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A Case Study of Modern Batch Pan Automation Implementation

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Abstract

During last couple of years Years, mills in India are seen moving towards modern process automation to improve the plant performance and process efficiency, better process control and higher operational consistency can be achieved by minimizing the human interference with good process automation resulting in better performance of the plant.

A modern batch Pan automation system along with online optical crystal monitoring system installed on one pan at MMSSK, Ausa,during the crushing year 2022-2023 after commissioning of the pan automation, the results of the pans operated manually, and the pan operated automatically were compared. The automated pan took approx. 20% less time than the manually operated Pan to complete one strike. the water consumption in the automatic pan was approximately. 60% less in comparison to the manual operation. In fact several pans strikes carried out without water addition .due to consistent operation and better brix development, the massecuite exhaustion was also improved by approx 0.70 units.

The paper present a case study of the pan automation system its results and future plans.

Keywords *- Batch pan automation, crystal monitoring system,energy efficiency, online optical crystal monitoring,manless pan operation, artificial intelligence.*

Introduction

The optimization of the batch pan operation offers huge potential of plant performance improvement into multiple directions. The pans being the largest vapor consumers in a sugar plant have significance influence on the steam economy of the plant. the sugar crystallization performance in a pan is the most important step to control this sugar quality. Whatever the crystal quality comes out from the pans, can't be improved in the subsequent processes. The crystal quality and uniformity from the pans have also significant impact on the centrifugal performance therefore; pan station is an area which requires special attention to improve the overall plant performance.

The manual pan operation consists of several limitations and operational drawbacks e.g. unavailability of the crucial measuring parameters. Pan operation in relied on the sense of feeling and experience of the pan operators.

- Delay in decision making.
- Delay in timely action due to occupancy of the operators somewhere else.
- Difficulty to operate the pans without water addition when the feed material brix is high
- Frequent False grain formulation
- Variations in the Massecuite dropping brix which impacts the centrifugal performance.

In several sugar factories, some instruments for semi-automation on the batch pans were installed. Of course, such automation gives some relief to the pan operators but otherwise,it doesn't have any real benefit to improve the pan operation to contribute to the plant performance improvement.

The fines or secondary grain formation can't be avoided with manual or semi-automatic controls. Once the fines or secondary grains develop, elimination of them by application of hot water is the usual and easy way. The water addition to the pans for false grains dilution has cascading drawbacks:

- Additional steam required; one tonne of water added is equivalent to 0.5- 1 T of exhaust steam depending on the heating vapor / bleeding arrangement
- Increased pans strike time
- Additional Pan capacity required

- Increased sugar color and inversion loss due to longer boiling time
- Additional power requirement at condensers, spray pond and pant circulators

Modern pan automation system allows a considerable reduction of the steam demand by eliminating or at least reducing the water additions. Another important aspect apart from the technical requirements is to overcome old operation habits that often cause Drawbacks in practice.

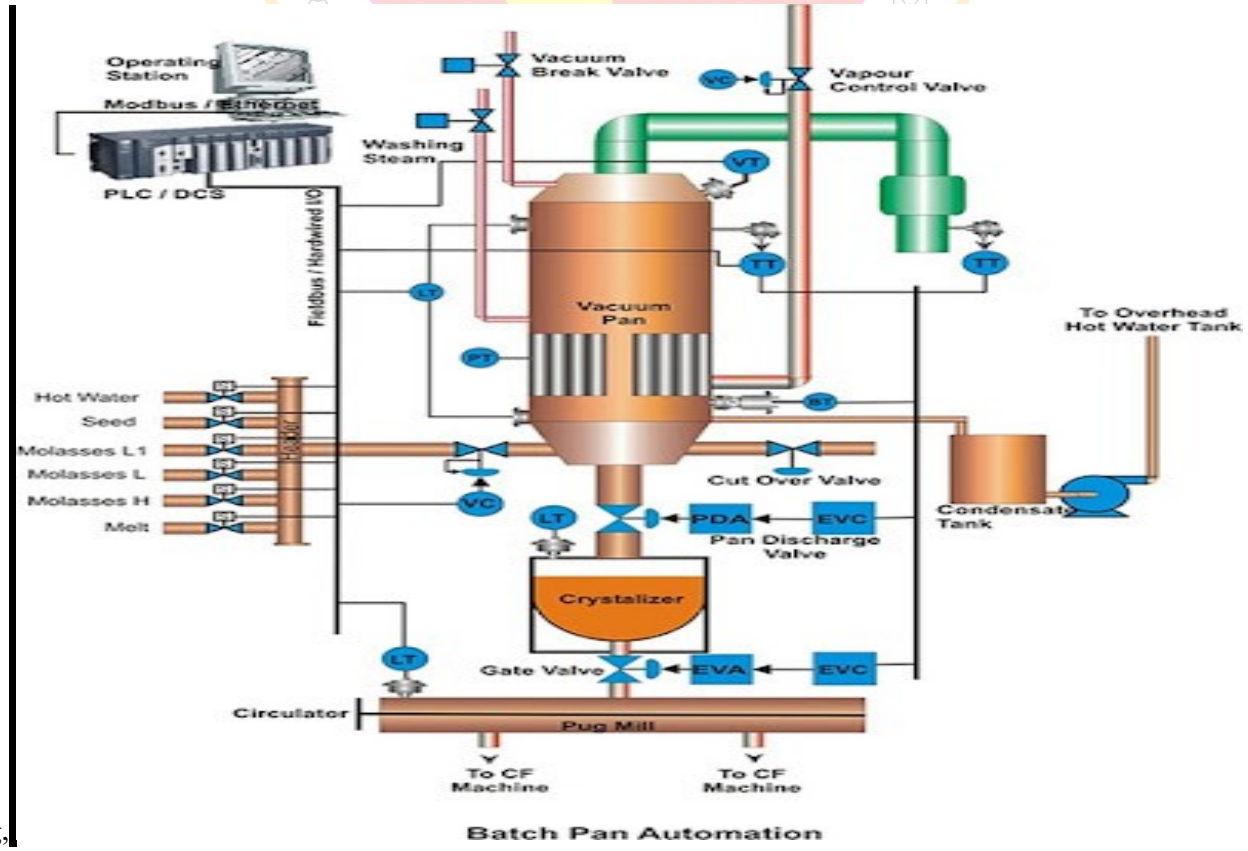
Implantation of modern batch Pan Automation system At MMSSK, Ausa.

Considering the above mentioned aspects, MMSSK limited (planned to implement a modern batch pan automation system at their ausa unit. After diligent review of available automation system in the market, MMSSK,limited, Placed the order to IPRO India private limited to install the modern batch pan automation system (Pan ^{plus} automation system. It was decided to install pan automation system initially at one pan of A Massecuite as a pilot project. The Pan number 3 of 100 Ton capacity mostly used for A Massecuite dropping was selected for the implementation.

Pan ^{plus} automation system consists of various algorithms which make it an intelligent system it can act against the various process flow fluctuations to good extent which helps to minimize the flase grain formation to a large extent. Therefore, it helps to reduce the water application to the pans from 60% up to 100% (no water) figure 1 displays the basic controls of the pan ^{plus} automation system.

PAN OPERATION AFTER IMPLEMENTATION OF PANPLUS AUTOMATION

The pan ^{plus} automation system is a user-friendly system. The system consist of several algorithms to handle different process situations without the interference from the operator which makes it and intelligence system. No Pan operator is required in the field. from the pan control room ,the operator needs to define only a couple of parameters to start the pan.e.g strike type, initial level pan starting source, massecuite dropping Brix and final level. After these setting once the start button is pressed the pan automation system fully takes care and no manual interference is required.



Fig, Batch Pan Automation

The batch pan automation advantages are as follows.

- Control the false grain in the pan body.
- The molasses purity is maintained as specified.
- Pan level is monitored continuously.
- Maintain the brix in the overall pan.
- Minimize the manpower.Improve the sugar purity (quality grain).
- Lesser consumption of water.
- Less consumption of steam.

Results

To quantify the performance improvement of Pan 3 which was automated it was decided to compare the operation results of pan 3 with Pan 2 which was operated manually. both the pans have same design, capacity, operate with same feed material and heating vapor. For the comparison hot water flow meter where installed on both the pans.

Reduction in the moment water strike time reduction and improvement of massecuite exhaustion were the key performance parameters for the comparison. The comparison of results was done for the period 05.03.2022- 11.03.2022 and total 27 pan strikes during this period where considered . the values mentioned in the table 1 are the average of the 27 strikes.

Parameter	Unit	Pan2 (Manual)	Pan3 (Auto)	Improvement in %
Strike Time	Min	1.35	108	20
Water Consumption/strike	M^3	4.78	1.73	63
Exhaustion	%	63.85	64.53	0.68

8 out of 27th strikes for Pan 3 were performed without water addition. Following are the main reasons of the water addition to most of the remaining strikes.

- Pan on hold due to non availability of feed material.
- Initial filling done from the vacuum crystallizer having already some fines which required water to wash them
- Heavy vacuum fluctuations during the Pan strike

Therefore there is potential to reduce water addition for the to achieve even better results .once all pans are automated the results will further improve system.

Future Aspects

The operation and the results of the pan automation system gave a lot of confidence to MMSSK limited to Implement this automation at all pans in the 3 sugar factories .It has been also observed that automation of refinery pans can be even more beneficial as the water addition to the refine massecuite pans is much higher than the a massecuite pans.

The automation on the pans will allow to increase the brix of feed material to optimize the process team demand along with the steam saving by avoiding the water addition to the pans additionally due to increase the brixs of syrup/melt lesser capacity of the pans will be required which will be used to increase the plant crushing capacity with Same pans.

The intelligence of the system is a crucial step towards implementation of artificial intelligence and machine learning in the sugar factory it will be further upgraded to make the entire pan station man less in all sugar factory of MMSSK limited step wise approach.

Operator training

A very important aspect for a successful implementation of a pan automation system is the training of operators, process and laboratory team members, and automation technicians. The pan operators often don't have the computer operation skills and to be confronted with a complex computer system is a challenge for them. Proper personal selection and computer training to them is therefore mandatory. Intense training on the job is another important aspect to the automation team needs to be trained to maintain the operability of the system. The process team needs to understand the technological background of the operation the laboratory team requires special training for analyzing the Brix samples to calibrate the brick sensors accurately.

Conclusion

With the implementation of the modern batch automation system, The sugar factories can cut down the water addition to the pans by 60-100% which can help to reduce the sugar boiling time more than 20%. Reduction in the boiling time will provide additional capacity at the pans to process more sugar usually, during the high recovery time, the batch pans become a bottleneck causing reduction in plant capacity which can be overcome by the modern pan automation system. In the case of plant capacity increase investment on the new pans can be avoided by operating existing pans automation system can help to improve sugar quality as well.

The man-power optimization is another aspect to consider here .The integration of the online optical crystal monitoring system makes the pan operation truly man less.

Due to stabilization of pan operation and heating steam supply to the pans with automation, the evaporator performance will also improve. Better exhausiontion of the massecuite and better uniformity of the crystals will be helpful to improve the performers of centrifugal machines which allow less sugar this recirculation in the process.

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To Enumerate the Microorganism in Distillery, Using the Different Chemical

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Abstract –

The effectiveness of multiple cleaning in place (CIP) procedures was observed from different local distillery inthe Sanglidistrict. Experiments were also carried out to investigate possible reductions in chemical, water and energy use with regards to CIP, without compromising the effectiveness of the CIP performed. The effectiveness of CIP cycles was quantified using Hygiene's Swab, with a relative with a indicating a clean vessel. It is recommended that distillery use at least a 2% v/v dilution for caustic CIP cleaning cycles (based on a ~32% wt caustic liquor) for 35 min to ensure a thorough clean. High temperatures (40-60°C) did not indicate an improvement in cleanliness levels over ambient temperature water (10-20°C) over the 35 min cycle time. A single pass of 100 L of rinse water is adequate for vessels up to 1200 L to ensure removal of caustic residue and should be followed by a sterilization stage. These recommendations are based on a final acid sterilization cycle with 1% v/v dilution of a 5% wt per acetic Acid (PAA) for at least 10 min. Reductions in the usage of caustic liquor, water and energy (heating) for caustic CIP cycles could yield distillery savings of over 83140 INR annually.

Key Words: Cleaning, Optimization, Distillery, CausticSoda, Hot Water, Sodium hydroxide (NaOH)

Introduction-

Cleaning used to be entirely manual, requiring employees to climb inside mash tuns, wash backs and pot stills, which entailed significant safety risks. CIP (Cleaning In Place) was developed to address this, by providing automated 'internal' cleaning systems within mash tuns, wash backs and pot stills."CIP became more widely used in the early 1990s, and it's standard practice to include CIP in new distillery equipment, though it can also be retro-fitted in older equipment. The cost of CIP can be anything from three to five per cent of the total cost of new build equipment dependant on size, though retro-fitting can be more expensive," says Richard Forsyth, chairman of Forsyth, which provides design, build, and installation and maintenance services.

Mash tuns require two cleaning systems, one above and one below the drainage plates at the base.

It is generally accepted that there are 4 main phases to the cleaning of distillery equipment to ensure a thorough clean: pre-wash rinse, detergent (typically Caustic based) wash, rinse and sterilization (typically acid) wash An additional acid cycle and rinse is occasionally performed after the alkali rinse as a de-scaling measure. On some larger scale distilleriesthe acid sterilization stage is replaced with sterilization in place (CIP) procedure, using (sterile) steam to create a sterile environment. The pre-wash is used to remove loosely bound soil, alkali chemicals to remove organic soils and acids are used to remove inorganic soils, mineral scales (Goode, 2012) and sterilize the vessel, and the final rinse is to remove any alkali or acid from the vessel. Typical guidance on the concentration of an alkali wash is to use Sodium Hydroxide (NaOH) at 2-5% w/v however; there have been drives towards a change to procedures in recent years due to price changes in chemicals. Traditionally, a hot caustic solution of 2-4% w/v was used for cleaning, but with increasing prices, the approach was changed to save costs and 1-2% w/v concentrations of caustic are now advised for the alkali wash for stainless steel vessels (Miller et al., 1960). It is generally accepted that no one material has all the desired qualities of a good detergent, but the detergent of choice is usually a mixture of different chemicals, with the primary chemical being Caustic Soda (NaOH) and possible sequestant additions „to improve emulsification and rinsability"

Material & Method –

Caustic soda, sodium hydroxide, hot water, pHmeter, titrationinstrument, sterile swab nutrient media, control plate.

Process (Using Hot Water):-I

To clean fermentor after production supply hot water (Temp 80-90^{0}c)

↓

Check to sterile swab on F_1 to F_2 and Y_1 to Y_3 incubated on nutrient plate 37^{0}c

↓

After incubation to check plate count

↓

Some colonies are seen it is spore forming

↓

But it is safe for production

Table no .I

Sr No	Temp	TVC Count (Agar plate)
1	40-50	100000X10^5
2	50-60	12222 X10^5
3	60-70	5000 X10^5
4	70-80	2500 X10^5
5	80-90	NIL

PROCESS (CAUSTIC SODA):-II

To clean fermentor after production run to caustic soda solution (Temp 1.5-2%v/v)

↓

Check to sterile swab in F_1 to F_5 and Y_1 to Y_3 inoculating in agar plate incubated on nutrient plate 37^{0}c

↓

After incubation to check plate count

↓

Some colonies are seen

↓

After 2%caustic soda solution count is nil

Table no .II

Sr.No	Caustic %	TVC Count (Agar plate)
1	0.5%	$80000X10^3$
2	1.0%	$6000X10^3$
3	1.5%	$2000X10^3$
4	2.0%	NIL
5	2.5%	NIL

Consulation –

Distillery must maintain high levels of cleanliness to ensure products are not contaminated, thereby avoiding reputational damage to their brands. It is reassuring that, in general, the distillery cleaning practices currently employed across North East England are considered acceptable and vessel cleanliness adheres to the RLU tolerance applied as part of this study. There is no single CIP technique employed by distilleries in the North East that could be deemed „the best." although some will feel peace of mind with SOP above the minimum requirements, based on the observations of this study, some distillery could be over using chemical, water and/or energy resources during cleaning. Thus, there is the clear potential for financial savings and mitigation of environmental impacts.

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Ethanol Production From Fruit Waste

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Abstract:

At present time the need of the petroleum products was increases day by day which also results in the increase in the price of such products. Therefore, it is need to discover the alternative cheaper source for production to fulfill the worldwide requirement. The fruit waste can also use as a substrate to produce ethanol with the help of microorganism Saccharomyces cerevisiae. The wastes such as peals of fruits such as banana, orange, pineapple, pea, sugarcane, etc. can used as source for ethanol production. Saccharomyces cerevisiae is most commonly and widely used for the production of ethanol due to its high yielding capacity. Ethanol is one of the critical industrial ingredient which is used as a chemical base for organic compounds. Fruit waste is the cheaper and easily available raw material for the production of alcohol. The fruit waste which is usually discarded has great antimicrobial potential. Different fruit wastes like peals of banana, orange, pineapple are subjected to fermentation for one week. After a week ethanol yield was checked and compared with each other.

Keywords: *Fruit waste, ethanol, Saccharomyces cerevisiae, fruit peals, organic compound, raw material, antimicrobial potential.*

Introduction:

In today's world there is a rapid increase in the use and demand of fossil fuels and petroleum products which results in increase in their prices, so it is need to discover an alternative source which is cheaper and also easily available at the same time. In early 1900s when the petroleum supplies were become short in Europe, the first use of ethanol as a fuel at large scale was happen. The ethanol was often traditionally produced from the petroleum byproducts but now the studies and researches shown us that the production of bioethanol can also done by the fermentation process by using renewable raw material.

The *Saccharomyces cerevisiae* have high yielding capacity and high tolerance capacity so due to that it is more commonly and widely used for the ethanol production. According to recent studies and researches the fruits or vegetables waste can be the best raw material for the ethanol production. The fruit waste like peels of banana, oranges, pineapples, peas, sugarcane, etc. can be used as a raw material for the sustainable production of ethanol. These raw materials are easily available and the cost is also low.

The utilization of large amount of fruit waste for ethanol production can be beneficial for both economy and the environment. One example of raw material is pineapple waste that is converted to bioethanol (Hossain et al., 2008). The wastes contain valuable components such as sucrose, glucose, fructose and other nutrients (Sasaki et al. 1991). Lignocellulose is the major structural component of woody plants and non woody plants. The use of mango peel as a source of pectin and fiber production also has been reported (Pandia et al., 2004). Grohmann et al. (1994; 1995; 1996; 1998) previously reported ethanol production from orange peel. Ethanol production from banana (Manikandan et al., 2008) and pineapple peels (Ban-koffi and Han, 1990) were also investigated. Dried orange peels have a high content of pectin, cellulose and hemi cellulose, which make it suitable as fermentation substrate when hydrolyzed. Insoluble carbohydrates are present in the cell walls of the peels, particularly in the form of pectin, cellulose and hemicellulose.

Literature Review:

In 1826, Henry Hennel in Britain and S.G. in France independently accomplished the first synthetic ethanol preparation. In 1828, Michael Faraday created ethanol using the acid-catalyzed hydration of ethylene, a method that is still in use today for the industrial manufacture of the fuel. The majority of ethanol is produced through fermentations employing S. Cerevisiae. The ability of Saccharomyces cerevisiae and Zymomonas mobilis to produce ethanol from glucose both aerobically and anaerobically was assessed by Karsch et al. (1983). S. cerevisiae, also referred to as Baker's yeast, is capable of fermenting a sugar solution with insufficient oxygen, producing carbon dioxide and alcohol as a byproduct. Zymomonas mobilis uses the Entner-Doudoroff pathway to break down carbohydrates into pyruvate. The only byproducts of the fermentation of the pyruvate are carbon dioxide and ethanol (Farombi and Britton, 1999). Additionally, A. niger produces cellulases, amyloglucosidase, and amylase. pectinases, lactase, and invertase.

By hydrolyzing banana waste cellulose with a cellulase enzyme from Trichoderma reesei QM 9414, maximum saccharification was attained. Banana peels that had been acid hydrolyzed (2·5% at 15 psi for 15 min) and cellulose yielded 1·38% and 0·78% (v/v) and 44·5% and 61·1% ethanol (mg g−1reducing sugars), respectively. The PET operon from Zymomonas mobilis on the plasmid pLOI555 is present in E. Chrysanthemi EC16, according to Grohmann et al. (1998). This increases the organism's synthesis of ethanol and lowers the final concentration of co-products (Beall and Ingram 1993). The amount of ethanol produced by Escherichia chrysanthemi EC16 fermentations of sugar beet pulp was 1.97 percent (w/v), which was less than the 2.55% (w/v) that E. Coli KO11 produced on the same substrate. Jayant Mishra et al. (2012) found that in their investigation, ethanol production from pineapple, orange, and sweet lime fruit peels was looked into. The total sugar content of orange, pineapple, and sweet lime was 0.8%, 0.5, and 1 correspondingly. Pineapple agro residue ferments in the solid condition to a maximum yield of about 2.16% using yeast. A strain switch to C. albicans results in a high yield of 1.08% for group A in a 50 ml capacity from pineapple. S. cerevisae yields a maximum of 1.87% when pineapple is used. Lavarack B. P. et al. (2002) tried dilute acid hydrolysis of bagasse for conversion of hemicellulose to xylose, glucose, arabinose, acid soluble lignin and furfural.

