gravity solids. Brix can be measured by means of hydrometer which is known as "Brix-Hydrometer or Brix-Spindle". In a highly pure sugar, solution which contains nothing else but only sugar, the Brix reading on the hydrometer will indicate the percentages

of sugar itself. Since Brix is on entity and treated as a substance the terms 'Total Brix', 'Tons Brix' and 'Quintal Brix' are also in use.

2) Pol or Polorisation

Pol is defined as the 'Value determined by the direct polorisation of normal or half normal solution in a polarimeter. This requires a little explanation. Say for example, if we taste a substance and find it sweet we say that the substance contains sugar. Another property of sugar (sucrose) is that is polorised light is passed through a solution of sucrose the plane of polorisation is turned towards right by certain number of degrees. The number of degrees by which the plane gets rotated is directly proportional to the percentage of sugar (sucrose) present in solution. Here it is also necessary to clarify the term sugar itself, as strictly speaking glucose, fructose, lactose, etc. are all called 'sugars' but what we mean by sugar is sucrose, which we recover from sugarcane in crystalline form in a sugar factory. Therefore, the term 'Pol' derived from polorisation denotes for all practical purposes only sucrose which we called it sugar.

3) Purity

The purity denotes percentage by weight of sugar in solid matter

or

$$\text{Purity} = \frac{\text{Pol}}{\text{Brix}} \times 100$$

Purity is the short term for coefficient of purity or quotient of purity. The term purity will indicate in a sugar factory, the proportion of sucrose present in total dissolved solids by weight. Suppose fresh cane juice sample is analysed, it will be observed that its purity is 80. We allow the juice to stay over for some time during which bacterial action take place and it ferments. That is bacteria have eaten some part of sucrose. We again analyse it when we observe that its purity is not 80 but only 75. This fall in purity indicates loss of sugar. Conversely if from the sugar solution some non sugars are removed the purity of the sugar solution will increase. This is broadly the significance of the term purity.

Factory Control

Mainly factory control is divided into two parts.

1) Mill House Control or Milling Control and

2) Boiling House Control.