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Production of ENA (Extra Neutral Alcohol) from molasses of sugarcane

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Abstract
Alcohol is a less poisonous and colorless chemical compound made of grain, it can be used as a fuel instead of gasoline. In some modern factories, it is also used as fuel, due to limited natural fuel, Ethanol is also an alternative means. In general use, it is presented as a beverage alcohol. Its chemical formula is depicted in various forms such as EtOH, CH3CH2OH and C2H5OH or its empirical formula C2H6O (which shares it with diethyl ether). Ethanol can be prepared by the fermentation of jar. After crystallization of sugarcane juice, the remaining mother is alcohol. It is dark brownish sticky liquid. It is a dark colored liquid made of sugarcane juice.
Ethanol can be prepared by fermentation of sugar made from sugarcane juice on an industrial scale. It is dark brownish sticky liquid. The molasses contain approximately 50% fermentable sucrose glucose. Ethanol is a volatile, flammable, clear, colorless liquid. Ethanol is a good solvent. It is also used in the form of disinfectants, beverages, antic fuel, fuel, depression and chemical intermediates. It can be made by fermentation process of the material Junk, ENA, Fermentation Technology, Sugarcane.

Keywords: molasses, ENA, fermentation technology, sugarcane

Introduction
Ethanol was fermented using 24 hours for development to carry forward the fermentation process.... to produce ethanol with final sugarcane molasses and to evaluate its quality. Urea was used as a nitrogen source and added molasses mash to 0.15%, 0.5% and 0.25% (w / v) for different concentrations.
Additional neutral alcohol, or ENA, is a colorless grade of alcohol without any impurities. There is neutral smell and taste in it, and usually 96% alcohol is by volume (ABV).... it is used to produce alcoholic beverages such as whiskey, vodka, gin, cane, liqueur and alcohol.
Fermentation technology is an area in which microorganisms and enzymes are used to produce compounds that apply to energy, materials, medicine, chemical and food industry.

Material and Method
Process Department
i) Procurement of Raw Material
As per instructions from HO Molasses sample is collected from respective sugar mills for quality checks.
The Molasses sample is checked in the process lab for Brix, TRS, Sludge and VA.
Quality Report of the Molasses sample particularly TRS send to H.O for further course of action
After confirmation from H.O. apply to State Excise Commissioner U.P. for allotment of the required quantity of molasses from the respective sugar mill.
Before lifting of Molasses from the concerned Sugar Mill all relevant papers like Excise allotment and Molasses Pass Book send to the sugar mill.
Authorized Tankers are placed to respective sugar mill for molasses loading.
Check all the relevant papers of loaded tankers before entering the factory gate by distillery representative and inform the same to the unit excise authority.
Before unloading the tankers each tankers molasses sample is checked for Brix by Refract meter by distillery representative to check for adulteration.
If the molasses quality deviate or not up to the mark from sugar mill side then further supplies are stopped with zero compromise approach.
After quality confirmation weighment of the loaded tanker is done in presence of distillery representative, excise authority and security representative.
Weight of the loaded tanker is checked against the MF-4 gate passes issued by the sugar mill excise authority.
If found ok then record is entered in MF-12 and MF-6 excise registers respectively and the tanker is unloaded at unloading pit.
Weighment of tankers is done again after unloading and record entered in MF-12 and MF-6 register.
Finally the molasses is transferred from the unloading pit to the molasses storage tanks (i.e. MT-4 and MT-5)

Process
Process consist of mainly four sections, Fermentation, Distillation, Effluent Treatment Plant, Ware House

ii) Fermentation Section
Fermentation section comprises of mainly two parts:
Process Laboratory where all analysis related to Molasses, Fermented wash, Boiler Water, ENA strength and losses, Yeast culturing, cell count and Microscopy are carried out.
Fermentation House where yeast propagation (Culture Vessel and Pre-fermenters) and fermentation process is carried out.
There are four types of fermentation available- Continuous, Semi Continuous, Batch type & Fed Batch type.

Due to the poor quality of Molasses in the region with TRS being on a lower side we have adopted Fed Batch type Fermentation Process

Fermentation process can be carried out in two modes Low Brix Mode and High Brix Mode but due to the following advantages and as a part of innovation we have adopted High Brix Fermentation at Rosa.

iii) Benefits of High Brix Fermentation

Higher Production, Less steam consumption, Less effluent generation, Saving of molasses due to less culture requirement, Higher fermentation efficiency

Maximum capacity utilization, Subsequently we have adopted the following practices to achieve High Brix Fermentation.

iv) Process Laboratory (Lab Yeast Culture Preparation)

As a part of our innovation we have In House developed Yeast Strain for high Brix fermentation. The yeast culture is purified on weekly basis and preserved at 4.0Deg C in the freezer. The Yeast culture is regularly tested for Tolerance at High Alcohol & Sugar %.Then proper selection and isolation of yeast strain is done. Next a master slant and working slants are prepared. Twice a week the fresh slant is changed.