Materials and Methods:

1. Peel preparation (Pineapple, Banana, Orange peels) for Ethanol Production:
   Peels from pineapples, bananas, oranges, and peas were cleaned, their outer coatings removed, and they were chopped into little pieces and left in the sun for a few days before being dried in an oven and refrigerated until needed.
2. Preparation of Growth Medium:
   The growth media used to produce ethanol is made up of 20 g of substrate (pea, banana, orange, or pineapple peel) in a 250 ml conical flask with 100 ml of pH-5.5 distilled water. For 20 minutes, the flasks were autoclaved at 121°C. After filling petri dishes, this medium is left to harden.
3. Inoculum Preparation:
   Yeast Extract Peptone Dextrose (YEPD) broth was used to culture *Saccharomyces cerevisiae* cells aseptically, and they were incubated for 24 hours at 30°C.
4. Saccharification of the Fermentation Medium with Aspergillus:
   Aspergillus spores were added to the substrate medium that was previously prepared. The culture underwent a vigorous aerobic culture incubation period of seven days at 28°C. Samples were collected for analysis at regular intervals following every twenty-four hours. The largest amount of total sugar was reached after 7 days in culture.
5. Production of Ethanol:
   A 270 ml medium was made and put into a Duran wide mouth bottle. After 20 minutes of autoclaving at 121°C, the media was chilled. After the saccharification process, 30 milliliters of the culture broth were added to the medium. Aspergillus has elaborated a cellulolytic enzyme complex that is present in this broth. 1752 Girisha Malhotra et al. 5% v/v of already activated Saccharomyces cerevisiae was used to inoculate the bottle. Static circumstances were used to cultivate the bottles. Every 24 hours, the samples were taken out at regular intervals.
6. Primary Product Isolation:
   After centrifuging the samples for five to seven minutes at 5000 rpm, they were kept at 20°C for additio nal examination.
   Using the potassium dichromate technique for the ethanol assay, the raw ethanol yield was determined.
7. Determination of Sugar Concentration by Refractometer:
   Refractive index measurements can be used to estimate the amount of sugar present in a sample. The foundation of this measurement is the idea that a sugar solution's index of refraction is proportionate to its concentration.
8. Ethanol Estimation:
   A 250 ml volumetric flask was filled with 10 ml of the sample. The volume was increased to 250 milliliters by adding water. A 20 ml aliquot was taken from this diluted material and placed in a conical flask. Using a measuring cylinder, 10 ml of 40% sulfuric acid was applied to each flask. Put each flask in a water bath set at 45 to 50°C for ten minutes, then loosely stopper it. The flasks were taken out of the bath after ten minutes, and each one received two grams of potassium iodide. Standard thiosulphate solution was put into a burette. Use the thiosulphate solution to titrate the contents of the flask. When the brown color of the solution turned green, 1-2 milliliters of starch were added.

Results & Observations:

The medium was made up of 20 grams of oven-dried substrate, and the pH was adjusted to 5.5 while the volume was increased to 250 milliliters. The media was injected with Aspergillus niger spores. The culture was incubated under aerobic conditions for seven days at 28°C. Utilizing the Starch Agar plate assay and the Cellulase Agar plate, the enzyme activity was qualitatively assessed. A maximum amount of residual sugar was found between hours 192 and 216.

With the help of refractive index of solution the concentration of reducing sugar was obtained during the fermentation process.

Sugar content of different fruit wastes:

Substrate	Sugar Concentration (in gram / 1 gm of substrate)
Pineapple peel	0.2
Banana peel	0.4
Orange peel	0.35

The Pineapple peel shows the sugar concentration of 0.2 gram per gram of substrate, banana peel shows 0.4gm concentration and orange peel shows the 0.35gram sugar concentration.

Maximum yield of different substrates:

Substrate	Maximum Yield In gm/L
Pineapple	36.5
Banana	30
Orange	31.5

The Pineapple peel shows yield of 36.5 gm/L, banana peels shows 30gm/L and orange peel shows the yield of 31.5gm/L. Hence the Pineapple peels has higher yielding capacity.

Conclusion:

From the experiments, it is proved and concluded that the highest ethanol production can be obtained from the pineapple peels as a substrate. The conversion of fruit wastes into ethanol was done. From the whole experiment it is concluded that we can produce ethanol from the waste of fruits and we can utilize the fruit waste in a sustainable manner and used them as a raw material for ethanol production.

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Ethanol Production From Preserved Sugarcane Juice

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Abstract –

Sugarcane feedstock mainly consists of sugar in the form of disaccharide (sucrose), which is readily fermented into ethanol by S. cerevisiae. The process of making ethanol from sugarcane starts when cane stalks are crushed to extract a sugar-rich cane juice. When cane stalks passed through extractor/expeller, cane juice is collected and delivered to a fermentation tank where the yeast fermentation reaction occurs to generate ethanol. The leftover fibrous residue called bagasse (45-50% moisture content) after juice extraction process is commonly combusted to generate heat/electricity for in-plant use. After fermentation, the fermentation broth containing approximately 5-12% ethanol by weight is now called beer. The beer is delivered to distillation column where the ethanol is recovered and the liquid residue known as vinasse is co-generated at the bottom of distillation column. At this process, the purity of ethanol can be up to 92-95% therefore further water separation process is required. Commonly, dehydration of the residual water is carried out using molecular sieves resulting in the final product, a fuel-grade anhydrous ethanol (200 proof or >100% ethanol)

Key-Word : *Sugarcane juice , ,culture(saccromycesis cervices) ,DAP ,Urea ,biobuster fermentation, distillation.*

Introduction

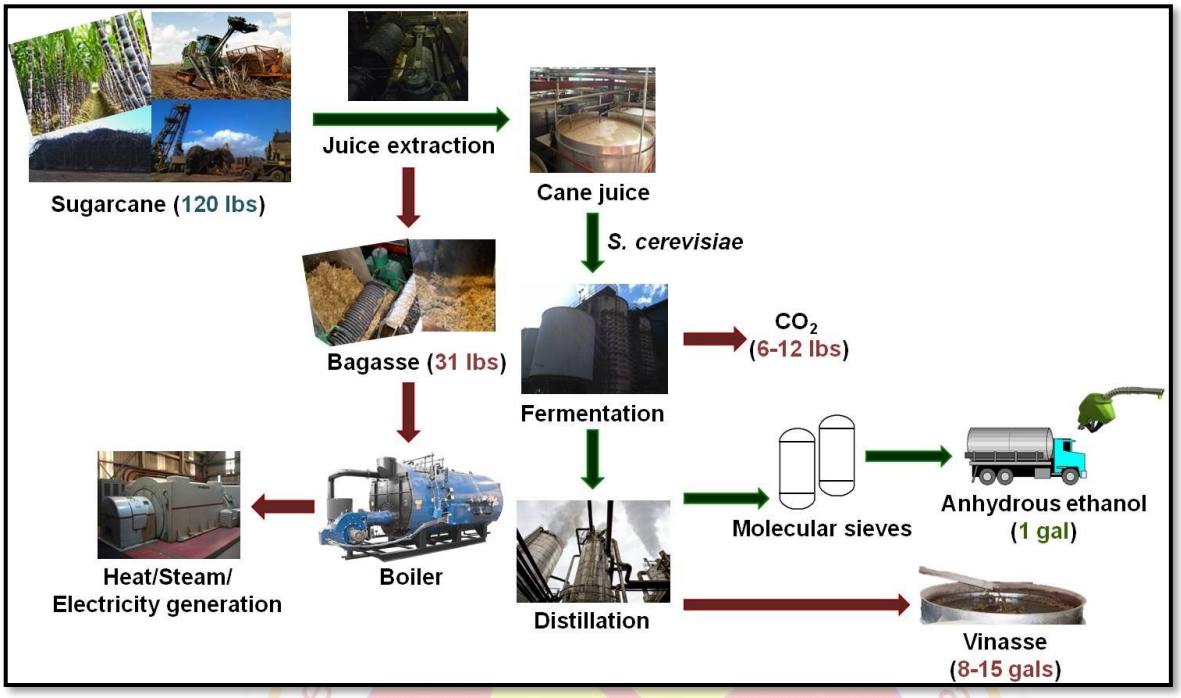
Sugarcane feedstock mainly consists of sugar in the form of disaccharide (sucrose), which is readily fermented into ethanol by S. cerevisiae. The process of making ethanol from sugarcane starts when cane stalks are crushed to extract a sugar-rich cane juice. When cane stalks passed through extractor/expeller, cane juice is collected and delivered to a fermentation tank where the yeast fermentation reaction occurs to generate ethanol. The leftover fibrous residue called bagasse (45-50% moisture content) after juice extraction process is commonly combusted to generate heat/electricity for in-plant use. After fermentation, the fermentation broth containing approximately 5-12% ethanol by weight is now called beer. The beer is delivered to distillation column where the ethanol is recovered and the liquid residue known as vinasse is co-generated at the bottom of distillation column. At this process, the purity of ethanol can be up to 92-95% therefore further water separation process is required. Commonly, dehydration of the residual water is carried out using molecular sieves resulting in the final product, a fuel-grade anhydrous ethanol (200 proof or >100% ethanol).

Materials And Methods

Sugarcane varieties namely Co86032, CoP 265, CoP 1005, CoS 271, CoS 767, CoP 84212, CoP 90223 and CoP 93227 obtained from Crop Research (India) were screened for their suitability for juice production. Canes were cleaned, washed and crushed by hand driven brass crusher to obtain maximum possible juice yield. Juice was filtered through a four layered muslin cloth. Juice yields were recorded and juices were subjected to physico-chemical and sensory evaluation.,culture (saccromycesis cervices) ,DAP ,Urea ,biobuster fermentation, distillation

Procedure-

Optimization of Treatments



Procedure-

Sugar Canes were cleaned, washed

↓

Crushed and juice extraction

↓

Juice Prepared

↓

Check juice parameter

↓

Maintain to parameter by adding DAP,Urea, S.cervices

↓

Fermentation (24 Hrs to 32Hrs)

↓

Complete fermentation

↓

Distillation

↓

Separate to Ethanol

Conclusion

On the basis of facts stated above it may be concluded that good quality beverage from sugarcane juice of variety CoP 92226 with it produced to ethanol production from preserved sugarcane juice it is almost effective in offseason. The process of making ethanol from sugarcane starts when cane stalks are crushed to extract a sugar-rich cane juice. When cane stalks passed through extractor/expeller, cane juice is collected and delivered to a fermentation tank where the yeast fermentation reaction occurs to generate ethanol.

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Sulphur-less Sugar Production

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Abstract:

The paper describes the details of equipment and the process used to produce Sulphur-less sugar and advantages of sulphur-less sugar.

Keywords: Raw sugar, Sulphur-less sugar, Colour, Turbidity, Sulphur-dioxide, Beverage floc, Conductivity ash, Sediment, Polarization

Methods:

Following internationally accepted ICUMSA methods are used for analysis of all intermediate products and final product, sugar.

a) Colour - ICUMSA GS 9/1/2/3-8 (2011)
b) Turbidity - ICUMSA GS 2/3-18 (2013)
c) Sulphur Dioxide - ICUMSA GS 2–33 : 2022
d) Beverage floc - ICUMSA GS 2/3-40 : 2019
e) Conductivity ash of sugar - ICUMSA GS 2/3/9–17 (2011)
f) Sediment content of sugar - ICUMSA GS 2/3/9–19 (2007)
g) Polarization - IS 15279 : 2003 clause 5&6

Introduction:

In India mostly plantation white sugar is produced by double sulphitation method i.e. juice sulphitation prior to clarification followed by syrup sulphitation. The sugar produced by double sulphitation contents higher quantity of sulphur in the range of 20 to 70 ppm or may be higher depending upon the operation of individual sugar factories. Due to higher sulphur content in sugar it is not accepted in International market. As per international norms, sulphur less than 20 ppm in sugar is acceptable.

In the case of sulphitation process, the equipment and piping in operation get corroded resulting in the requirement of repair, maintenance and replacement cost.

The plantation white sugar produced by the double sulphitation process is said, to have an adverse effect on the human body. Growing awareness of using sulphurless sugar for the benefit of the human body, environment, additional revenue etc. it is now right time for Indian sugar industry to switch to the production of sulphurless sugar.

Process steps for production of Sulphur-less sugar:

1. Production of raw sugar by juice defecation
2. Raw sugar melting – screening – clarification – filtration
3. Melt concentration
4. Pan boiling, crystallization and centrifugation

Description of the process and equipment used:

A) Producing good quality raw sugar : The initial stage is of producing Raw sugar. Following scheme will help to produce better quality raw sugar.

1. Two stage rotary juice screens at mill house
2. Raw juice flow stabilization
3. Hot raw juice screening system
4. Juice defecator with pH automation

5. Defecated juice flow stabilization
6. Auto temperature control of defecated juice
7. Short retention time clarifier
8. Continuous Pans etc.

Raw sugar specifications

Colour	: 400 to 600 IU
Turbidity	: Less than 250 IU
Sulphur-dioxide	: Less than 20 ppm
Conductivity ash	: 0.04 to 0.05 %
Sediment	: Below 100 mg/kg
Polarization	: 96 to 97 %

B) Producing Sulphur-less sugar

1. Raw sugar melting and screening

Raw sugar shall be delivered to sugar minglers. Minglers are generally kept below raw sugar centrifugal machines. Alternatively, belt conveyor is kept below centrifugal and mingler is kept above sugar melter. Raw sugar magma will be produced using hot water. Magma brix shall be kept at around 92°.

Raw sugar magma shall be fed to sugar melter. 3 compartment type horizontal sugar melter is used for melting raw sugar. Brix of melt at the outlet of melter shall be 60 to 62° and temperature shall be in the range of 65 to 70°C to achieve better screening efficiency. To maintain above parameters auto Brix and temperature control is required.

Raw sugar melt is then passed through rotary melt screen. This melt screen is of fully closed type to minimize temperature drop during screening. Automatic timer operated washing arrangement is provided to wash the screen periodically as per system requirement.

2. Melt clarification system

Screened melt is delivered to screened melt tank. Colour precipitant is added according to raw melt flow. Screened melt is then pumped to melt heater and temperature at outlet of the heater is around 80-85°C. Bled vapours from first or second body evaporator shall be used as heating media.

Heated melt is then passed through a three compartment type melt reaction vessel cum aerator. Lime sucrate and phosphoric acid is added in the first compartment of reaction vessel. First two compartments are provided with stirrers for proper mixing of chemicals. Auto pH control system is provided to achieve desired pH of treated melt which is generally around 7.

Treated melt overflows to aeration compartment fitted with aeration disc for micronized air mixing with the melt. Flotation polymer is added at the outlet of aerator.

Aerated melt is then fed to flotation clarifier where scum is removed from top surface. Clear melt withdrawal is from bottom takeoff coil and with telescopic valve arrangement it will be delivered to clear melt tank.

Scum resulted from melt clarification is collected in scum tank and then fed to mud tank or scum de-sweetening system for effective de-sugarization. Sweet water from first stage will be delivered to sugar melter and final scum to mud tank of rotary vacuum filter.

Clear melt is collected in clear melt tank and then pumped to Multibed filters.

Chemical usage: - Depends on the quality of raw sugar

Following chemicals are required for melt clarification system:

1. Colour precipitant : 100 to 250 ppm
2. Phosphoric acid : 250 to 350 ppm

3. Lime sucrate or MOL : to maintain desired pH of treated melt
4. Flotation polymer : 10 to 12 ppm

With respect to melt flow rate Colour precipitant, Phosphoric acid and Flotation polymer dosing shall be in auto mode. Dosing of Lime sucrate is adjusted to meet desired pH of treated melt.

3. Multibed filtration system

There are minimum 2 nos. Multibed filters (1 no in operation and another in backwash mode). 6 layered filter media will help to filter any suspended solids which may escape through clear melt.

Filtered melt is then collected in filtered melt cum back wash tank. Backwash tank partition will be always in filled condition so as to allow back wash at any given time. Filtered melt is then pumped to bag filters fitted with 50 micron filter bags installed before two effect melt concentrators.

4. Melt concentrators

Filtered melt brix is in the range of 58 to 60 degree. To reduce steam consumption the brix is raised to 68 to 70 degree and then pumped to pan supply tanks. Two effects of FFE, plate type evaporator or Robert body evaporators are generally used.

5. Pan boiling scheme

Generally R1, R2 and R3 pan boiling scheme is adopted. The concentrated fine liquor is pumped to pan supply tanks for feed to pans. The liquor is boiled in vacuum pans. For refined massecuite vacuum pan should be low head with fast natural circulation rapid boiling calandria. First boiling uses concentrated fine liquor as feed. Runoff separated from this massecuite is used as feed for second boiling, runoff from second boiling is feed for third boiling.

R3 massecuite runoff and surplus raw washing are processed in raw sugar pan boiling station.

6. Centrifugal station operation

a. At Batch type centrifugal machine, R1 massecuite is cured and R1 Sugar, R1 heavy and R1 light molasses are separated.
b. R1 sugar is dryed through hopper and then grading is done through grader. Sugar is then transferred to silo and then sugar bagging is done.
c. R1 heavy and R1 light molasses is send to R2 massecuite through pumps for the further processing.
d. R2 massecuite is also cured in batch type machine.
e. R2 sugar is dryed, graded and then bagged through silo.
f. R2 Molasses is pumped to R3 massecuite as a feed for it.
g. R3 massecuite is cured in batch machine.
h. R3 sugar is dryed, graded and then bagged through silo with R2 sugar.
i. R3 molasses is pumped to raw sugar pan boiling station.

7. Automation

Entire system of melt clarification and filtration is fully automatic and controlled through DCS.

Following are the control schemes

a) Raw melt brix and temperature
b) Melt flow stabilization at various stages
c) Screened melt temperature and pH
d) Chemical dosing
e) Multibed filter in auto sequential mode
f) Brix control at melt concentrator
g) Pan station automation

Sulphur-less sugar specifications

Colour	: Below 45 IU
Turbidity	: Less than 40 IU
Sulphur-dioxide	: Less than 5 ppm
Conductivity ash	: 0.02 to 0.03 %
Sediment	: Below 50 mg/kg
Polarization	: Above 99.5 %
Reducing sugar	: Below 0.04%
Moisture	: Below 0.04%
Beverage floc	: Negative

Advantages of Sulphur-less sugar:

- Most important is to eliminate highly toxic Sulphur di-oxide gas thereby corrosive levels are negligible resulting into improved life of equipment with its piping and other adjacent equipments including building.
- 100% saving in sulphur cost and around 30-35% saving in lime cost.
- Reduction in cost for de-scaling chemicals.
- Good exposure for sugar to international market.
- Improved keeping quality as compared to sugar produced using double sulphitation process.
- Lower insoluble matter in final sugar due to removal of fine fibre particles during melt clarification and filtration.
- During the production of raw sugar and sulphurless sugar near-neutral pH is maintained thereby less risk of inversion loss and possibility of rise in recovery.
- White sulphurless sugar meets the various parameters as specified out by beverage manufacturers.

Reference Books

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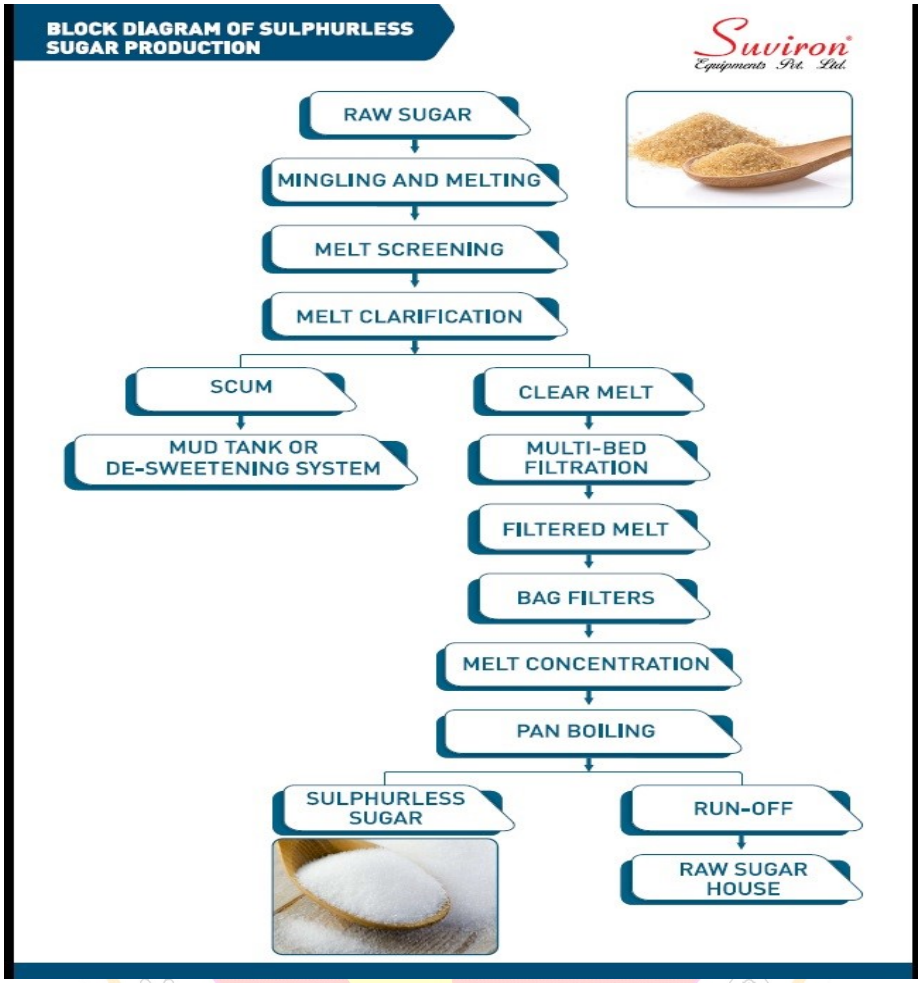
2) Manufacture &refining of raw sugar By-v.e.Baikow
3) Hand book of sugar engineering By - H.Eugot
4) Hand book of cane sugar By - R.B.L. Mathur
5) Cane sugar engineering By-Peter Rein
6) Machinery and equipments of cane sugar factory- By Tromp.

Block diagrams of the process:



Conclusion:

Sulphur-less sugar production is beneficial for human, machine and atmosphere. This sugar gives higher premium. It is also a step towards refined sugar production. Hence now it is right time for our sugar industry to adopt this technology.

Acknowledgement:

Authors express their sincere gratitude to the management of Rajarambapu College of Sugar Technology Islampur for giving us an opportunity to present the paper. We are also thankful to Nirani group for providing their continual support, successful operation and data collection at their factories.

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Maximizing ethanol production of Indian distilleries by advancements in fermentation process with final sugar cane molasses, B heavy molasses, and sugar cane juice syrup .

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Abstract:

To boost ethanol production domestically and meet the nation's ethanol needs in order to meet the government of India's 2025 aim of 20% ethanol blend with gasoline. The distilleries must maximize their ethanol production in order to surpass the target and meet the complete need of ethanol for blending with gasoline. This paper examines the technical aspects of fed batch fermentation and very high gravity fermentation alone or in combination using final sugar cane molasses, B heavy molasses, and syrup to maximize ethanol production. Additionally, the use of biochemical boosters and improved strains of active dry yeast to improve the fermentation process in existing distilleries is discussed.

Key words: *Fermentation, Ethanol, Biochemical boosters, B- heavy molasses, Sugar cane juice syrup, Stoichiometry, Fed batch fermentation, Very high gravity fermentation.*

Introduction:

Oil Marketing Companies (OMCs) sell gasoline that has been blended with ethanol under the government of India's Ethanol Blended with Petrol (EBP) Program, which is being implemented nationwide. The government has set a target of 20% ethanol blend with gasoline by 2025 under the EBP program.

About 1016 crore liters of ethanol are needed to reach the 20% blending target by 2025; the overall amount of ethanol needed, including for other purposes, is 1350 crore liters. If the plant runs at 80% efficiency, over 1700 crore liters of ethanol-producing capacity must be in place by 2025. The government has forecasted the amount of ethanol needed for a 20% blending by 2025, taking into account the anticipated expansion of gasoline-powered cars in the passenger and two-wheeler segments as well as the anticipated sales of Motor Spirit (MS).

Ethanol has been produced by fermenting sugars, since prehistoric times. This technique till produces all beverage ethanol, fuel ethanol and industrial ethanol. The primary components are simple sugars. Sugar cane, sweet sorghum and sugar beet are utilized as sugar containing feed stocks in manufacturing of ethanol across the world. Maize, wheat and other grains contain starch which can be turned into sugars. Sugar cane molasses is primary source of ethanol in India. In India, ethanol is mostly prepared from sugar cane molasses around 74% and 26% from grains.

In view of, 20% blending of ethanol with petrol by 2025, India's current alcohol production has to be increased considerably.

Observation and Discussion:

As far as sugar factories are concerned following are the alternatives to increase the ethanol production.

1) Ligno- Cellulose ethanol from bagasse.
2) Sugar cane juice syrup.
3) B- heavy molasses.

These are good options to cope up with increased ethanol requirement.

The first alternative is entering in new phase of development. Sugar cane juice syrup and B – heavy molasses are the present suitable alternatives. Final molasses has been used for ethanol production from long time.

Composition of sugar cane juice syrup, B – heavy molasses and final molasses are given here.

Sr.no.	Parameters	Cane sugar syrup	B-Heavy Molasses	Final Molasses
1)	Degree Brix	55 - 58	85 - 88	86 – 90
2)	Total Reducing Sugar, (%/mass)	51 - 54	54 -58	45 – 50
3)	Specific Gravity	1.15 – 1.20	1.33 – 1.37	1.40 – 1.45
4)	pH	4.5 – 6.1	4.6 – 6.1	4.5 – 6.0
5)	Unfermantable Sugars (%/mass)	0.5 – 0.7	2.5 – 3.5	4 - 6
6)	F/N Ratio	6.0 – 6.5	2 – 2.4	1.1 – 1.5
7)	Total volatile Organic Acids (PPM)	800 - 1000	2000 - 2500	3500 – 5500

During sugar manufacturing, syrup produced is normally double sulphited but for fermentation at least single sulphited syrup should be used. Because presence of high amount of sulphites are inhibitory for fermentation by yeast. Therefore the fermentation reaction become slow. Due to this, fermentation time increases .i.e 46-50 hrs. In process of raw sugar manufacturing defecation process is used, so no use of sulfur, therefore syrup is sulphite less, so the fermentation time is reduced.

Syrup brix typically ranges from 54 to 58 degrees. After cooling, it needs to be diluted to a brix of 28 to 30. Spent wash can be used, once cooled, to dilute syrup. Secondary juice is also appropriate for diluting if necessary.

Fermentable to non fermentable (F/N) ratio for syrup is around 5 to 6 and it is very suitable for fermentation. B – Heavy molasses can be stored like the final molasses and fermented in the similar ways as the final molasses. Its (F/N) ratio is more than 2. For good fermentation F/N ratio should be more than one.

Compared to final molasses sugar cane juice syrup and B – heavy molasses are more suitable for fermentation. Because there are less inhibitory factors of fermentation as compared to final molasses.

For commercial ethanol production. 1) Batch type of fermentation process, 2) Continuous fermentation process are used. Currently fed batch fermentation is recent process adopted by some distilleries for ethanol production

Batch type fermentation is old fermentation technology; its efficiency is low compared to other fermentation technologies. Due to inferior quality of molasses. i.e. High bacterial contamination, high volatile acids, high caramel content and sludge content, and due to its inhibitory effects, it is difficult to run the continuous fermentation process also. To increase the alcohol percent in fermented wash and overcome these difficulties of inhibition the new improved fermentation process i.e. a) Very high gravity fermentation process and b) Fed batch fermentation can be used

Very high gravity (VHG) fermentation:

Using high-sugar musts or feedstock to maximize ethanol production while lowering production costs, VHG fermentation is an emerging technique for raising the alcohol percentage in the fermented wash. Generally speaking, there are three categories for sugar concentrations needed to produce ethanol: normal gravity (less than 180 g/L), high gravity (between 180 and 240 g/L), and extremely high gravity (more than 250 g/L). In VHG fermentations, large ethanol concentrations are attained by consuming over 30% of the solids. Very high gravity fermentation can achieve more than 15% (v/v) of ethanol, compared to the average of 10–12% (v/v).

Reduced energy, water, and waste output are some of the advantages of VHG fermentation, which also lowers production costs and improves environmental sustainability. However, increased metals and sodium ions, nutrient stresses (e.g., nutrient limitations, such as free amino nitrogen and dissolved oxygen), elevated

temperatures, acidic conditions, osmotic stress, and elevated ethanol concentrations all cause multiple stresses for yeasts during VHG fermentation. As fermentation proceeds, the increased osmotic pressure on the yeast cells may cause an accumulation of intracellular ethanol, which will reduce production efficiency and the survivability of the yeast cells. Despite the fact that certain yeasts, including S. rouoxii, are more resistant to certain osmotic stressors, very high gravity fermentation offers a significant chance of producing high percentage of ethanol in fermented wash.

According to studies, adding nutrients to a simple medium containing 300 g/l of glucose increases the levels of ethanol. For instance, adding 4% (w/v) soy flour increased the ethanol levels to 12.8% (w/v); adding finger millet flour (Eleusine coracana L.), malted cowpea (Vigna unguiculata L.) flour, and horse gram flour (Dolichos biflorus) increased the ethanol concentrations to more than 15% (v/v) in a 72-hour fermentation period with productivities greater than 2 g l−1 h−1. In batch VHG fermentations of up to 330 g/l glucose, low-cost nutritional sources such CSL, urea, and magnesium sulfate have been used to achieve maximal ethanol output [18.6% (v/v)].

Very high gravity fermentation using fed batch fermentation technique with high cell density is promising approach for enhancing the ethanol production.

Studies have also shown that VHG fermentation of sugarcane juice fortified with molasses (34-35 % w/v) yielded ethanol as high as 15.8% (v/v) at 30°C within 48 h

Fed batch fermentation for improving the alcoholic fermentation process:

Fed-batch fermentation is like batch fermentations, except nutrients are incrementally added to the fermenter throughout the fermentation . The consistent addition of nutrients results in increased cell density during the exponential phase and thus enhances product yields. For example, continuous supply of sugars to yeast cells in the stationary phase can maximize ethanol yield.

Some of the salient features of fed batch fermentation:

1) In fed batch fermentation process the substrate feeding rate is the only manipulated variables.
2) The regulation of the substrate concentration in fermenter is most effective in overcoming the effect of subtracted inhibition, product inhibition, and initial load of contamination in molasses.
3) During the process of fed batch fermentation, such as sugar concentration, ethanol concentration, cell count etc. are also varying with respect to time.

Fed batch fermentation process is carried out as follow:

a) At first fermenter is cleaned.
b) The calculated quantity of water is taken in the fermenter.
c) Pre- fermenter contents are transferred to fermenter.
d) After starting pre-fermenter contents transfer, immediately start the charging of the calculated quantity of subtracts (molasses, or B – heavy or sugar cane juice syrup) within 12 – 15 hrs.
e) After completing molasses feeding, set up gravity is to be checked.
f) Total fermentation time is 30 – 40 Hrs (depending on substrate).

Operating sequence of fed batch fermentation process with time.

Sr.No.	Fed batch fermentation steps	Hours
1)	Process water filling	0 – 2 hrs
2)	Cell mass transfer	2 – 3 hrs
3)	Feed stock supply	2 – 15 hrs
4)	Fermentation reaction	15 – 29 hrs
5)	Discharge to mash charger	29 – 32 hrs
6)	Cleaning of fermenter	32 – 33 hrs
	Total hours :-	33 hrs

Total hours may change according to composition of feed stock.

Use Active Dry Yeast:

Active dry yeast, improved strain of saccharomyces cerevisiae for getting higher alcohol tolerance, to maintain higher yeast cell count, higher yeast viability count and for high gravity fermentation is used.

Consumption of active dry yeast 0.2 kg/KL of alcohol is achieved with pre-fermenter stage. It can be further optimized by adding one stage propagation before fermentation stage.

Use of Enzymes or Biochemical boosters

Some biochemical fermentation boosters i.e. enzymes, like alpha amylase, amyloglucosidase , cellulase, xylose isomerase, dextranase, galactosidase can convert unfermentable sugars partly converted into fermentable sugars. These fermentable sugars get ferments to ethyl alcohol and carbon dioxide by yeast. So this will be additional alcohol yield can be obtained from sugar cane based feed stocks. Enzymes like proteases converts available proteins into amino acids which is good source of assimable nitrogen to yeast .Some of the antibacterial agents/ antibiotics and micronutrients are used along with enzymes.

Therefore considerable alcohol yield will increase by using these biochemical fermentation boosters.

Dosage of enzymes.

Total dose of 5—7 ppm of wash is used in two stages for optimum benefits.

a) Pre fermentation b) Main fermentation

Nutrients:

In case of syrup, there is higher consumption of nutrients to provide adequate food to yeast, as syrup being cleaner substrate.

Performance of Fermentation Process

Sr.No.	Alternatives of raw material for alcohol Production	pH	Alcohol percentage in fermented broth	Residual Sugars
1)	Sugar Cane Juice Syrup	4.0 – 4.1	13.0 – 14.0 %	0.5 – 0.6
2)	B – Heavy Molasses	4.1 – 4.2	11.0 – 12.0 %	0.7 – 1.0
3)	Final Molasses	4.3 – 4.4	10.0 – 11.0.0 %	1.1 – 1.4

The performance of fermentation process of cane juice syrup and B- heavy molasses is better to comparison with final molasses.

Spent wash generation comparison with various alternatives of raw material for alcohol production with advancement in fermentation techniques described above.

Sr.No.	Alternatives of raw material for alcohol Production	Spent wash recycle to fermentation %	Initial solid content in spent wash	Spent wash generation, lit/lit of ethanol
1)	Final molasses	0	15-16	10-11
2)	B – Heavy Molasses	25	13-14	7.5-8.0
3)	Cane juice syrup	50	7—8	2.5 –3.0

Distillation:

For distillation scheme an analyzer with a degasser column, an aldehyde column, a rectifier, and a FOC column are used in conjunction with a molecular sieve dehydration unit to produce ethanol from C-molasses and B-heavy. However, simply an analyzer with a degasser column and a rectifier column combined with a molecular sieve dehydration unit may be used for the production of ethanol from sugarcane juice syrup. Due to the fact that sugarcane juice syrup is a cleaner raw material and has fewer bacterial contamination than b-heavy or C-molasses, RS manufactured from syrup has less impurities altogether. Due to this there is reduction in energy consumption considerably.

Conclusion:

1)To increase ethanol percentage in fermented wash by use of very high gravity fermentation, fed batch fermentation alone or in combination are potential energy saving, productivity and efficiency maximizing technologies in existing production system.

2) Along with above techniques by using various alternatives of raw material for alcohol production like sugar cane juice syrup, B-heavy molasses and final molasses with the use of a) enhanced strains of active dry yeast b) biochemical busters for alcoholic fermentation, will maximize ethanol production and significantly reduce energy consumption.

3) It is also seen that VHG fermentation of sugarcane juice fortified with molasses results in considerable increase in alcohol percentage in fermented wash.

4) The increased alcohol percentage in fermented wash will result in reduction of steam consumption, reduction in effluent volume and increase in ethanol production.

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"Effluent Treatment Plant" in Distillery Waste

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Abstract:-

Distilleries are among the most polluting industries because ethanol fermentationresults in the discharge of large quantities of high-strength liquid effluents with high concentrations of organic matter and nitrogen compounds, low pH, high temperature, dark brown color, and high salinity. The most common method of managing this wastewater (distillery stillage) is to use it for soil conditioning, but this requires thickening the waste water and may cause soil pollution due to its high nitrogen content. Therefore, treatment of distillery stillage is preferable. This review discusses individual biological and physico- chemical treatment methods and combined technologies. In addition, special attention is paid to valorization of distillery stillage,which is a valuable source of polysaccharides and volatile fatty acids (VFAs), as well as natural antioxidants, including polyphenols and other bioactive compound so finterest to the pharmaceutical, cosmetic, and food industries. New directions in improvement of valorization technologies are highlighted, including the search for new eutectic solvents for extracting these compounds. Such technologies are essential for sustainable development, which requires the use of management and valorization strategies for recovery of valuable compounds with minimal disposal of waste streams.

Keywords *– distillery industry, Effluent treatment, Performance evaluation, sludge.Reverse osmosis. Removal efficiency, Waste water characteristics,*

Introduction

The quality of water is of vital concern for mankind since it is directly linked with human welfare. It is a matter of history that fecal pollution of drinking water caused water borne disease which wiped out entire populations of cities. At present, the menace of waterborne disease and epidemics still looms large on the horizons of developing countries. Polluted water is the culprit in all such cases. The major sources of water pollution are domestic waste from urban and rural areas, and industrial wastes which are discharged into natural water bodies. Generally Speaking, water pollution is a state of deviation from the pure condition, where by its normal function and properties are affected. It has been mentioned before that knowledge of aquatic environmental chemistry is the key to the understanding of water pollution and its control. Water pollution can be best considered in the perspective of possible pollutant cycles through the environment.

Advanced wastewater treatment technologies are essential for the treatment of industrial wastewater to protect public health and to meet water quality criteria for the aquatic environment and for water recycling and reuse The effluent treatment plant is designed and engineered based on primary treatment and secondary treatment. Primary treatment consists of physical and chemical purification where as secondary consists of Biological carried out into two stages i.e. Anaerobic or Aerobic.The anaerobic process takes place is there like Hydrolysis (H*R*2*R*O), acidogenesis & Methanogenesis. The Micro-organism responsible for methane production is classified as archaea the principal genera includes the rods (Methanobacterium, Methanobacillus) and spheres (Methanococcur, Methanothrix).The entire anaerobic process takes place in absence of oxygen and it removes majority of organic contaminants' from the influent.The anaerobic process is also called on activated sludge process in which treatment process takes place in presence of oxygen, which is supplied from ambient for metabolism activities of bacteria. These bacteria stipulates remaining organic load from the waste water and make its quality conforming to norms. Discharge of untreated effluent wastewaters into water bodies may put at risk riparian communities that depend on these waters for domestic and personal

1. Material and Methodology:

The experiment was conducted in Rajararambapu SSK,Ltd Sangli,Maharashtra.The existing effluent treatment plant facilities consist of following tanks and equipments:

- **Primary Treatment:**
- **Secondary Treatment:**

❖ **Primary Treatment:**

Bar Screen Chamber:

The combined influent passes through the heavy trap and bar screen to retain fibrous particles of 10 mm size and above. The Floating particles fall into the scum portion of the chamber and settles down to clean at an interval of one week. The bar screen is having provision of one working and one standby enabling cleaning operation without interrupting influent flow.

Principle of Working of Bar Screen Chamber :

Bar Screen Chamber should act as settling tank for the removed of inorganic solids which are heavier than organic effluent solids. Hence the velocity of flow should be right to permit the settlement of heavy element only but not the effluent solids. This velocity called "Differential Scouring Velocity". This limiting velocity should be always less than the souring velocity of heavyparticles.

Skimming Tank:

The oil, grease and floating impurities are trapped into skimming tank by plug flow arrangement and slow movement of waste water allow all lighter components to float up and trapped between the two baffle walls and such trapped impurities which are mainly oil and grease is manually removed every day. There are one skimming tank in online working scum is removed by mechanical & physical working in sum digester. There are scum's digestion is 100 days using digester .

Equalization Tank:

The effluent coming from each unit of plant their own characters which are no tuniform. But we are going to treat the combined effluent. So the effluent of each unit has to be will mixed so as to get on effluent with uniform characters this is main purpose of providing equalization tank. The waste water pH varies with respect to time and process discharge which is Equalization and Neutralization in this tank by adding calcium hydroxide solution and homogenized by operating floating operator of 5.0 HP Capacity. The supernated effluent coming to this unit from skimming tank, is well operated to maintained COD and to keep its pH constant lime is added time to time as per requirement to adjust the pH, the supernated effluents coming to equalization tank posses pH 7.5-9.0, BOD 100-300 mg/l, COD 200-500 mg/l, there are two equalization cum neutralization tank are working and one stand by.

Waste Water Transfer Pump (Sump Tank):

The waste water up to equalization and neutralization tanks flows by gravity either through underground pipeline or through underground tanks. The neutralization and equalized waste water is transferred from underground tank by these transfer pumps into secondary treatment plant which is installed above the ground.

❖ **Secondary Treatment:**

Anaerobic Contact Filter:(ACF)

There are 3 no. of anaerobic contact filters all are operating in parallel. The biological treatment place in ACF's in absence of oxygen and most of the organic load is stipulated by Micro- organism. This process of treatment is also called as Biomethanization which liberated biogas with a composition of 65% methane and 35% Carbon dioxide. Supply this gas in canteen for kitchen fuel. Anaerobic wastewater treatment is considered as the most cost- effective solution .The waste water transfer pump forces waste water from bottom of Anaerobic Contact Filter: (ACF) and make it pass through blanket of anaerobic on palrings. While organic contaminant comes in contact with colonies of bacteria, most of organic substances are consumed by these bacteria and supernatant effluent flows out from top to the next stage. The sludge production is low, when compared to aerobic methods, due to the slow growth rates of anaerobic bacteria Total ACF's outlet flow

obtained is 160 KL/ day. The excess bacteria are removed from bottom of digester occasionally in the form of sludge on to the sludge drying beds from drying and disposal as organic manure.

AerationTank:

The treatment of effluent with bacteria is known as biological treatment, Biological treatment is the most important stage in processing of industrial effluents because primary treatment30-35% of BOD and 60% of suspended solids are removed the remaining pollutants load should be removed by biological methods. We use approximate 90KL of domestic in aeration tank. The principle objective in biological treatment is the Stabilization of its organic matter. The organic matter is broken down by bacterial action into simple substance that will not decompose further stabilization can bed one either by aerobic bacteria. Decomposition rate is more rapid than is aerobic process generally we use cow dung is aerobic process. The three technologies evaluated were aerobic digestion utilizing mechanical thickening, membrane thickening, and gravity thickening.

Theory of Activated Sludge Process:-

Effluent flowing into the aeration tank from ACFs contains organic matter is serves as a food for microbe. Due to aeration in the tank, the active biomass metabolizes the organic waste by taking dissolved oxygen and release Co2 &produce new cells. Protozoa utilize some bacteria cells as their food and grow rapidly. Some of the bacterial cells die due to endogenous respiration the recycling of sludge helps in the initial build up of high concentration of the active micro- organism in the mixed liquor which accelerator BOD removed. Once the required constriction of Micro-organism in the mixed liquor has been reacted its further increase is prevented by regulating the quality of sludge recycled and washing the exase sludge from the system. Activated sludge, which consists of stirred and aerated flocculated suspension of a mixed bacterial population that comes into contact with wastewater, is the most commonly used process in aerobic treatment. There are two aeration tanks both are operating in parallel and each is fitted with 10 HP surface aerator, the biological treatment takes place in these tanks in presence of oxygen which is continuously supplied by means of surface aerators. The balance organic contaminants are removed in this stage through bacteria which are maintained in defined percentage in terms of mixed liquor suspended solids (MLSS). The mechanical agitation through surface aerator mixes waste water vigorously with MLSS which in turn stipulates organic substance and purifies water. The treated effluent flowing out from aeration tanks contains MLSS which is recycled back into aeration system through secondary clarifier system.

Secondary Clarifier:-

This tank is provided to maintain mixed liquor suspended solids (MLSS) of the effluents. The secondary clarifier plays an important role in achieving the strict efficiency standards of WWTPs. The design and operation of the secondary clarifier are commonly based on solid flux theory N. Raggul and R. Saraswathi (2013). The MLSS along with effluent from aeration tank is received into a central well of secondary clarifier from where it is allowed to move down and subsequently moved up with a very slow velocity. In the process of downward and upward movement MLSS is settled down and clear supernatant effluent is obtained at final treatment effluent at the outlet of clarifier whereas bottom thick slurry which is mostly containing MLSS is transferred back into aeration tank through a slurry transfer pump to maintain desired level of concentration and excess sludge is disposed on to sludge drying beds for sum drying, dewatering and final disposal as organic manure.

Sludge Drying Beds:

Sludge is by products of all effluents treatment with the help of effluents treatment plant from effluent the purified water is recycled in sump tank and by products sludge is used as manure after drying derived sludge is very useful for agriculture process because of its high fertility. There are sixteen sludge drying beds in the effluent treatment plant. Which is removed time to time from the sludge from beds and it's used as manure.

Treated Water Collection Tank:

The treated effluent from secondary clarifier is collected in to a underground sump of holding capacity 567 M*PP*. This tank is fitted 2 nos. of centrifugal transfer pump with one working and one standby arrangement to pump out treated effluent for gardening and lawn developments.

- **Result & Discussion**

Industrial polluted water is very harmful for every living organism and environment. Treatment plant controls the germination of effects and disease on this industrial area and no effect seen local people. The effluent treatment plant is delivering treated effluent quality well within the normsas laid by pollution control board. This process is healthy for environment. The pH, COD and BOD is analyzed in (Table 1). SG chamber is removed heavy particles from effluents and control the clogging process in pipelines. There are skimming tank is a good removal for oil, grease, fat and other floating impurities and implement the effluent quality from this process. pH is low after anaerobic treatment because three process are involve for treatment in anaerobic contact filter there are hydrolysis, Acidification, and Gasification.

Table 1: Annual effluent treatment analysis

	TOTAL	PH		COD(mg/l)		BOD(mg/l)		Total Viable count (CFU/ML)	
DATE	Flow (M^3/d)	UNTRE.	TRE.	UNTRE.	TRE.	UNTRE.	TRE.	BEFORE TREATME-NT (CFU/ML)	AFTER TREATM-E NT (CFU/ML)
Apr-22	251.7	6.0	7.6	8560.0	91.1	2800.0	17.0	$100000X10^5$	**$11X10^5$**
May-22	260.0	6.4	7.9	8523.1	104.0	2900.0	19.0	$102000X10^3$	**$9X10^3$**
Jun-22	262.0	5.9	7.7	8793.9	84.3	2860.0	1.0	$106000X10^5$	**$10X10^5$**
Jul-22	261.0	6.1	7.8	8237.0	88.9	3075.0	16.2	$102500X10^5$	**$8X\ 10^5$**
Aug-22	**262.0**	**5.8**	**7.7**	**8829.0**	**85.3**	**2800.0**	**18.0**	**$92000X10^6$**	**$7X10^6$**

When flow is high across flow pH will be low. If we do not proper closing of Urea and DAP in aeration tank there are not prepare healthy MLSS and treated water quality are not pure in this care. Aerobic action takes place when sufficient amount of free oxygen is available for the bacteria. Anaerobic bacteria grow in the absence of free oxygen and release energy. They get energy from various compounds which are decomposed by these bacteria. The Decomposition takes place in a number of stages. The principal end products of decomposition of carbonaceous organic matter and nitrogenous matter are COR2R, CHR2R and organic acid, NHR3R. The average value of COD and BOD is calculated . the value calculated from monthly data and daily analysis.

Conclusion -

Percentage of COD reduction is depending on over all treatment units and healthy nature of anaerobic and aerobic bacteria. Treatment of effluent in secondary clarifier its depend on heavy concentration of MLSS. Treated effluent quality obtained turbid If-Low pH water and high percentage of mass dissolve with effluent. Though treated waste water may not comply with drinking water standards, contacts with water carrying high pathogenic loads may potentially lead to the transmission of enteric infections .but this water is used for industrial purpose for washing , cleaning etc.

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Hot Raw Juice Screening By Rotary Screen

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Abstract

In now days most of the sugar factories use hot raw juice screening which helps to reduce fibrous material from raw juice and their by color of juice. This paper describes the details of hot juice rotary screen installed at few sugar mills along with data collected. Data shows improvement in quality of clear juice & their by quality of sugar. Cold juice screening which is universally carried at milling tandem out has the following limitation.

1. *Very fine cane preparation has increased fine particles of bagacillo in the juice which is not satisfactorily removed by 500 micron screen in Single stage.*
2. *These fine particles interfere with clarification process besides chocking of various juice pipes.*
3. *Particles have also been observed floating in clear juice.*
   As bagacillo is swell up after heating and become easy to screening Hence it is decided to provide further screening of heated raw juice using a finer mesh at the rotary screen. The results were quite interesting and encouraging. The Sugar colour improved making sugar easily acceptable to the beverage industry.

Keywords: Unscreened mixed juice, screened mixed juice, rotary juice screen,fibre, ppm.

Methods

Following internationally accepted ICUMSA methods are used for analysis.

Fibre content of juice - ICUMSA GS7-13 (1994)
Colour of juice - ICUMSA GS1/3-7

Introduction

To improve mill extraction we need to increase preparation index (PI) of prepared cane. At higher PI dust formation takes place resulting in very fine fibre particles which escape through opening of juice screening arrangement installed at milling tandem generally having a rotary juice screen of 500 micron opening. A rotary juice screen installed to screen the mixed (raw) juice after first stage heating (primary heating) say upto 75 deg.C. Screening at this temperature helped to enhance screening efficiency and to reduce chocking problem. Much finer opening screen (180 Micron) is used to achieve maximum possible fibre reduction from juice entering process house.

Equipment Details

At milling tandem the rotary screen is open type of construction as the juice temperature is ambient. As hot raw juice screen is installed after first heating it is necessary to avoid temperature drop across the screen. Hence this screen is of totally closed type of construction. Feed end, discharge end, juice collection trough and top of the screen are closed to avoid temperature drop.

The screen is made from working screen in stainless steel construction having much finer opening supported with backing screen also of stainless steel construction. Feed and discharge end drum and other juice contact parts like feed pipe, distributor, juice collection trough etc. are also of stainless steel construction. Other non wetted parts are of mild steel construction. The screen drums along with drive and discharge end drums are supported on 4 nos. rollers which are mounted on heavy duty base frame. Power is transmitted through chain – sprocket arrangement. Spray nozzles are fitted on piped header located inside the screen drum to cover the entire length of screen. Screen washing is carried out automatically by a timer operated pump.

The Rotary Screen for hot raw juice screening is located near juice sulphiter. The hot raw juice from SO_2 absorption tower is delivered to juice inlet pipe of rotary screen and screened hot raw juice outlet

of the screen is delivered to juice sulphiter by gravity. The bagasse discharged from the screen is delivered to a receiving tank by gravity and is pumped to mills/mud mixer of vacuum filter in a slurry form.

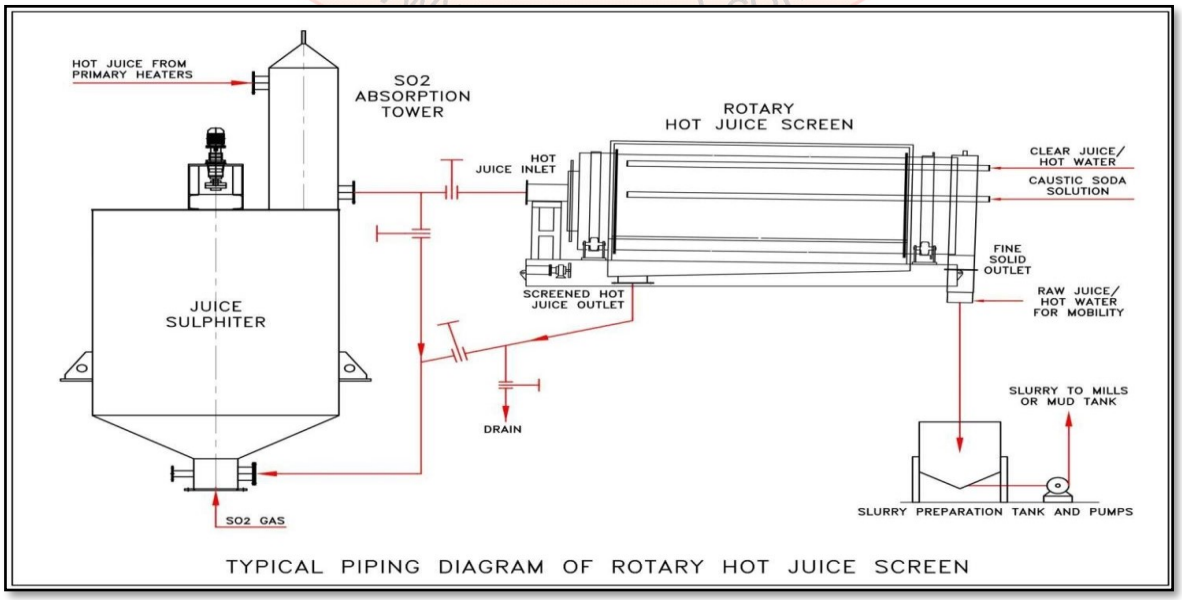
Analytical Data

Table No. 1
Efficiency of rotary screen having 0.18 mm opening (hot juice)

Sr. no.	Quantity of bagacillo before screening gram/lit of juice	Quantity of bagacillo after screening grams/lit of juice	Efficiency %
1	1.623	0.458	**71.78**
2	1.852	0.472	**74.51**
3	1.525	0.443	**70.95**
4	1.923	0.415	**78.42**
5	1.752	0.423	**75.86**
Average	**1.735**	**0.442**	**74.30**

Table no 02
Color removal across the hot juice screen with 0.18 mm opening

Sr. no.	Color before screening	Color after screening	% removal	Color clear juice	% removal
1	13522	12688	6.17	10758	**15.21**
2	14102	13254	6.01	11192	**15.56**
3	13358	12142	9.10	10236	**15.70**
4	13412	12430	7.32	10488	**15.62**
5	12025	11190	6.94	9083	**18.83**
Average	**13284**	**12341**	**7.11**	**10351**	**16.18**



TYPICAL PIPING DIAGRAM OF ROTARY HOT JUICE SCREEN

Multiple Advantages Of "Hot Raw Juice Screening"

- Reduction of Clear Juice colour by 1500 – 2000 IU.
- Reduction of Clear Juice turbidity and improvement in transmittance.
- Additional separation of 0.15 to 0.165 % cane of dry fibre for extra power Generation.
- Lowest ever fibre in screened hot raw juice 400 – 500 ppm (Aprox. 0.4 to 0.5 g/l)
- Reduced solid and colour loading on subsequent process of juice, syrupand melt clarification.
- No fibre contamination of sugar crystal.
- Other mechanical advantages like chocking at PHE is eliminated
- Increase in capacity of existing clarifier and vacuum filter/Decanter capacity due to reduced solid loading.
- Most importantly, improvement in sugar colour by 10 - 15 IU in normal condition and 15-20 IU in favorable situation.

Conclusion:

Total Fibre separation from unscreened mixed juice to screened hot rawjuice is achieved to the extent of 95 %. The fibre reduction helped to reduce suspended solid loading of clarification house and improve overall performance and to improve the keeping quality of sugar.

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Guide Lines to Take High Imbibition Water on Mill And to Get Reduced Moisture in Bagasse

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Introduction

Hereby guide lines are given for increasing imbibition percentage on mill and reducing the moisture in the bagasse. The number of ways to reduce reabsorption in the milling process are given which helps to increase mill extraction. Decreasing sugar loss in bagasse and reducing moisture in bagasse goes hand in hand. In the article, there are adoption of well-judged combination of different techniques and changes in mill rollers and sequence of pitch adaptation in tandem, differential angle grooving, mill speed & mill setting suitable to bagasse PI etc. for ultimate result to reduce moisture at increased imbibition percentage.

Guidelines to reduce moisture in Bagasse :

An increasing extraction and reducing bagasse moisture are go in hand in hand. Reducing reabsorption, thereby reducing moisture in bagasse, following points are carefully looked-for;

- Improve Cane preparation,
- Adopt low mill roll surface speed
- Adopt efficient juice drainage
- Increase hydraulic pressure to optimum level
- Mill Roller Roughening
- Mills setting

Various methods to reduce moisture in Bagagsse :

1. **The first method** starts from cane in the cane carrier. The fresh cane may be procured as far as possible for crushing. The preparation of fresh cane is better than stale cane. For the high percentage of fibre and trash requires more power for preparation and we get less PI. Higher trash content reduces preparatory Index. The hint is, PI during start of season better than season end.
2. **The second important method is cane preparation (PI)**: The cane preparation increases through put capacity of the plant and it helps to get better mill extraction. Similarly, the power required for cane preparation is 25 % of total factory power. Hence, care has to be taken that there should not be dusty preparation & there must be effective use of equipment and power.

   The power put in one point of cane preparation has advantage, that the power will be reduced at each milling station. Say in five milling tandem, power required is reduced at each of five milling points.

   The cane preparation is measured by three methods: Bulk Density, Bagasse size and Cane Preparatory Index or PI. The 0.75-1 mm dia and 5-55mm in length and 20% powder are best in size. But prepared cane must not have cane pieces more than 3 -5 mm dia thick and 15mm long size or more.

   To get good PI, minimum knifing and intensive shredding of cane is required and thereby fibre is separated from cane and juice cells are opened. The opened juice cells are crushed/compressed in the mill roller and juice is extracted. This helps to reduce moisture in bagasse.

   The prepared cane must not have big cane pieces, it displays three times bagasse pol% and moisture in final bagasse. One-unit increase in PI increases about 2 units of PE and 0.05 to 0.06 overall extraction. In international seminar (Pyaine-1982), it was reported that increase of 4 units PI increases 1% extraction.

   To get reduced moisture in bagasse, PI shall be in the range of 85-88%. To achieve this range of PI=85-88%,

i. The cut cane fed to fibrizer must be 65-70% PI.
ii. The fibrizer hammer tip speed must be 85-90m/sec
iii. Fibrizer anvil plate wrap angle must be $160^0$and pocket size must be 220mmx270mmx150mm deep
iv. The cutting edge shall be hard faced with welding rods and its hardness must be 600BHN minimum.
v. The height of supporting rings of cutting edge must be 1 " less than height of cutting edge, which helps not to fill the anvil plate pockets.
vi. There are two systems shredder and fibrizer. In Shredder system- one chopper and two number cutters and shredder. Out of two cutters one or both must be reverse direction operation and feed 75-80PI to shredder on top of its head. In Fibrizer system one chopper and one cutter & fibrizer. Out two knifing one must be reverse direction in operation.

The cane shredding/preparation is the process of getting good fibrous preparation is striking the fibrizer hammer tip on cane pieces. When hammer tip strikes bagasse pieces, partly go to the cutting edge and partly cane pieces go to the pocket of anvil plate and bounce back, and again hammer strikes these broken pieces, in this way again and again hammer tip sticks pieces and cane get fibre separated & shredded.

If the pockets of anvil plate filled with bagasse, the big cane pieces and rinds travel in the gap between hammer tip and bagasse filled pockets or in between two hammers directly to the delivery of prepared cane. This affected adversely on reducing moisture in the bagasse.

vii. Anvil plate bottom setting shall be in between 10-15mm, and if it increases beyond it, the PI starts reducing. The anvil centre setting must be average of top and bottom setting. Average centre setting must not be above 40-50mm
viii. The selection of combination of preparatory equipments judicially for direction, speed and power and latest swing type leveler, heavy duty fibrizer defiantly give 85-88% PI
ix. The installed total power to preparatory devices shall be 12-14 KW/TCH. The fibrizer must have power of 80HP/tfh). Total preparatory devices must consume 8-9KW/TCH for 85-88% PI. The power at preparatory devices must be kept excess than required by 33-35%. This will help to maintain PI at increased fibre % or at blunt hammer & knives by adjusting clearance setting of preparatory devices at the later period of season.

In this way the above 8 points if you implement, it will give 85-88%PI.

3. Auto Cane Feed Control Unit:

To reduce bagasse moisture, next technique is use of ACFC to get 85-88% PI and use to increase primary mill performance.

ACFC helps to keep 2-3 feet height in Donnelly chute, which in turn help to have continuity in crush rate and always keep secondary wet mills on load. Secondary carrier speed shall be operated in the range of 70-85%, so that

ACFC in preparatory devices must be set so as to control carrier speed on fibrizer load only not on chopper & leveler. The load on chopper and leveler must be 75-80% of its installed and it must be adjusted by adjusting clearance between knife tip & cane carrier surface. This is skill to have operate these equipments 80% of operation time. The overload of chopper & leveler to tune of 95-98% loading will cut the cane carrier speed.

The fibrizer setting logic for fibrizer load & carrier speed, must be such that fibrizer must operate 10-15-amp difference of set load. This keeps all preparatory devices on load and we PI85%+.

The DCS system has added additional dimensions in mill automation, in which from cane carrier to last mill and mill automation, each equipment is synchronized to get 100 % performance. In DCS automation all above automations plus auto imbibition on 3rd mill load in 4 milling tandem, top roller lift indicators, individual mill x &TRPF/GRPF, RPM control as per mill load, interlocking from carrier to RBC, bagasse height in all Donnelley chute, crush rate control on MJ tank height etc work well

4. **Primary Extraction**:

With the judicial combination preparatory devices to get PI85%+, and use of pressure feeding devices such as TRPF /GRPF/ TRF, heighted Donnelly chutes and DCS type auto control systems helped to improve and achieve consistency in primary mill performance Primary extraction (Pol based) being achieved 75 - 80 as well as primary bagasse moisture is also reduced to 52-53 %. In new installations 80% PE is the target. To achieve higher PE of the order of 75+, preferably GRPF having 15 – 20 % higher diameter than mill and separate drive to GRPF shall be adopted. Use of GRPF at first mill also results in increasing fineness of fibrous mass –first mill bagasse and this also helps to achieve low Pol% in bagasse and lower moisture in subsequent mills.

To have better juice drainage from 1st mill, GRPF, UFR, mill top & discharge rollers shall be 3 nozzles type & 8mm dia each. The mill feed roller & GRPF bottom roller must be adopted with maceration knives.

5. To increase mill juice drainage:

Mill having as high as PI 85%+, high imbibition (37- 40% + cane) & high compression livered with low mill speed (8-9m/min), the mill must have good juice drainage, then and then only, we have good extraction (96%+) with low bagasse moisture (48-49).

i. The first juice extraction system come in to force is use of TRPF/GRPF feeding devices. In this system, juice is first extracted and compressed blanket is fed to the mill. This increases mill through put capacity and extraction increases. In this regard, GRPF is having more strength than TRPF but GRPF requires more power.

ii. Next good extraction system is use of high (40-60mm) trash plate heel clearance. The adopting trash plate heel clearance (40-60mm) depends on space available between discharge roller and trash beam. The juice extracted between top & discharge roller has got better space for juice drainage. It helps to reduce re-absorption and boost for reduction in bagasse moisture.

iii. Third juice drainage technique is use of lotus rollers for top & discharge rollers.

- The front side mills or roller pitch having above 50mm pitch must have be used 3 nozzle type & 8 mm dia lotus holes for top & discharge rollers.
- Roller pitch having below 40mm pitch must have be used 3 nozzle type & 6 mm dia lotus holes for top & discharge rollers.
- The last mill must have top & discharge roller as 3 nozzle type & 6 mm dia lotus holes for top & discharge rollers.
- In conventional three roller mill, top scrapper is to be raised 10-15 degree above shaft center horizontal line. This will arrest complete recirculation of juice on discharge side bagasse.
- With lotus rollers, it has become possible to take imbibition water as high as 40-50% cane.

iv. Forth juice drainage technique is roller pitch and differential grooves:

The sequence of mill pitches as per mill no in the tandem & differential grove angle are selected considering mill size and crush rate, then good juice drainage is achieved. This is effect of appropriate pitch & groove angle.

- For feed roller, acute groove angle plus deep maceration grooves must be used. For initial mills, each groove maceration groove is used and below 25 mm pitch alternate groove maceration grooves shall be used.
- If crushing is higher than its size, ie 3500TCD crush rate on 30"x60" size 5/6 milling tandem, then 1st mill has to be 60mm pitch, second & third mill 50 mm pitch and latter mills 35-38mm pitch.
- In normal crush rate or up to 20 % higher crush rate, initial mills 2 mills 50 mm pitch and latter 30mm pitch. For example, standard 33x66 size 4 mills, first two mills 50 mm pitch and latter two mills 30 mm pitch.
- The differential grove angle means top roller and bottom rollers have different groove angle. Generally, in differential groove angles, top roller 50^0, discharge roller 45^0 and feed roller $35^0/40^0$-degree are used.

- For acute groove angle (<40^0), in crushing operation, bagasse blanket due to fibrous wavy nature, juice travels faster than bagasse towards groove root. Secondly, the radial component of hydraulic pressure on groove surface also reduces and near groove root it is almost negligible. Therefore, there is good amount of space having less pressure near groove root for juice drainage. Hence, for juice drainage, bottom rollers have used acute groove angles.
- As groove angle increases, the radial component of hydraulic pressure on groove surface increases and bagasse moisture reduces. Therefore, for top rollers, groove angle used is 50^0/55^0.
- For last mill top & discharge roller, same groove angle shall be used and it must be 50^0/55^0.
- For feed roller, acute groove angle plus deep maceration grooves must be used. For initial mills, each groove maceration groove is used and below 25 mm pitch alternate groove maceration grooves shall be used.

v. **To increase juice drainage fifth system is use of low mill speed**:

During mill compression, fed bagasse grabbed by rollers travel in to the mill, whereas juice extracted travel to drain out opposite in direction of bagasse flow, that period if mill speed is low then, juice get time for drainage. Simultaneously, the co-efficient of friction of bagasse on the roller groove surface increases and roller grip on bagasse increases. Hence, mill may be set at high Fibre Index to get good extraction and help to reduce moisture in bagasse.

Considering mill size and crushing capacity, adopt mill roller peripheral speed as low as below 8 m/sec. The low speed with feed roller maceration grooves and Top roller & discharge roller as lotus and high heel clearance has great effect on juice drainage and hence reduction in moisture of bagasse is achieved.

Milling tandem to adopt low mill speed, following groundwork in milling is essential;

- Mill roller roughening: Mill roller roughening up to 2/3 groove depth to be done.
- The groove landing tear drop welding (spigot welding) shall be done.
- Chevron groves on top, feed and UFR are very much effective to run mills at lower RPM. Even, roughening reduces during course of season or long season duration, chevron grooves are helpful to grip bagasse. Also, it is helpful to maintain grip on bagasse at when imbibition temperature increased to 85^0-90^0
- Heighted Donnelly chutes are preferred for compacting prepared cane feeding to four roller mills.
- As per our practical experience, considering P.I. and feeding devices, the mill speed is achieved as low as given in Table-1, which will help for mill extraction.

Table-1: Mill speed against PI

Preparation of cane	Mill speed m/min	
	UFR + Donnelly	GRPF / TRPF + Donnelly
Coarse PI ≤ 75 & Medium PI≤85	11 - 15	10 - 13
Fine PI = 80 to 85%	10 - 13	8 -11
Very fine PI > 85	8 - 10	6 - 8

6. **Mill Setting:** The relative positions of three rollers with the mill empty determine those when operating, when the top roller lifts against the hydraulic pressure under the thrust of the bagasse. The mill ratios (m) feed to discharge work opening decides sharing of hydraulic load by feed & discharge roller. The ratio (m) and trash plate profile are very important for best extraction. Hence, for extraction and moisture control following guide lines for selection of mill ratio (m) have to be followed;
    - Mill ratio (m) varies from1.65 to 2.2+ for various mills. The load distribution changes when the ratio is changed.
    - Low Mill ratio (m = 1.65-1.7) can be adopted for good extraction, mill having feeding devices like TRPF, GRPF etc. but for inadequate juice drainage, the mill requires higher ratio with higher

speed. In this case, roughening of rollers by arc welding & tear drop welding is recommended to work mill at low work ratio and low speed.

- The increasing order of mill ratio in milling tandem is preferred.
- For crushing rate 100 % + and imbibition % on cane, 30+, the value of work ratio will be 1.8 onwards.
- For coarse preparation & having UFR as feeding device the work ratio should be 2 to 2.2 for initial to last mill. For fine preparation and with positive feeding devices like GRPF/TRPF, the low work ratio of 1.7 to 1.9 for initial to last mill.

7. Mill Imbibition:

If juice drainage is enough then increase in imbibition% don't increase moisture in bagasse. Even though there is enough juice drainage, decrease in imbibition temperature below 70^0C, don't get desired effect for moisture reduction. Hence, imbibition temperature must be in the range of 75^0-85^0C. The higher imbibition temperature become fibre cells soft and with less hydraulic load easy to reduce moisture in bagasse.

The effective imbibition depends on quantity of imbibition water, temperature of imbibition water, method of application of imbibition water on bagasse blanket and type of tray used for spraying imbibition water on full width of bagasse carrier and rotary macerators to break bagasse blanket thickness for mixing juice effectively with bagasse.

The increase in imbibition quantity for **each 10% on fibre, the mill extraction in 5 mills increases 0.017% - 0.03%.** Similarly, the increase in imbibition quantity by 10% on fibre, the **loss in bagasse in 5 mills decreases by 0.012% - 0.024%**.

- The box type imbibition tray used in for rake carriers, has found full penetration of bagasse blanket by juice & uniform distribution of juice trough out width of mill roller when juice falls at the point where bagasse blanket breaks while passing to next IRC.
- The imbibition water additions at top & bottom of bagasse blanket after penultimate mill give good mixing of juice and bagasse.
- However, the rotary macerator with steaming arrangement for all mills will be better option for getting better effective mixing of water with each bagasse particles and will reduce moisture by 1%.
- The imbibition quantity shall be 37 – 45 % + on cane as evaporator and economy allows, and temperature shall be about 75- 85^0C + as per mill roller roughening allows.

8. **Mill hydraulic and top roller lift:**

Free floating of top roller and equal lift of both ends of roller is essential for extraction. Simultaneously, optimum hydraulic loading is necessary to reduce re-absorption and power consumption. As per our experience, the Specific Hydraulic Pressure (S.H.P.) of each mill is given as follows:

Table 2 - Mill wise Specific Hydraulic Pressure (T/dm^2)

No. of Rollers	Specific Hydraulic Pressure in (T/dm^2)					
	I	**II**	**III**	**IV**	**V**	VI
12 Rollers	26	24	27	30	---	---
15 Rollers	26	23	25	27	29	---
18 Rollers	**25**	**22**	**24**	**25**	**26**	**28**

If Preparatory Index is more than 85- 88 %, the specific hydraulic pressure will be reduced by 2 to 4 Ton/dm² observing free floating of top roller.

9. **Individual Mill extraction (IME):**

The performance of each mill weekly basis is to be assessed with regard to extraction and bagasse moisture of individual mills. Keep the record of IME and bagasse moisture since beginning of season, which help to understand poor working of mills and take corrective action. The mill wise, bagasse moisture range is as under;

Mill no	Mill no 1	Mill no 2	Mill no 3	Mill no 4	Mill no 5
Bag. Moisture range	53-54	52-53	50-51	49-50	47-48

10. **Mill roller arcing & chevron grooves:** To have close mill setting for higher extraction means positive grabbing of bagasse by rollers and pushing inside mill against mill hydraulic, needs heavy arching up to 2/3 groove depth for three rollers of mill and chevron grooves to top and feed discharge roller are essential.
11. **At increased mill imbibition quantity and control bagasse moisture**

To increase imbibition as high as 50% +, mill & mill setting shall be designed to adopt high load of juice & water quantity and following basic work of 5 - 6 arrangements must be followed to get results;

- Cane preparation must be in the range of 85-88 %PI and there must not be big cane pieces and rinds
- As per crushing rate, there must be enough juice drainage and to increase juice drainage TRPF/GRPF, Lotus rollers, increase trash plate heel clearance etc to be adopted.
- To adopt high quantity imbibition (50%+), to control moisture, latter mills must have GRPF or mill size bigger than initial mills.
- Mills shall be operated at low speed and speed & load on mill regulation has to be done by AC VFD drive
- For running mills at high imbibition, heavy roller roughening and tear drop welding (spigot) on groove landing and chevron grooves are to be adopted.
- The mill must have high bagasse compression ie full hydraulic pressure as said above.
- Mill pitch sequence in milling tandem must be higher to adopt juice quantity.
- Donnelly chute must have bagasse height of ½ -1 m in it.

Conclusions:

For reducing moisture in bagasse for higher quantity imbibition on mills, cane juice reabsorption milling process shall be minimized with implementation of guidelines discussed in this article. To control reabsorption, adopt low mill speed, use optimum hydraulic pressure and follow effective imbibition systems which results in increase in sucrose extraction as well as decrease moisture in bagasse. Bagasse moisture may be reduced by adopting different methods and devices to increase and improve juice drainage, obtaining positive results against reabsorption- Lotus mill rolls, Slitted rolls, Messchaert grooves, lower angles in teeth profile, forced feeding systems like GRPF /TRPF and effective imbibition system with rotary macerators etc.

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A View on Production of Second Generation Bioethanol from Lignocellulosic Biomass

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Abstract:

The National Policy on Biofuels-2018 sets an indicative aim of 20% ethanol blending under the Ethanol Blending Petrol Programme (EBP) by 2030. Right now, India has met its 10% petrol blend goal. India is increasing manufacturing capacity nationwide to 150cr.lit by ESY25–26 in order to reach the E20 blending objective. In order to increase biofuel production, the country is supporting a new technology for producing ethanol from non-food feedstock known as "Advanced Biofuels," which includes second generation (2G)[1]. In 2G ethanol plants use surplus biomass and agricultural waste like sugarcane bagasse, rice straw, rice husk, municipal solid waste, timber and etc., but producing bioethanol from cellulose biomass is not as simple as producing ethanol from first-generation feedstock. The article discusses the production difficulty and several pretreatment strategies that should be used in the process of producing biofuels.

Key words: *Cellulose, Hemicelluloses, Lignin, Biomass, Biofuels, Pretreatment,*

Introduction:

India consumes nearly 30% of the world's fossil fuels and spends approximately 16 lakh crore on fossil fuel imports. The transportation sector in India emits 90% of its carbon dioxide through road transportation, which accounts for the greatest consumption of petrol and diesel as fuel (98%). The government is pressing forward with a policy of using indigenous fuel as a cost-effective, pollution-free substitute in the transportation industry. Because of this, the Indian government launched the National Biofuel Policy in 2018. The government permitted the production of ethanol from damaged and excess food grains, including maize and rice, as well as from sugarcane juice, syrup, and B-Heavy and C-heavy molasses. These first-generation feedstocks have made significant contributions to ethanol production and the achievement of the E20 blending target. In addition, the government permitted the production of ethanol from non-food feedstocks other than molasses, such as cellulosic and hemicelluloses materials obtained through petrochemical processes, with the aim of increasing ethanol supply. Oil PSUs intend to set up 2G ethanol biorefineries across the country.

The government has additionally initiated the Pradhan Mantri JI-VAN (Jaiv Indhan-Vatavaran Anukool Fasal Awashesh Nirvan) Yojana to provide viability gap funding to give the country's initial push toward creating 2G ethanol capacity and associated investment in this sector. For a total financial outlay of RS 1969.50 cr throughout the years 2018–19 to 2023–24, this sector provides financial support to twelve integrated bioethanol projects that use lignocelluloses biomass and other renewable feedstock[2].

Apart from lowering emissions through ethanol blending, 2G ethanol has further advantages. It will give farmers a profitable way to get rid of their stubble without burning it, which has been raising pollution levels annually. It gives agricultural produce waste a purpose and has the potential to generate additional income for farmers. Additionally, jobs across the value chain will be created by the ethanol manufacturing plants.[3]

Understanding Lignocelluloses Biomass:

Cellulose:

Cellulose is a polysaccharide made up of linear glucan chains linked together by ß-1, 4-glycosidic bonds, with cellobiose residues serving as the repeating unit at varying degrees of polymerization depending on resources, and packed into microfibrils held together by intramolecular hydrogen bonds and intermolecular van der Waals forces. Although polymorphism has been documented for cellulose, native cellulose exists as cellulose Ià mixture of the polymorphs Ia and Ib. Cellulose Ia is the predominant component of the primary wall in lower plants and certain microorganisms because it is generated simultaneously with the expansion of the microfibril network. On the other hand, taller plants store cellulose Ib in their secondary walls for strength. The triclinic unit of cellulose Ia has one chain, according to the decipherment of its crystalline structure, but cellulose Ib's monoclinic unit has two chains, which provide additional intramolecular hydrogen bonds and increase its stability. In order to convert plant biomass's cellulose Ib into amorphous polymorphs that the celluloses can attack more effectively, harsh conditions are required.[4]

Hemicellulose:

Hemicelluloses are a diverse group of polysaccharides with the b-(1-4)-linked backbone structure of pentose (C5) sugars like xylose and arabinose, and hexose (C6) sugars like mannose, galactose, and glucose as repeating units, all with the same equatorial configuration at C1 and C4. The structural similarity between hemicelluloses and the b-1,4-glycosidic linkages of the cellulose molecule benefits from a conformational homology, which can lead to a strong non-covalent connection with cellulose microfibrils.

Hemicelluloses are random and amorphous, which makes them easily hydrolyzed to monomer sugars in contrast to cellulose, which is crystalline and resistant to degradation. However, hemicelluloses are embedded in and interact with cellulose and lignin, increasing the strength and hardness of plant cell walls. The two main hemicelluloses in plant biomass are xyloglucan and xylans. The oligosaccharide made up of xylose (X) and glucose (G) with different side chains, XXXG or XXGG for vascular plants, including grain crops, is the repeating unit of xyloglucan, which is abundant in the main walls. The backbone of xylans is made up of b-(1-4)-linked xylose residues, which are frequently changed by a-(1-2)-linked glucuronosyl and 4-O-methyl glucuronosyl residues, as well as acetylated at the O-3 position of xylose residues. The predominant noncellulosic polysaccharide in the secondary walls of dicots is xylan, commonly referred to as glucuronoxylan. Thus, xylose, arabinose, glucose, and galactose are the main sugars in the hemicellulose hydrolysate.[4]

Lignin:

Since lignin is a non-sugar-based polymer and cannot be used as a feedstock for microbial fermentation to produce ethanol, it has a significant effect on the yield of the corresponding bioconversion processes. This is because lignin is a major source of inhibitors of microbial growth and fermentation during the pretreatment required to make cellulose susceptible to enzymatic attack. Meanwhile, lignin yields, being the second most abundant component in biomass after cellulose. a suitable option for producing combined heat and power (CHP) in the biorefinery's environmentally and ecologically friendly mode because it burns with more energy. Furthermore, lignin serves as a great precursor for a wide range of goods, such as value-added chemicals and transportation fuels, which might boost the efficiency of bioconversion processes and increase the economic viability of bioethanol. It is clear that a basic understanding of lignin biosynthesis is necessary to design microorganisms with enhanced inhibitor tolerance, which will enable them to ferment the hydrolysate more quickly and with higher yields, as well as to develop more effective pretreatment and conditioning procedures and subsequent enzymatic hydrolysis of cellulose.[4]

Different Lignocelluloses biomass feedstocks:

1. Sugarcane Bagasse:

Sugarcane bagasse is fibrous residue which left after extraction of juice from sugarcane stalk, which is obtained from last mill of milling tandem. The quantity of bagasse varies from 25-35% on cane quantity.

Sugarcane processing generates a large volume of bagasse. Disposal of bagasse is critical for both agricultural profitability and environmental protection. Sugarcane bagasse is a renewable resource that can be used to produce ethanol and many other value-added products, cane processed bagasse could be used to produce fuel grade bioethanol.

The sugarcane stalk consists of two parts, an inner pith containing most of the sucrose and an outer rind with lignocellulosic fibers. During sugar processing, the sugarcane stalk is crushed to extract sucrose. The composition of obtained bagasse is as given below:[5]

Cellulose (%)	**45-55**
Hemi cellulose (%)	20-25
Lignin (%)	18-24
Pectin (%)	0.6-0.8
Ash (%)	1-4
Extractives (%)	1.5-9

The strong chemical and physical relationships between lignin and the polysaccharides found in plant cell walls, as well as the crystallinity of cellulose, are the main obstacles to the generation of bioethanol from bagasse. In order to do this, numerous chemical pretreatment techniques are used to convert these polysaccharides into monomers. Biomass hydrolysis: This procedure turns cellulose and hemicelluloses into

sugurs, which can be used to produce ethanol. Most cellulose hydrolysis yields glucose, which bacteria can readily convert into ethanol, but most hemicellulose hydrolysis produces xylose, which only a few microorganisms can ferment into ethanol.

Lignocellulose materials can be hydrolyzed using two different techniques: acid hydrolysis and enzymatic hydrolysis. Usually, acid hydrolysis takes place in hot environments. Two common acids used in acid hydrolysis are sulfuric and hydrochloric acids. If the conditions in this type of reaction are not sufficiently controlled, the final products will degrade. Numerous techniques for dilute acid prehydrolysis have shown to be effective pretreatments; although, other reagents, including as phosphoric, nitric, and hydrochloric acids, may be used instead.

Enzymatic hydrolysis is a low-temperature, non-pressurized technique that generates less pollution; it uses an enzyme complex rather than an acid. It was recently shown that ligin might be removed by combining hydrogen peroxide and acetic acid prior to bagasse being digested enzymatically.[6]

Using *Saccharamyces cerevisiae* strain 765 yeast, bagasse is fermented following pretreatment and saccharification.

2. Rice straw:

Rice straw is a by-product of rice production and great bio resource. It is one of the abundant lignocellulosic waste materials in the world. It is the largest amount from a single biomass feedstock. Rice straw predominantly contains:

Cellulose	**32-47%**
Hemicelluloses	19-27%
Lignin	5-24%
Ashes	18.8%

The pentoses are dominant in hemicelluloses which xylose is the most important sugar followed by arabinose and hexoses. The carbohydrate of rice straw involves glucose 41-43.4%, xylose 14.8-20.2%, arabinose 2.7-4.5%, mannose 1.8% and galactose 0.4%.[7]

Several pre-treatment processes have been developed for lignocelluloses biomass to bioethanol convertion, such as: Alkali pre-treatment, Acid pretreatment, Alkali/enzyme pre-treatment, Acid/enzyme pretreatment, Subcritical water pre-treatment, Ultrasonic pretreatment. In these methods acid pretreatment method shows good result.[7]

Acid pretreatment: About 50 g Chopped dried rice straw was suspended in acid solution (1, 3, 5, 7 and 9% Sulfuric acid) in ratio of 1:10 (w/v) rice straw and Sulfuric acid. The mixtures were autoclaved at 121°C for 15 min. After that, hydrolysate was pressed through cheese cloth and the amount of reducing sugar in juice was measured as above.

Effect of acid pre-treatment methods on sugar content: The relation between sugar content and acid concentration is illustrated. Increasing the acid concentration showed reverse effect on sugar concentration in sample. This is maybe because of degradation of monomeric sugars (xylose, glucose) in furfural and hydroxymethyl furfural. The highest sugar up to 21.45% sugar (on the rice straw basis) could be obtained using 1% sulfuric acid.

Fermentation: In acid-pretreated samples shows the impact of fermentation duration on the conversion of sugar to ethanol, with and without ultrasonic and rice straw that was subsequently enzyme-treated. Nearly all of the fermentable sugar (glucose) for S. cerevisae will be transformed to bioethanol over the three days of fermentation. Extended fermentation periods of up to six days have minimal impact on the generation of bioethanol. After six days of fermentation, the sample's sugar content dropped from 4-5% w/v to around 1.5% w/v. This is equivalent to 55–65% of sugar being bioconverted to bioethanol.

3. Wheat straw:

Wheat straw, a by-product obtained after harvesting of wheat grains. It has the potential to be utilized to make many value added products like bioethanol, biodegradable plastic. Wheat straw consists mainly of cellulose (28%–39%), hemicelluloses (23%–24%), lignin (16%–25%), and fewer contents of ash and protein. The wheat straw would be pretreated by chemically with 0.75% H_2SO_4 or 2.15% H_2O_2 and by enzymatic method using cellulase, B-glucosidase, xylanase and esterase. The hydrolysis condition should be 45^0C, pH 5.0 about 72-120 hr depending on chemicals used. Sugar yield after treatment is around 51.5 – 67.2%. After treatment the fermentation is carried in pH 6.5, 35-37^0C for 39-48 hour with recombinant E. coli FBRS and get ethanol yield about 0.2-0.24g/g of feedmaterial.[9]

4. Corn stover:

Corn stover refers to the stalk, leaves, and cobs that remain in fields after corn harvesting. Ethanol can be made from this biomass. In the US, corn stover is the main biomass source utilized to produce cellulosic ethanol. About 70 percent of corn stover composed of cellulose and hemicelluloses, remaining 15 to 20 percent is lignin. Cellulose and hemicelluloses can be turned into ethanol.[8]

Corn stover can hydrolyse by 3% SO_2 catalyzed stem explosion or by using enzymes cellulase or xylanase at 45^0C for 72 hr. this process yields glucose 96% or xylose 86%[9] After treatment the fermentation is carried in pH 5.5, 30^0C for 144 hour with baker yeast and get ethanol yield about 0.29 g/g of feed material.[9]

5. Barley straw:

Barley straw is is the byproduct of barley grain production. It is the plant material that is left over after the grains have been harvested. The straw has very little nutritional value, so it's mainly used as feed for livestock, mulch in garden, controlling algae in ponds. The barley straw has 70-72% holocellulose, 15-17% lignin and 5-6% extractives.

Barley straw can hydrolyses by NaOH pretreatment with enzymes 2% cellulase After treatment the fermentation is carried in 45^0C with *Kluyveromyces marxianus* IMB3 and get ethanol yield about 0.2 g/g of feed material.[9]

6. Olive tree pruning:

Olive tree (*Olea europaea* L.) pruning biomass (OTPB), an especially relevant lignocellulosic residue, largely available at low cost with no practical applications. Moreover, to achieve the best results in terms of bioproducts like antioxidants, bioethanol, oligosaccharides and the most complete use of the material.

Olive tree prunings can hydrolyse by 1% H_2SO_4 at 190^0C or by using enzymes cellulase or B-glucosidase at 50^0C this process yields glucose 58.7%. After treatment the fermentation is carried in pH 3.5, 30^0C with *P. tannophilus* ATCC32691 and get ethanol yield about 0.1 g/g of feed material.[9]

Like this many lignocellulosic biomass materials can used in the production of bioethanol.

Conclusion:

The following conclusions can be made about the production of biofuel: - Agriculture generates large amounts of lignocellulosic materials (LCM) annually, which can be turned into second-generation bioethanol rather than being burned and wasted. A significant amount of wood biomass, which is cost-effective and useful for producing bioethanol, is produced by forests. This will lower the amount of crude oil imported, reduce pollution, aid farmers by providing them with additional cash, and provide jobs in rural regions. Further research on pretreatment of lignocellulose biomass is required to reduce the costs of ethanol production, and then several industries and investors have expressed interest in this area.

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Clarification & De-colorization of Raw Sugar for Refine Sugar Production

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Abstract:

Being an essential commodity entire supply chain of sugar industry in India is under government control which might be beneficial for the consumers but it puts a burden on sugar factories balance sheet With GOI's ethanol policy and due to global supply chain disruption fortunately sugar season 2021 - 22 has been a very good year for the industry.Inthe yearsto come GOI will not provide any export incentive for sugar export global sugar price might come down to the tune of 450 USD/ton. In such circumstance producing double Sulphitation sugar will become unviable for the factories to survive.

Demandfor refined sugar is a rising in India every year, production of refined sugar over double separation sugar has a numerous advantages ranging from reduction in production cost, increase shell life, premium on selling price etc.to benefit with refined sugar already over 100 sugar factories out of 550 sugar factories in India are covered from double sulphitation to refined sugar production either partially or fully.Whileconverting DS plant to a refinery, selection of a refining technology is a crucial it depends on a various factors like plant capacity, requirement of sugar quality, cost of production, effluent treatment norms, captive investment,ease of operation etc.

Keywords:
Refinery, Double Sulphitation, Backend, clarification, filtration, Color Removal, GOI(Government of India)

Introduction:

To cope with this demand, it is essential to produce refine sugar with less sulphur, low impurities, minimum ash content and suspended particles. Being the world's second largest producer of sugar it is much viable to setup a backend refinery over standalone refinery in India.

Onthis principle over last few decades100s of factories in India have been converted from conventional double sulphitation process to refined sugar process.Inthe year to come even more factories are expected to convert as refineries.Whileconverting what will be the ideal process for clarification either phosphotation or carbonation, decolourisation through Ion exchange or Powder Activated Carbon or Granular Activated Carbon melt concentration through Robert bodies orFFE.

Toselect the most appropriate process depending on the sugar quality requirement, plant capacity, captive investment, operating cost, pollution control norms,ease of operation etc. is the most important step to make the project suitable and profitable.

Refining Process Selection:

The quality of refined sugar or white sugar of any grades is normally based upon the process Technology and systems followed.However, the first priority in case of refined sugar is their color value. Therefore, sugar refining process has to be controlled by color parameters on each stage.

The substance responsible for a sugar color are normally classified as a non-sugar impurities in the production of both Raw and refined sugar the removal of these coloured impurities becomes extremely important, especially in view of the increasing demands for high quality white refined sugars.

1) Clarification
2) Filtration
3) De-colourisation including
4) Melt concentration.

CLARIFICATION:

a) Phosphotation Process:

The main purpose of this process is to remove color and turbidity by means of floatation separation technique. In this process melt from buffer tank is pumped to reaction tank through heat exchanger, where it is heated up to 85^0C. The liquor flow rate is measured and controlled to desire setting automatically by flow control valve. Phosphoric acids, lime sucrate and color precipitant are dosed in to the pipe line prior to reaction tank by dosing pump. The phosphoric acid dosing pump is automatically adjusted in proportion to melt flow rate and dosage setting. The speed of lime sucrate is automatically adjusted to regulate desire pH. The color precipitant dose is adjusted in range 200-250 ppm.

The reaction of phosphoric acid and lime sucrate produce calcium phosphateprecipitate (primary flocks) which adsorb colloidal and color matter to its surface. The reaction tank agitators ensure the complete mixing of these chemical.The liquor then overflow in to aeration compartment where it is aerated by cavitations aerator, from aeration compartment the liquor goes to clarifier by gravity.flocculent is dosed in line between reaction tank and clarifier by dosing pump

Pros of phosphotation:

- Initial investment is a less as compared to other process
- Operation is a very easy
- Higher degree of suspended solids and colloids removal
- Only single stage of filtration is a required for polish filtration

Cons of phospotation:

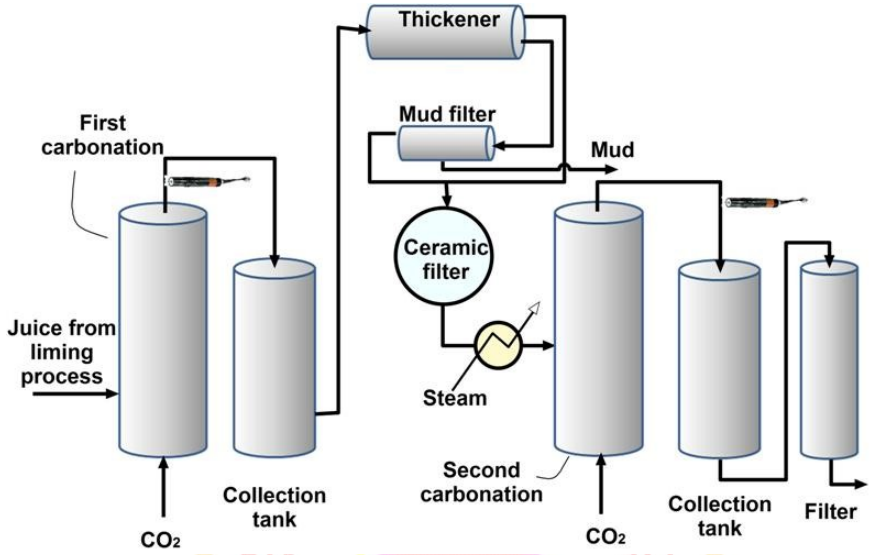
- Color reduction is a lace when compare to carbonation
- Higher chemical cost when compare with carbonation
- Inversionlosses may occurs the process is operating at lower pH.

The estimated operating cost of phosphor flotation process of clarification is INR 79.59 per turn off refined sugar

Carbonation Process:

Inthis process color removal is higher (50%) against phospho-floatation process (35%) but initial capital cost is too high. This process involves two steps. In 1st step melt liquor after screening is heated up to 75^0c in tubular juice heater. And treated with milk of lime so as to increase the PH up to 10.0 to 10.5 The dissolved impurities in the melt liquor get coagulated.This lime liquor is fed to two set of carbonators composed of two columns. These columns are equipped with Richter tube for effective gassing. The carbon di oxide gas obtained from boiler flue gas after scrubbing is bubbled through the liquor in each body till the PH come down7.8 to8.0 The liquor that comes from carbonator is called carbonated liquor. This process is carried at brix 60 – 65%. Lime and CO_2 gas reacts and produced gelatinous calcium carbonates flocks which adsorb color matter.The 2ndstage consist of conditioning of the precipitate in order to improve filterability.In this step carbonated liquor is heated in PHE up to 85^0c . The heated liquor is pumped to 1st leaf filter to remove coagulated impurities. The 1st leaf filtrate is again pumped to 2nd leaf filter as safety filtration.

Figure - Carbonation Process



Pros of Carbonation:

- Robust process.
- Higher color reduction.
- Suitable for higher color raw sugar.
- Variationin the raw sugar quality can be managed in the process.
- No inversion losses since the process are operating at higher pH.
- Less chemical lost as only lime is brought out chemical.

Con of carbonation:

- Higher initial investment cost.
- Occupies more space.
- Solid waste generation is high.
- Higher maintenance cost.

Estimated operating cost of carbonation process is inner 70.20 per ton of refined sugar

Decolorization:

There are three different decolorization process all perform same function of reducing color of clarified melt. The choice will be depends on the combination of capital cost, operating features and quality of refine sugar required.

1) Powdered active carbon (PAC)
2) Granular activated carbon (GAC)
3) Ion exchange resign (IER)

Powdered Active Carbon (PAC):

PAC is prepared from vegetable origin like coconut shell, and it can only be used on a throw away basis. PAC can be very suitable decolorizing agents for low color input raw sugar. A very small quantity of PAC is used, about 0.05 to 0.3%, on the weight of sugar solids. This process is flexible and quantity of powdered active carbon used can be optimized depending upon the quality of the sugar liquor being processed and quality of product to be made.The expected color reduction will be maximum, 50%. Operating Cost of PAC is INR 163.15 per ton of Refined sugar. In this Process PAC are added in liquor at a defined temperature and retention. Then liquor is filtered in the Membrane filter/candle filter and after filtration, carbon is discarded. As its single use, is considered a regular consumable like a process chemical.

Granular Active Carbon (GAC):

In thisprocess instead of PAC,GAC is used.The clarified liquor is passed through columns containing granular carbon for de-colorization .The de-colorization liquor is send for fine filtration to remove any carbon fines, which may get entrained in it from decolorization column. The GAC get exhausted after certain number of cycles. and therefore it need to reactivate or regenerate and this done by kilning the granulate in the furnace at around 950^0c temperature.The process can achieve good level of color removal. In this process minimum 8 column required to use and hence initial cost is high.

Pros of GAC:

- High degree of a color reduction.
- Processis robust and simple.
- No environmental issues.

Cons of GAC Process:

- Suitable for very higher capacity refinery only.
- Veryhigh investment cost.
- Occupiesmore space.Initialprocess stabilization will take long time.
- Highoperating cost as a fossil fuel required in a furnace or regeneration of GAC.
- Inversionloss possible due to drop in pH across the system.

Estimatedoperating cost for GAC is INR 265 per ton of refined sugar.

Ion Exchange Resins System:

In this process synthetic ion exchange resins or adsorbent resins are used for decolorization. There are two main polymeric structure resins which differ by their hydrophobicity .One is styrenic matrix resins which tends to be more hydrophobic and other is acrylic matrix resins which tends to more hydrophilic. In addition of their chemical structure both the adsorbent exhibit some important porosity .In refinery either one or both adsorbents are used for de-colorization .Acrylic resins remove large molecular weight coloring compounds and it is suitable when input color is high. Styrenic resins have higher de-colorization capacity than Acrylic but it is suitable when input color is low.

The sugar liquor is percolated through Acrylic resigns beads which adsorb the color this percolation is again percolated on .second styrenic resins beads which again remove color. Thus double percolation removes higher color. The level of color removal is as high as 80% of input color.

Pros of IER

- Lower operating cost.
- IER system regenerated chemically rather than thermally; hence costly fossil fuels are not required.
- IER system required a much shorter contact time that carbonate systems hence a much smaller volume of adsorbent is needed.
- there is no pH drop in the system.
- Waterrequirement are much lower.
- They can be regenerated in a place rather than having to be transported to a regeneration facility.Thesweet water volume is a relatively low and of high purity.
- Equipmentcost is a relatively low and automation is easy.
- Unlikegranular carbon, makeup requirements are low.

Cons of IER:

- Treatment of the dark brine from the IER zero discharge.
- Nano filtration will be required to recover the brine as well as to reduce the volume ofeffluent.Concentratedreject from Nano filtration disposal required.

Estimated operating cost of IER process is INR 78.53 per ton of refined sugar

Conclusion:

The selection of process for clarification and decolourisation depends upon various factors like raw sugar quality, refined sugar quality, local environmental norms, operating cost, capital cost etc. Hence selection of suitable process varies factory to factory depending upon the requirement and the factory management has an option to select the technology depending upon their discretion after weighing the pros and cons of various process.

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Ethanol production from Elephant Grass

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Abstract

An overview of the basic technology to produce bioethanol from lignocelluloses biomass is presented in this context. The conventional process includes two main steps. First, lignocelluloses must be pretreated in order to remove lignin and enhance the penetration of hydrolysis agents without chemically destruction of cellulose and hemicelluloses. Second, the pretreated material is converted to bioethanol by hydrolysis and fermentation. Some typical published studies and popular processing methods inattempts to improve the biomass conversion to bioethanol and increase the cost-effectiveness are also introduced briefly. Herein, the refinery of the resulted raw bioethanol mixture to obtain higher concentrated solution is not regarded.

Keywords
Bioethanol , lignocelluloses ,pretreatment ,hydrolysis , fermentation Lignocellulose

Intorduction:

Cellulose and hemicelluloses, like starch, are made up of sugars. However, most of the cellulose in the nature is in the form of lignocelluloses. Lignocelluloses is a complex structure of natural materials found in plants. It represents the most abundant source of renewable organic matter on the earth. Cheap lignocelluloses biomass resources can be forestry, agricultural, and agro-industrial wastes. A variety of such materials can be mentioned here including Cellulose containing plant . In contrast to a desire of utilizing these materials to produce valuable products, lignocelluloses wastes are still accumulated every year in large quantities, causing environmental problems.

Lignocelluloses consists of cellulose, hemicelluloses, and lignin and always exists beside other extracts and mineral traces. The general composition of lignocelluloses is presented In lignocelluloses, cellulose fiber strands are formed by cellulose linking to each other via hydrogen bonding. The cellulose structure within the polymer is not homogenous.

Crystalline regions are where cellulose Nano-fibrils are organized in order and compact, while amorphous regions are disordered and easier to be hydrolyzed. Cellulose fibers are like skeletons surrounded by hemicelluloses and lignin.

This structure naturally protects the polysaccharides from hydrolysis by enzymes and chemicals, thus raising a difficulty in both chemical and bioconversion of lignocelluloses to other products, i.e., ethanol. In lignocelluloses, besides cellulose, hemicelluloses are also a noticeable polysaccharide. Hemicelluloses isa linear and branched heterogeneous polymer typically made up of five different sugars—L-arabinose, D-galactose, D-glucose, D-mannose, and D-xylose. The backbone of the chains of hemicelluloses can be either a homopolymer or a heteropolymer (mixture of different sugars). Hemicelluloses differ from cellulose not only by the different sugar units but also by their molecular morphology of being amorphous, where shorter chains are branching from the main chain molecules. As a result of this chemical characteristic, hemicellulose is easier to be hydrolyzed than cellulose .Mechanical processes reduce the size of the biomass and thus enhance the contact surface. Mechanical processes do not change the chemical properties of the materials. Therefore, they just can be a step to process raw materials before other steps of the pretreatment. Cutting, crushing, milling, and grinding can be carried out with specific equipment.

Conversion of pretreated lignocelluloses to bioethanol

Pretreated biomass can be converted to bioethanol by both direct microbial conversion (DMC) and hydrolysis along with fermentation . In fact, DMC method requires much time, while the conversion yields

were rather low with high risk of contamination . In contrast, enzymatic hydrolysis combining microorganism fermentation is a more preferable method with proven much better performance .

Sacchacrification of lignocelluloses

After lignocelluloses being pretreated, the polysaccharide-enriched material is hydrolyzed to single sugars (hexodes and pentoses) with enzymes. The commercialized enzyme to hydrolyze cellulose and hemicelluloses is in fact a mixture of some different kinds of enzymes, commonly called cellulose, extracted from microorganism. These enzymes cleave glycoside linkages in carbohydrates, typically via inverting or retaining mechanisms, the latter of which proceeds via a two-step mechanism that includes formation of a glycosyl-enzyme intermediate.

Fermentation

Microorganisms are employed to metabolize the liberated single sugars from enzymatic hydrolysis to convert them to bioethanol. There are two approaches:

- Separate hydrolysis and fermentation (SHF): the hydrolysis is carried out until
- finish, and then microorganisms are added to the mixture to ferment the sugars. This method has some inherent weak points, including contamination, formation of inhibitors, and requirement of more time and extra equipment.
- Simultaneous sacchacrification and fermentation (SSF): the enzymatic hydrolysis and microorganism fermentation are carried out in the same equipment at the same time. Both enzymes and microorganisms are loaded to the mixture. This method is proven much better than the SHF above with shorter time, less equipment, and minimized risk of contamination.

SSF is currently considered the optimal method to convert lignocellulose to bioethanol. The process is reported with high conversion yield . However, there are still some small backwards of this method. The optimal temperature for enzymatic hydrolysis is 45–50°C, while fermentation is at its highest efficiency at 28–35°C. Moreover, some intermediate products also resist the growth of microorganisms.

Material & Method

Raw material such as hatti grass

Enzyme ,H2so4,and Hcl

Microorganism -Saccharomyces cervices

Process

To take a popular hatti grass

↓

Crused it

↓

This crushed volume to add enzyme (lignocellulase or cellulase) for hydrolysis

↓

After hydrolysis this volume taken by fermentation adding Saccharomy cescervices for 24-32hrs.

↓

After fermentation send distillation

↓

Separate the Alcohol

Conclusion

Renewable fuels and energy are a vital demand of the human being when fossil resources are exhausted and the global warming is at the red alarming level. The production of lignocellulosic bioethanol can meet the requirement of food security and the sustainable vision of a green world. The process includes pretreatment, enzymatic hydrolysis, and fermentation stages. Intensive studies are being carried out in over the world, in order to increase the cost-effectiveness of ethanol production and to make the transition from the laboratory to the industrial/commercial scale. This brief background was written in hope to spot out some noticing information for the readers about lignocelluloses-based bioethanol's technology, which currently attracts a lot of studies to shorten the gap between research and commercialization.

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Role of Chemistry in Cane Juice Clarification & Decoloration

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Abstract:

Sugar production is a complex multi stage process, it usually include extraction of juice,clarificationof juice, evaporation of juice.De-colorationor bleaching of syrup,sugar crystallization, sugar separation and dry product packing.Some process are related with engineering activity and some are related with technological activity. Technology is manifestation of science and particularly sugar technology is manifestation of sugar sciencethat sugar chemistry.We consider here chemistry and technology ofcane juice clarification & de-coloration.

Keywords: *Non-sugar, defecation, sulphitation, carbonation &decoloration Suspended ,colloidal ,dissolved*

Analaticalmethod :GS2/3-10 for white sugar color GS7-13(1994)for fibre content Routeen analysis for brix ,pol ,purity of juice sugar ete

Introduction:

The purpose of clarification process is to remove non-sugar (impurities) as many as possible and to improve purity of juice, with reduction incolor values of juice. As such to provide transparent, opaque color clear juice to downstreamprocess. The clarification process plays important role in quality ofsugar. Improper clarification will lead to a series of problem such as Sugar loss in molasses, Scale in heat exchanger and Final sugar quality.The widely used processes are defecation, sulphitation and carbonation for production of raw, white and refinesugar respectively. The efficiency of these process are depends up on the ability of precipitated vizCalciumPhosphate/Calcium Sulphate/Calcium Carbonate to adsorb impurities in the way that allow separation bysedimentationand filtration.Most of sugar factory still measured process offline and some are measured on line by using MAPCON model but yet not become popular due to want of skilled man power.

Chemistry of Cane Juice:

The sugar cane juice which is received from Millis is acidic in nature &sweet in test, it is light gray to dark green in color & on standing it ferments.

The Composition of Cane Juice:

Constituents	Percentage
Water	70 – 88
Sucrose	10 – 16
Reducing sugar	0.5 – 2.00
Organic substance	0.5 – 1.00
Inorganic substance	0.2 – 0.6
Nitrogen body	0.5 – 1.00

Impurities of Cane Juice:

a) Organic compounds – proteins, pentose, pectin, wax, and coloring matter
b) Organic acids — Glucollic, Maltic, Succinic, Tannic, Bytricanctonicetc
c) Inorganic cations- Sodium, Potassium, Calcium, Magnesium, aluminum and iron
d) Inorganic Anion — Chloride, sulphate, phosphate, nitrate, silicate etc.
e) Nitrogen body — Amides, Amino acids, ammonia.
f) Coloring matter- Chlorophyll, anthocyanin, and saccharatin

Nature of impurities:

1) **Suspended state**: Fine particles of bagasse, sand, clay from soil, cane wax.
2) **Colloidal state**:
   Some organic and inorganic substance like gum, protein, coloring matter, compounds of silica, iron, aluminums and clay
3) **Molecular State (dissolved state):**
   Sucrose ,Reducing sugar, Na, K, Ca, Mg, Al, Fe .and H cations occur in molecular solution in electrolytic equilibrium with anion such as organic and inorganic acids like phosphoric, sulphuric ,silica, hydro-choric, oxalic, citric, and aconite.

Nature of Colored impurities:(pigments)

The sugar cane stalks contain mixture of two coloring matter chlorophyll and anthocyanin.The chlorophyll is colloidal and harmless can be removed by adsorption and filtration.

The anthocyanin is readily soluble in water so during milling process it passes to juice and causing green color to juice it can be removed by heat and lime.

The fibrous material contain saccharin which is colorless but on heating it becomes yellowish

Objectives of clarification process: Considering composition juice and nature of impurities the primary objectives of clarification are

1) Removal of suspended impurities by basic concepts of chemical engineering process. For removal of suspended impurities we should adopt process like screening, straining ,filtration as and when required in process
2) Removal of colloidal impurities by basic concept of surface chemistry of calcium phosphate flock, which mostly adsorbcolloidal impuritiesand become dense and settle.
3) Removal of dissolved impurities by precipitation,coagulation,sedimentation and filtration.For this we should follow technology process like defecation, sulphitation&carbonation as per final sugar production.
4) Removal color impurities by adsorption &decoloration&Imparting clarity and transparency in juice by optimizing and controlling process parameter like temperature ,retentiontime and PH . For Imparting clarity and transparency in juice is not easy task, needing careful control on quality and judicial use of regent used in clarification process. It is obvious that different dissolved impieties will gate precipitate at different pH valve as such accurate pH control over different step of clarification process is must.

Technology of CaneJuice Clarification :

a) Removal of suspended impurities:

Main suspended impurity is fine bagacillo particles which is insoluble in juice. Higher quantities of bagacillo increases the color of clear juice as tea brewing effects, increase the mud volume and suffered filtration station. It also blocks juice heater tubes and passes to clear juice and further find its way in sugar. The sugar quality becomes dull. Thus removal of bagacillo is must. These fibrous materials mainly consist of cellulose, semi- cellulose lignin which forms the color after heating. **Hence as process parameter there should be zero fibrous material in juice to avoid color formation.**

Single stage rotary screens for cold juice screening are now commonly installed in most of sugar factories during last 15 years using 0.50 mm opening. Each sugar factory claims that efficiency of the unit is more than + 90% and moisture is about 75%, but the quantity of bagacillo is still about 1.8 – 2.0 gram/lit of juice (0.18 – 0.20% on cane) which is against zero parameter.

It is further advocated that on heating juice finer fibrous particles are swell up so become essay for screening .So hot raw juice screening is fallowed that is screening of juice after heating and before sulphitor. Following sugar factories have installed rotary screens for hot raw juice screening by using 0.15 – 0.18 mm opening and reported that there is reduction in color of clear juice by about 2500-3000I.U. The quantity of finer bagasse of screened juice is about 0.20 gram/lit of juice. The color reduction of sugar is by 20 to 25 IU.

Table No – 1 Source: Seminar at Sonhira SSK.

Sr	Name of Sugar Factory	Fibre seperation % cane - Dry basis			Colour reduction IU		
		Before screening	After screening	Seperation	Before screening	After screening	Reduction
		a	b	a-b	c	d	c-d
1	Sonhira S.S.K. Ltd	0.155	0.018	**0.137**	13362	10768	**2594**
2	The Sanjivani (Takli) S.S.K. Ltd.,	0.135	0.0185	**0.1165**	21234	16868	**4366**
3	Shri Chhatrapati Shahu S.S.K.Ltd.	0.2168	0.0195	**0.1973**	15909	13975	**1934**
4	Krantiagrani Dr. G.D. Bapu Lad SSK Ltd.	0.1645	0.0177	**0.1468**	14533	11348	**3185**
5	Jaywant Sugars Limited	0.168	0.024	**0.144**	14636	11708	**2928**
6	Vishwasrao Naik S.S.K. Ltd	0.17	0.023	**0.147**	15400	12300	**3100**
7	Hutatma Kisan Ahir S.S.K.Ltd.	0.25	0.0575	**0.1925**	13442	10102	**3340**
8	Y. M. Krishna S.S.K. Ltd	0.166	0.029	**0.137**	20229	17242	**2987**
9	Baramati Agro Ltd.	0.181	0.056	**0.125**	21024	18788	**2236**

b) Removal of Colloidal Impurities:

Colloidal impurities are organic and inorganic in nature.Colloids are of two types in juice hydrophobic and hydrophilic. i.e suspended and dissolved. Colloid settles slowly and forms bulky settling. Colloids slowdown the filtration and cause foaming. Colloids increase the viscosity of syrup and molasses. Colloids increase the color and finally interfere in the crystallization process. H**ence it is needed to remove maximum colloids during clarification process.**

Colloids are negatively **(–ve)** charged and do not get precipitate until it is neutralized. After neutralized it is adsorbed by calcium phosphate. Therefore phosphate contents of juice is an important constituent from standpoint of colloids elimination.(minimum 300mg/lit of juice). There is linear relation between phosphate contain and colloids removal. The increase in colloids removal is accompanied by an increase in weight and volume of mud. With increase in phosphate content of juice the rate of volume of mud is more as compare to rate of weight of mud. Hence for thickening of the mud, flock conditioning is required.

Flock conditioning means bringing dispersed flock by adding externally higher molecular weight flocculent polymer &get properly admixture with incoming juice homogenously thus allowing loose flock come together to form thick flock. As such settling is fast .The density of mud is important for settling. That is weight of one liter mud shall be 1060-70 gram

The certain specific time is required for building the flock, by experiment it is found that minimum 2 to2.5 minute are required for flocculation activity, similarly to admixture with juice homogenously the flocculent solution shall be diluted (0.1%).Hence total system of preparation of flocculent, addition of flocculent & building of flock is essential activity in settling process.

c) Removal of dissolved impurities

It is common practice to remove dissolved impurities by Precipitation. Coagulation, Sedimentation &filtration.There are three process used vizdefecation where lime and heat is used for raw sugar production sulphitation where lime heat and SO_2 gas is used for white sugar production &carbonation process where lime heat and CO_2gas is used for refine sugar.The removal these impurities is done in such manner that neither sucrose nor reducing sugar destroyed in considerable quantity.The every loss of sucrose must be avoided for sugar recovery. Similar destruction of reducing sugar is harmful due to dark color production which hinder the whiteness of sugar.

When sucrose is in acidic media, inversion take place and this inversion is directly proportional to temperature and time. Therefore products of three factors.

Temp. X Acidity X Time shall be minimum

Similarly when reducing sugar is in alkaline media destructions take place and this destruction is directly proportional to temperature and time.therefore products of three factor.

Temp. X AlkalinityXTime Shall Be Minimum

In above both case**"Temp."** is first because it has great important in reaction rate, heating of juice prior liming has advantages for coagulation of colloidal impurities at low ph.

Second factor is **"Reaction Media"**sucrose demand is slightly alkaline media to avoid inversion while reducing sugar demand slightly acidic media for minimum destruction of reducing sugar. As result juices are kept at neutral media.

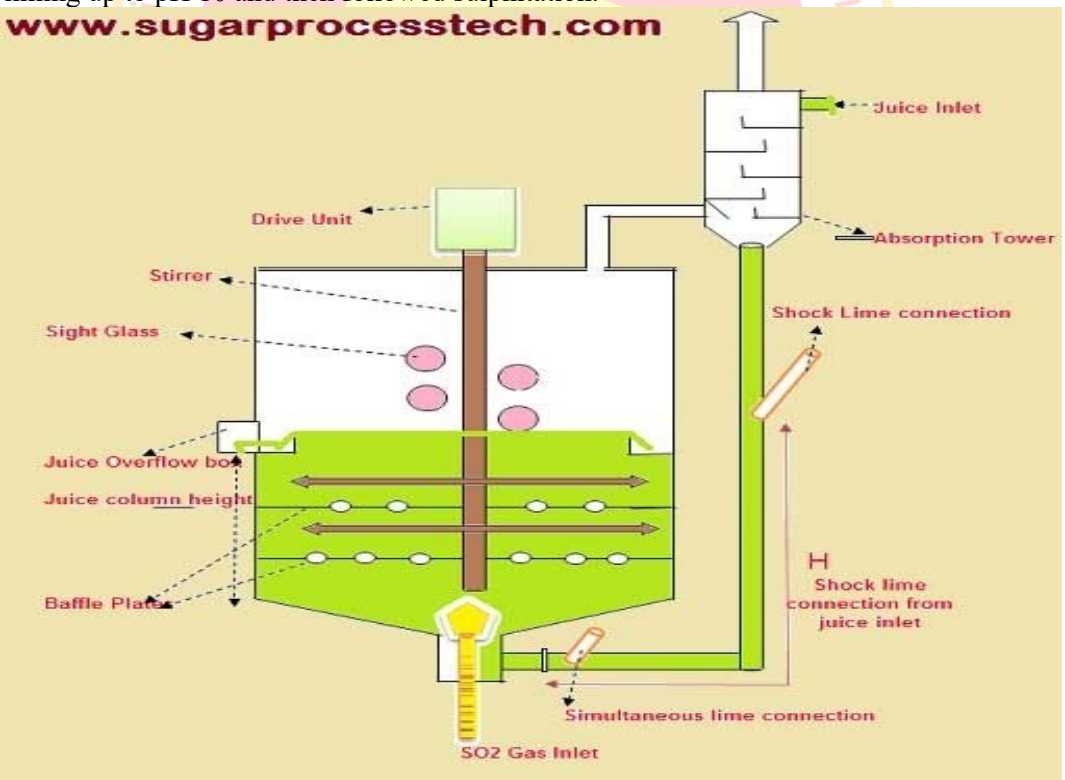
Third factor is **"Time"** it shall be minimum as possible .The regent is to be mixed homogenously with juices .maximum time required is 7 minute.

Sulphitation Processfor white sugar production

Purification of juice by using heat, lime and SO_2 gas is termed as sulphitation process. In this process excess lime is added and it neutralized by SO_2 gas. 1st step is addition of excess lime it is called as defecation and 2nd step is neutralized excess limeby SO_2 gas is called as sulphitation.Thus it isdefico- sulphitation process but commercially termed as sulphitation.

This process is further divided in three part depends up on mode of liming and sulphitation.

1) Simultaneous liming and sulphitation at 70^0c and maintain more or less neutral condition.
2) Pre-liming of juice at pH 7.2 to7.4 and followed by continuous liming and sulphitation process.
3) Shock liming up to pH 10 and then followed sulphitation.

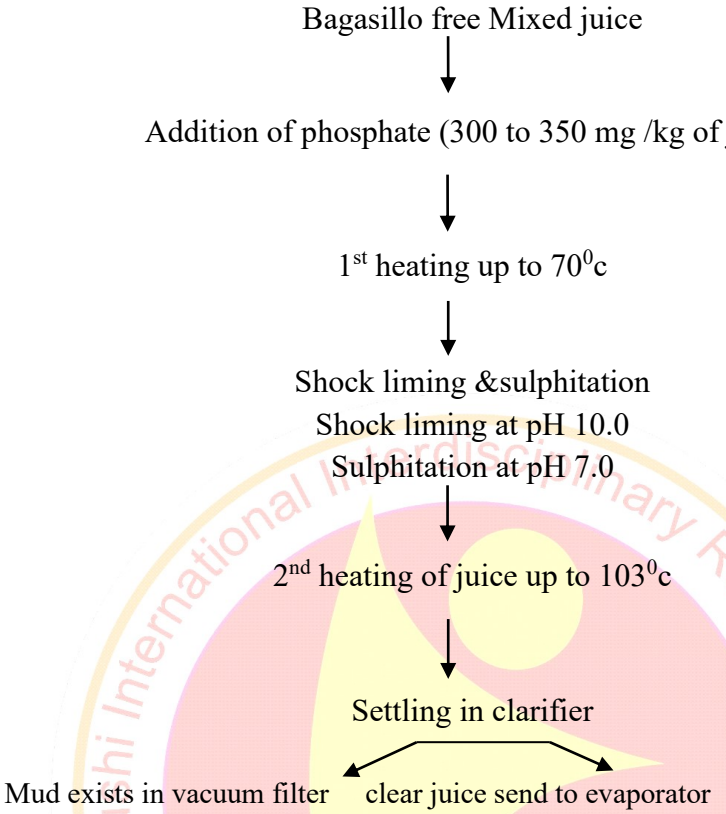


Shok liming and sulphitation:

In thisprocess total lime is added as shock lime, it is in contact with juice for not more than 15 seconds hence very less destruction of reducing sugar. pre-determined quantity of lime is added hence removal of non-sugar is better.

In 1st stepexcess lime gives maximum flock of Ca-tri-phosphate and in the 2nd step it neutralizedby SO_2 gas which gives max flocks of Ca-sulphite.Ca- triphosphate has more affinity to adsorb colloidal but less rate filterability of solids while Ca – sulphite has higher rate of filterability and lesser affinity of adsorption. As such

in this process settling as well as filtration improved and thus juice obtained is light and brilliant in color with free from turbidity.



This is the process widely used in all most all sugar factories due to

1) Contact time of juice &lime is less
2) For proper mixing of regent juice sparger with stirrer is provided.
3) Two loop ph. control system easy to operate.

Fixtation of lime dose

Lime dose fixation -mixed juice +filtrate (90+10%) source Waranassk

Mj+fil. Clear juice with

Sr. no	Particular	Mj+fil . pH 5.0	Shock pH 8.5	Shock pH 9.0	Shock pH 9.5	Shock pH 10.0
1	ml MOL required (v/v%)	-	0.9	1.9	2.8	3.4
2	Brix	17.77	18.36	18.28	18.72	17.90
3	Pol	15.17	15.85	15.85	16.33	15.67
4	Purity	85.37	86.33	86.70	87.23	87.54
5	Rise in pty		0.96	1.33	1.86	2.17
6	ICUMSA color at 422 nm	17418	12785	8527	1116	1018
7	%color removal	-	26,60	51.00	35.90	48.50
8	Mud volume (ML)	360	350	260		230

Shock pH 10 is to be consider for purity rise and color reduction, minimum mud volume

- **Removal of color**

The original color that is pigment present in juice like chlorophylls, and anthocyanin are removed by adsorption process during clarification. Their removal is about 45%in sulphitation process. Remaining goes to syrup.

But there are some color forming compounds which develop colorduring process such as saccharin-which present in fibrous material gives yellowish color on heating,poly phenol-reacts with iron and produced phenolic iron compound which increases the color of juice.Melanodianis formed as result of reaction between reducing sugar and amino acids and amids. It imparting radishbrown color to juice.Carmal is formation as action of heat on sucrose and action of heat and alkali on reducing sugar which imparting yellow or brown ting to juice.

Thus syrup contain suspended, colloidal and color impurities these need to be removed so that final product (sugar) will have minimum coloring matter to absorbed into inter crystalline layer during crystallization process.

Normally syrup sulphitation is done before sending to pan for crystallization. In this process syrup is bleached with action of SO_2gas The SO_2 gas reduces the ferric salts of syrup into ferrous salt which prevent development of dark color compound resulting from the reaction of ferric compounds with polyphenols.The SO_2gas most probably blocks the carbonyl group of reducing sugars, thereby checking the caramel and melanoidin formation, the reactions leading to development of color. But removal of color in this process is 10%only and no removal of suspended and colloidal impurities of syrup.

To remove the colloidal,suspended, and remaining color impurities from syrup a separate syrup clarification is required and then bleaching can be done.It is now become essential to choice syrup clarification to produces sugar color below 100 IU. Thesyrup have Brix above 60deg.hence phosflotation process can be used in which above impurities can be removed as scum.

In this process floatation clarifier, Juice heater, reaction tank and aerator are required.

Flow diagram.

Syrup buffer tank

↓

Addition of color precipitant (150 to 200 ppm on syrup solid)

↓

Heating up to 85° c

↓

Reaction tank

(Addition of phosphate 200 to 250 ppm on syrup solid&then neutralization by lime sucrete)

↓

Special aerator for flock formation

(Addition of Flocculent chemical 13 to 15 ppm)

↓

Floatation clarifier

↓

Scum to mud tank &syrup for crystallization either direct or after bleaching.

In this process

1) Addition of color precipitant reacts with soluble color like polyphonal& and amino acid and gives precipitate which remove along with scum.
2) Ca–tri–phosphate adsorbs coloring matter, suspended as well as colloidal impurities.
3) To active floatation air is admitted through special aerator before clarifier.
4) In the floatation clarifier scum is removed to the surface and clarified syrup is taken through silent zone.
5) Removal of color is 30 – 40%
6) Removal of suspended matter is 70 – 80%
7) Removal of colloidal impurity is 25 – 30%
8) Viscosity reduction is remarkable.

For Imparting clarity and transparency of juice

1) **The juice flow in the boiling house should be steady**
   The stabilized flow ensure following
   a) Uniform juice heating
   b) Better juice treatment at sulphitor
   c) Improve juice clarification.
   d) Compact mud formation
   e) Judicious consumption of regent.

Optimizing lime dose:

While optimizing lime dose normally we consider the quality of mixed juice but when filtrate which is rich in CaO, low in phosphate, high in non-sugar & colloidal matter, cloudy and dirty in nature is mixed with mixed juice quality of mixed juice changes. Thus results obtained are not even and consistent, however change in quality of mixed juice is directly related to quantity and pH of filtrate hence while optimizing lime dose in lab test mixed juice +filtrate should be taken. Lime dose shall be in the range 9-9.5 pH

2) Grit removal from MOL:

Quality of lime is most important as impurities enter in juice through MOL. It contains grit, ash, unburned particle& coke etc. The grit gets accumulated in juice and leaves on evaporation station and cause the scale. Grit enter in clarifier fluctuate pH and cause the purity drop. Grit enters in syrup and cause viscosity and increase molasses quantity. Therefore separation is essential. Rake type classifier for coarse grit removal and vibro-screen for fine grit removal is required. Grit shall be less than 0.5 gm/lit of MOL

3) Continuous supply of SO2 gas:

SO_2 is used for neutralization of excess alkalinity caused by addition of lime. Lime reacts with sulphurous acid and gives calcium Sulphite. Excess SO_2 lower the pH & forms calcium bisulphate which is soluble, less SO_2 blowing leads to incomplete reaction with lime & leave more CaO in juice. Thus hardness of clear juice increases. Therefore continuous supply shall be generated from burner.Film type sulphur burner is best burner for continuous supply of SO_2 gas. In this molten sulphur is transferred to furnace by metering pumps for continuous supply of SO_2. Now in most of sugar factories film type continuous burner with three compartment melter, dosing pump for feeding molten sulphur is used.

4) **Controlling over the pH:**

"Sucrose demands slightly alkaline media to avoid inversion while reducing sugars demand slightly acidic media for minimum destruction of reducing sugar. As a result juices are kept at neutral media which is at 7.00 pH. The different dissolved impurities will get precipitated at different pH values as such accurate control over shock pH is required (9.0 -9.5 pH)

The best result of clarification process is expected when process is managed at desired "pH" parameter. In sugar factories different type of pH control system are practiced. All are based on micro processer automatic pH control system (MAPCON) The three loop, two loop and single loop pH control system among them two loop pH control system become popular.

Two loop pH control system:

In this system shock lime PH and final PH is control. Set point of shock liming is pre- determined in lab. The pH of shock lime is about 9.5to 10.00 is maintained by addition of milk of lime through flow meter, the SO_2 gas is used to control final pH 7.00. SO_2 generation is ensured by VPC temperature.

- **Controlling reactions**
  For producing brilliant light color of clarified juice we shall aware and control various reactions which are responsible for imparting color on juice and thereby on sugar. Following are the main color producing reaction
  Poly phenol reacts with iron and produce phenolic iron compound which increases the color of juice. The dark tin in white sugar is due to phenolic iron.
  Melanoidins- Melanoidin is formed as a result of reaction between reducing sugar and amino acids and amides. The reaction is known as Maillards reaction imparting radish brown color to juice.

Caramel- Caramel is formed by action of heat on sucrose. Further action of heat and alkali on reducing sugars produce degradation products which are imparting yellow or brown ting to juice Caramel enters in sugar crystal lattice and imparts yellowish color to sugar.

Conclusion

The best result of this clarification process is expected when suspended, colloidal, dissolved and colored impurities are removed as many as possible. This means that every minute juice particle has to go exactly same treatments with same change in pH and time.

When sucrose is in acidic media, inversion take place and this inversion is directly proportional to temperature and time. Therefore products of three factors namely-

TEMP. X ACIDITY X TIME SHALL BE MINIMUM

Similarly when reducing sugar is in alkaline media destruction takes place and this destruction is directly proportional to temperature and time.Therefore products of three factors namely-

TEMP. X ALKALINITY X TIME SHALL BE MINIMUM

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Investigation Into the Reduction of Microbiology Loading During Beer Fermentation

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Abstract

To maintain the high standards of product quality in the brewing business, microbiological quality control testing is essential. Microbial contamination, which can originate from a variety of species including bacteria, wild yeast, and mold, can drastically change the flavor and performance of beer fermentation. This can lead to unfavorable taste, flaws in aroma, turbidity, and decreased yeast activity. This study looks at the crucial role that microbiological activity plays during the fermentation stage and throughout the beer-making process. It also emphasizes the necessity of active control techniques to maintain the integrity of the finished product and lessen off-flavor in the beer. The objective of this study is to carry out a thorough analysis of the best practices for reducing microbial contamination throughout the fermentation process. On the other hand, the quality of the product may suffer if undesirable microbiological pollutants are present during fermentation. Thus, the goal of this research is to better understand the variables that affect microbial contamination during fermentation and to develop strategies for managing and reducing these impurities in order to improve both process effectiveness and product quality. The goal of the study is to examine the crucial impact that microbiological activity plays at each stage of the brewing process, with an emphasis on the fermentation phase. It is crucial to comprehend how microbes interact and impact the brewing process in order to consistently produce high-quality beer. In order to preserve the integrity of the finished beer product, active control procedures are crucial, as this thesis highlights. The detrimental effects of microbiological contamination can be avoided or at least lessened with the use of strict quality control procedures and preventive measures. This could include things like temperature control, raw material quality, clean equipment, and more. The goal of the research is to improve the overall quality of the beer product as well as the brewing process' efficiency by tackling the problem of microbial contamination. Higher levels of customer satisfaction and more consistent brewing results may result from this development.

Keywords: *Brewing, Fermentation, Beer*

1. Introduction

Beer is a widely consumed alcoholic beverage that is usually made with malted cereal grains, flavoring hops, and a slow fermentation process. It's an elegant alcoholic beverage with a broad range of flavor-active ingredients present in different ratios.

Brewing, the craft of making beer, is the process of turning barley starches into sugars and then using water to extract those sugars. After this sweet liquid is fermented with yeast, beer, an alcoholic beverage with a mild carbonation level, is produced. The usual range of alcohol content in beer is 2.5% to 13% (v/v) ethanol. Beers are often classified according to the amount of alcohol they contain. They are classified as low-strength (containing about 2–3% alcohol), medium or average strength (containing about 5% alcohol), and high-strength or strong (containing more than 5–6% alcohol).

After cooling and removing spent hops, the resulting liquid, known as 'hopped wort,' is pumped into fermentation vessels. Yeast is introduced with aeration to promote growth. In the anaerobic phase, yeast cells convert sugars into ethanol and carbon dioxide. Depending on fermentation temperature and yeast collection methods at the end of fermentation, beers are classified as 'bottom fermentation' or 'top fermentation.'

Fermentation typically spans about one week, yielding a 'green beer' or 'young beer,' which is not ready for consumption due to the presence of undesirable compounds that result from fermentation. During fermentation, yeast releases various molecules, including ethanol and CO2, which can influence the flavor. All

brewing strains generate glycerol, vicinal diketone (VDKs), alcohols, esters, short-chain fatty acids, organic acids, and various sulfur-containing substances. The levels of these compounds in beer depend on factors such as yeast strain, precise fermentation conditions, including pitching rate, temperature, oxygen addition, fermentation and maturation duration. VDKs, particularly diacetyl, impart an undesirable buttery character to beer. These VDKs can be controlled by conducting a diacetyl rest, which involves raising the fermentation temperature slightly (15˚C-21˚C) when the gravity is a few degrees Plato from the terminal. Beers require a maturation or lagering period of several weeks at around 0°C to break down undesirable components before they can be considered ready for packaging. For extended preservation, beers may undergo pasteurization.

Microbiological quality control testing is indeed crucial in breweries to ensure high product quality. Microbial contamination, arising from bacteria, wild yeast, and mold, can significantly impact the flavor and fermentation performance of beer, leading to undesirable defects in taste, aroma, and turbidity, as well as reduced yeast performance. Throughout the beer production process, from raw materials to packaging, various microbial activities are involved. While some are desirable for traditional food fermentation, others can threaten the final product's quality and must be actively managed and controlled.

(Ref :- Vaughan, A., O'Sullivan, T., & Van Sinderen, D. (2005). Enhancing the microbiological stability of malt and beer a review. Journal of the Institute of Brewing.)

Beer is inherently a microbial product, and microbial activity plays a significant role in shaping its sensory characteristics, ultimately contributing to its overall quality. While the fermentation of cereal extracts by Saccharomyces yeast is the most important microbial process in brewing, numerous other microbes can influence the entire brewing process. Despite beer's general inhospitable conditions for most bacteria due to its low pH, high CO2 and alcohol content, and presence of bittering agents, some beer spoilage bacteria, such as Lactobacillus spp., Pediococcus spp., Pectinatus spp., and Megasphaera spp., have adapted to grow undisturbed under these conditions. While these microorganisms usually do not pose health hazards to humans, they can cause off-flavors and lead to the loss of entire batches of beer. If contamination is suspected or detected, it is crucial to promptly investigate the entire brewing process chain to identify the source and take corrective actions to preserve the beer's quality.

In summary, maintaining strict microbiological quality control measures throughout the brewing process is vital for producing high-quality beer that meets consumer expectations. This involves monitoring and managing microbial activities to ensure the absence of spoilage microorganisms that can negatively impact the beer's flavor, aroma, and overall quality.

Microbiological quality control testing in breweries is essential for maintaining high product quality. The effects of microbial contamination, derived from organisms including bacteria, wild yeast and mould, can changes beer flavour and fermentation performance to gross flavour and aroma defects, turbidity problems and reduced yeast performance. Brewing beer involves microbial activity at every stage, from raw material to the packaging of beer. Most of these activities are desirable, as beer is the result of a traditional food fermentation, but others represent threats to the quality of the final product and must be controlled actively through careful management.

Beer, like any fermented food, is an immutably microbial product. Microbial activity is involved in every step of its process, defining the many sensory characteristics that contribute to final quality. While fermentation of cereal extracts by Saccharomyces is the most important microbial process involved in brewing, a vast array of other microbes affects the complete process. Microbial interdiction at every step of the barley-to-beer continuum greatly influences the quality of beer.

(Ref :-Faparusi, S. I., Olofinboba, M. O., &Ekundayo, J. A. (1973). The microbiology of burukutu beer.)

Therefore, in this study, our objectives were to reduce microbial contamination in fermentation stage & to find out the root cause analysis, 5 why for micro-organisms growth.

2.Materials And Methods

Materials

Laminar air flow, Micropippete, Incubator, colony counter, compound microscope, Autoclave, Membrane filtration unit, Distillation unit, Petri plates, Parrafin wax, Distilled water, PPE, Bunsen burner, Inoculation loop, Pipette tips, Forceps, Aluminum foil, Spreader

Media : Raka-Ray (RR), YMCA, WLD, PCA, WLN, MAC-CONKEY, YMC

2.1Process flow sheet for plating of sample

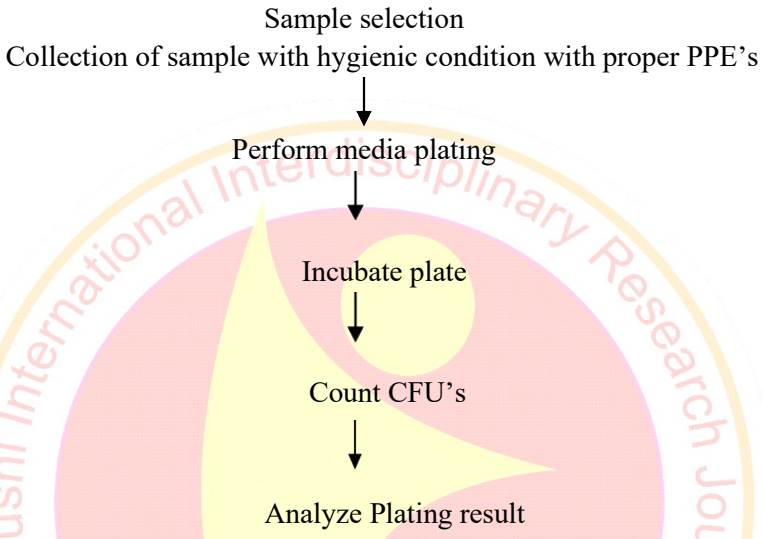

Fig:- **Flow sheet for plating of sample**

2.2 Microbiologcal analysis

Total plate count

PCA was suspending 23.5 grams in 1000 ml distilled water. One milliliter of every dilution become pour plated on PCA in sterile petri plates and incubates for 72 hours at 30-32°C. Finally of the incubation period the petri plates were eliminated for counting the developed colonies in cfu/ml. CFU were counted usage a colony counter.

Yeast &mould count

The RBCA media is used. Plates were set in a hatchery at 25°C for 120 hours and perception was accounted for in CFU/ml of the article the article

Total coliform count

The Violet red bile agar (VRBA) medium is used for total coliform detection, the medium was moved sterile petri dishes, and after that an example was filled it. Plates were set in a hatchery at 38°C for 24 hours and perception was accounted for in CFU/ml of the article.

(Ref :- Pattison, T. L., Geornaras, I., & von Holy, A. (1998) International Journal of Food Microbiology)

2.3 Contamination Control Strategies

This study identified critical factors contributing to contamination, leading to the development and implementation of effective control strategies :

a) Water Treatment Optimization: By enhancing water treatment protocols, by maintaining hygiene during chemical dosing and regularly maintenance of machinery & UV lamp, water quality improved, resulting in a reduced initial microbial load and minimizing the risk of introducing contaminants during the brewing process.

b) Yeast Handling Improvements: Implementing dedicated yeast handling equipment and rigorous

cleaning practices proved effective in reducing contamination from yeast.

c) Process-Specific Cleaning Protocols: Tailoring cleaning-in-place (CIP) procedures to the characteristics of fermenting vessels ensured a more thorough removal of residues and contaminants.

3. Result & Discussion

1. In Brewery the contamination found in the beer during fermentation that affects the flavor, pH, Haze, Yeast viability, Yeast consistency, off flavor, Fermentation velocity in the beer.After study found that there are following chances from where the contamination is carried Micro-organisms will thrive in the most inhospitable conditions. When they are deprived of their nutritional requirements, bacteria can often form spores which are more difficult to destroy than the active live bacteria. Consequently, they
2. Infect the beer from many different sources. The tables below identify the main sources of contamination.

Source of contamination	Comment
Water	The brewing water in the wort undergoes boiling as an essential step in the brewing process. Nevertheless, there remain potential risks of contamination, particularly during procedures such as Cleaning in Place (CIP) and the final rinse water stage.
Pitching yeast	Storing yeast may create conditions conducive to the growth of other microorganisms already present in the yeast slurry. This poses a significant challenge as contamination has the potential to spread throughout the brewery unless effectively managed through thorough plant cleaning and, in some cases, acid washing
Chilled Wort	Wort chillers and wort mains play a crucial role due to the nature of the wort. The heat exchangers, in particular, often encounter significant fouling, and inadequate cleaning can provide a protective environment for microorganisms. Wort, being rich in sugars, proteins, minerals, and oxygen, serves as a conducive medium for the growth of microorganisms.
Wort Airation	Wort aeration system required free from contamination.
Yeast handling tanks	This can be a source of contamination because of nature of yeast.
Fermenting vessels/ Unit tank	Difficult to clean due to left over residue of yeast and hops. FV/UTs are the major sources of contamination because of the storage time of beer.

Samples were collected from multiple sources including water, cooled wort, Air used for aeration, yeast handling tanks, pitching yeast and fermentation vessels.

The microbial load was quantified using media plating techniques for both bacteria and fungi.

2. Sampling Results

In the Brewing Water, Cooled wort, Harvested yeast, CIP Sample the contamination is found

The following are the Root Cause & 5 Why Analysis For Microbial Contamination found in different sources:

A. Root Cause Analysis for water contamination:

Problem Statement: Microbial growth is occurring due to water contamination.

Immediate Cause: Presence of microorganisms in the water.

Underlying Cause: Inadequate water treatment and sanitation procedures.

Root Cause: Lack of proper water treatment protocols and monitoring.

5. Why Analysis:

i) Why is there microbial growth in water?

Because microorganisms are present in the water.

ii) Why are microorganisms present in the water?

Because the water treatment process is not effectively removing them.

iii) Why is the water treatment process not effectively removing microorganisms?
Because the treatment methods and equipment might be insufficient or improperly maintained.
iv) Why are the treatment methods and equipment insufficient or improperly maintained?
Because there might be a lack of regular maintenance and updates to the water treatment system.
v) Why is there a lack of regular maintenance and updates to the water treatment system?
There might be inadequate resources, or a lack of awareness about the importance of maintaining the system.

By addressing the root causes identified through the 5 Whys analysis, such as improving water treatment methods, ensuring proper maintenance, and raising awareness about the importance of water treatment, you can work towards mitigating microbial growth related to water contamination.

B) Root Cause Analysis for CIP sample:

Problem Statement: Contamination is occurring in the CIP sample.
Immediate Cause: Ineffective CIP process.
Root Cause: CIP process design and execution need improvement.

5 Why Analysis:

1.Why is contamination occurring after CIP?
Because theCIP process is not effectively removing contaminants.
2.Why is the CIP process not effectively removing contaminants?
Because the cleaning solution might not be reaching all areas of equipment.
3. Why is the cleaning solution not reaching all areas?
Because there might be inadequate flow or pressure in certain parts of the equipment.
4. Why is there inadequate flow or pressure in certain parts of the equipment?
Because the equipment design might not be optimized for even distribution of cleaning solution.
5.Why is the equipment design not optimized for even distribution?
The equipment might not have been designed or updated with the latest insights into fluid dynamics and cleaning efficiency.

C) Root Cause Analysis for cooled wort contamination:

Problem Statement: Presence of microorganisms detected in cooled wort, impacting the quality of the brewing process.
Immediate Cause: Detection of microbial contamination in the cooled wort samples.
Underlying Cause: Ineffective cooling and aeration process allowing for microbial growth and contamination.
Root Causes:

a. Poor Aseptic Handling: Inadequate aseptic handling practices during the cooling phase, such as exposure to non-sterile surfaces, could introduce microorganisms.
b. Insufficient Aeration: Lack of proper aeration during the cooling process may create an environment conducive to microbial proliferation.
c. Contaminated Cooling Equipment: The cooling equipment, such as heat exchangers or pipes, may be contaminated, serving as a source for microbial introduction.
d. Temperature Fluctuations: Fluctuations in cooling temperatures may create pockets within the wort that are not adequately cooled, promoting microbial survival.

5 Why Analysis of Contamination found in Cooled Wort:

1. Why were microorganisms found in cooled wort?
Because the cooling process might not be effectively reducing the temperature to levels that inhibit microbial growth.

2. Why is the cooling process ineffective in reducing temperature?
   Because the cooling equipment, such as heat exchangers, may not be functioning optimally, leading to insufficient heat exchange.
3. Why is the cooling equipment not functioning optimally?
   Because there is a lack of regular maintenance and cleaning, resulting in the buildup of contaminants on the heat exchange surfaces.
4. Why is there a lack of regular maintenance and cleaning of the cooling equipment?
   Because a robust preventive maintenance schedule and cleaning protocols have not been established or consistently followed.

D) Root Cause Analysis for pitching yeast:

Problem statement: Microorganisms were found in the pitching yeast, compromising the fermentation process.

5 Why Analysis of Microorganism Contamination in Pitching Yeast:

1. Why were microorganisms found in pitching yeast?
   Because the yeast propagation or storage conditions may not be adequately sterile.
2. Why are yeast propagation or storage conditions not adequately sterile?
   Because the equipment used for yeast handling and storage might not be properly sanitized between uses.
3. Why is the equipment not properly sanitized between uses?
   Because there may be gaps or lapses in the cleaning and sanitation procedures, allowing for the persistence of contaminants.
4. Why are there gaps or lapses in the cleaning and sanitation procedures?
   Because there is a lack of rigorous training and supervision regarding yeast handling protocols, leading to inconsistencies in execution.

Based on the root cause analysis and 5 Whys, here are some potential strategies for improving the CIP process to reduce contamination:

- Enhance Equipment Design:Collaborate with engineers to optimize equipment design for even distribution of cleaning solution, minimizing dead spots.
- Monitor Flow and Pressure: Implement sensors to monitor flow rates and pressure throughout the CIP process, ensuring adequate coverage.
- Review Cleaning Solutions: Evaluate the effectiveness of cleaning agents and adjust formulations if necessary to ensure thorough cleaning.
- Update CIP Protocols: Develop detailed CIP procedures tailored to each piece of equipment, including flow rates, pressure settings, and cleaning durations.
- Regular Maintenance: Establish a regular maintenance schedule to check and calibrate equipment, ensuring consistent performance.
- Employee Training: Train staff to understand the importance of proper CIP execution and the impact on contamination prevention.
- Validation and Verification: Implement validation procedures to confirm the effectiveness of the CIP process, including swab testing for cleanliness.
- Continuous Improvement: Establish a feedback loop for process improvement, gathering insights from staff and analyzing post-CIP contamination level

Table 3.1.2:Results of colonies found in particular media. (Monthly avg. data)

SAMPLE NAME	MEDIA NAME	1st. Month (Avg.)	2nd Month (Avg.)	3rd Month (Avg.)	4th Month (Avg.)
BREWING WATER	**WLN**	**50**	**45**	**8**	**1**
	PCA	**10**	**9**	**5**	**0**
CIP PLATING	**WLN**	**TNTC**	**40**	**17**	**0**
COLD WORT	**WLN**	**17**	**17**	**8**	**2**
	MAC-CONKEY	**12**	**10**	**4**	**0**
HARVESTING YEAST FROM YST TANK	**WLD**	**25**	**12**	**8**	**1**
	YMC	**10**	**6**	**2**	**0**
FERMENTATION SAMPLE	**WLD**	**24**	**15**	**6**	**1**
	RR	**0**	**0**	**0**	**0**
	YMC	**12**	**8**	**2**	**0**

Fig 3.1.3:- Monthly Average data of analytical & Microbiological parameter for particular month.

Sr. no	Parameter	For 1st month (Avg.)	For 2nd month (Avg.)	For 3rd month (Avg.)	For 4th month (Avg.)
1	**pH**	**4.07**	**4.11**	**4.15**	**4.18**
2	**Haze**	**0.65**	**0.61**	**0.55**	**0.48**
3	**Yeast Viability**	**95%**	**96%**	**96.5%**	**97%**
4	**Yeast consistency**	**62%**	**64%**	**65%**	**66 %**
5	**Phenolic off flavor score out of 10**	**3**	**3**	**2**	**1**

Conclusion

The study's findings demonstrate the intricate interactions that occur between various fermentation stages and how these interactions affect microbial contamination. Although the initial water quality and boiling successfully decreased the microbial loads, problems surfaced when handling the yeast and cleaning the fermenting vessel. Potential risks to product quality include the presence of residual microbes in yeast handling tanks and the challenge of cleaning fermentation containers. Treating the underlying causes was essential to the effectiveness of pollution control measures. Water treatment process optimization reduced pollutant introduction and increased water quality. Improving procedures for handling yeast decreased the possibility of yeast contamination. Cleaning procedures designed specifically for fermenting vessels highlighted the importance of customized methods for efficient decontamination. This study emphasizes how crucial it is to use a thorough strategy to reduce the amount of microorganisms present during fermentation. It highlights how crucial it is for engineers, brewers, and microbiologists to work together to develop best practices and continuously improve procedures. Breweries can guarantee the production of high-quality, uncontaminated fermented goods that satisfy industry requirements and consumer expectations by implementing and modifying contamination control measures. "Yeast and hop residue left behind makes it challenging to clean fermenting vessels and unit tanks." Because of how long beer is stored, FV/UTs are significant sources of contamination."

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