We make it a point to maintain sterile and aseptic conditions in the microbiology lab which include use of laminar flow table, UV light, transfer under Flame, Spirit Wash etc. Each flask is properly studied for microbiological activities under the microscope.

v) Fermentation House

We transfer the lab yeast culture into the Culture vessel. Normally, 3 No's of culture vessels are used for yeast propagation. At Rosa we have developed an In House System in which we utilize only a single culture vessel i.e. CV3 in order to avoid chances of bacterial growth in two stages and reduce time cycle. As a result we are able to get pure yeast culture (approx. 3000 liters) in a lesser time. For further increase in Yeast cell Biomass the fresh yeast culture from the Culture vessel is transferred to the pre fermenters. Yeast cell count (YCC) has a important role in High Brix Fermentation so the culture vessel and Pre- Fermenters are checked for Yeast cell count and the cell count is maintained at 2.0 -2.5 * 10^8 per ml of yeast before transferring the culture to the next stage. When Yeast culture in the Pre- Fermenters is ready fermenters filling is started in Fed Batch mode by adding measured quantity of water and transferring yeast culture from the PF to the fermenters. Simultaneously measured quantity of molasses is added to the fermenters and the fermenters are set up. Fermentation process completes in about 20 hrs. And temperature is maintained at 32-34 deg. C by the help of PHE's.Finally fermented wash with 8-9% alcohol is obtained which is then transferred to Wash Holding Tank.

vi) Sterilization and Cleaning practices at Fermentation House

Culture Vessel is cleaned by using Spent Lees which is available at 100 Deg C and Caustic solution (Strength 5% w/v).After cleaning, the Culture Vessel is sterilized by Formalin vapors. As Yeast propagation is an aerobic process so for the same we utilize sterile air in CV3 and Pre-Fermenters. A very important Practice followed by us is sterilization by formalin vapors of all air lines, Filling Lines, Transfer lines in each and every shift to avoid any bacterial contamination. All Fermentation culture activities (CV3 & PFs) is thoroughly monitored under microscope during every shift and if any abnormality/ contamination observed – corrective action is taken.

vii) Fermentation Contd.

Initially M/s PRAJ had given yeast vessels only for pasteurization of wort. We have come up with an in house modification in which Culture Vessel No 3 is now with a wort sterilization system in order to avoid contamination in yeast culture. As a result we get pure yeast culture for Pre Fermenters which help us in enhancing our fermentation efficiencies. As a part of good practices we make it a point optimizes our usage of nutrients and enzymes in according to process requirements. In addition we thoroughly monitor the sugar loading in Fermenters & PFs in order to avoid sugar losses. Above two points contribute substantially for achieving higher efficiencies in fermentation.

viii) Distillation Section

At Rosa we have state of the art Multi Pressure Wash to ENA Plant of 30 KLPD capacity supplied by M/s Praj industries. We have six columns in our MPWE plant

1) Analyzer Column
2) Pre-Rectifier Column
3) Extractive Distillation Column
4) Rectifier cum Exhaust Column
5) Fuel Oil Concentration Column
6) Simmering Column

1) Analyzer column

This column is operated under vacuum to avoid the chocking. First fermented wash fed in Analyzer column, where alcohol strips off from the fermented wash and discharging the rest waste material as spent wash which comes out from the bottom of analyzer column. Alcohol water vapor from top of the column is fed to the Pre rectifier column.

2) Pre rectifier column

Pre rectifier column is operated under vacuum. The purpose of this column is to remove low boiling impurities like aldehyde Esters and uncondensed gasses etc. Rectified spirit of 95% v/v alcohol of Pre rectifier column is fed to the ED column.

3) Extractive distillation column

This column is operated under atmospheric pressure with extractive mode of operation and is principally used for removal of high boiling impurities.

The RS from the pre- rectifier column is fed in the middle part of the column and dilution (D.M Water + Spent Lees) is done on the top tray of the column. Vapors of ED column top are passed to the Simmering Reboiler for heat recovery and collected in ED condensate tank; from there they fed to FOC Column.

ED Column Contd...

Alcohol water mixture from ED column bottom is fed to the Rectifier column.

4) Rectifier cum exhaust column
This column is operated under high pressure and principally used to concentrate the alcohol and to draw ENA. The vapors from column top are used to heat the analyzer column and bottom of the column comes out as spent lees.

5) Simmering column
The ENA draw of Rectifier column is fed to the simmering column this column is operated under atmospheric pressure at high reflux principally to remove Methanol and Di-acetyl impurities from ENA maintaining the strength of ENA.

6) Simmering column contd..
Final product draw i.e. ENA (Extra Neutral Alcohol) passed through ENA Cooler and collected to Receivers Tanks.

7) FOC column
This column is operated under atmospheric pressure and used for removing all impurities of fuel oils final draw of FO fed to PRC FO washing.
Final product ENA should have strength b/w 94 - 96% v/v and sensory score not below than 6.0 as per USL standards.

ix) Effluent Treatment Plant
Distillery effluent resulting from cane molasses based distillery is one of the most polluting Industrial effluents. The pollution effect of Distillery wastes is due to high B.O.D. and color discharge of untreated distillery effluent into water course resulting in rapid depilation of oxygen content of water making the environment unfair for marine life. The effluent also imparts color and odor to the water and result in unsightly condition in the water course.

x) ETP Process Description
Effluent Treatment Plant comprises of three steps:
Primary Treatment or Bio Methanation, Reverse Osmosis Plant, Bio Composting

Primary Treatment or Bio Methanation:
The Effluent coming out from the distillery is termed as spent wash. Spent wash is transferred from distillation plant to spent wash settling/holding tank through primary clarifier. The spent wash has COD approx. 140000 to 150000 ppm, TSS- 15000-20000 ppm, pH 4.0 to 4.5 & temperature 40-45°C.From settling/holding tank spent wash is fed to buffer tank, through yeast settling tanks. In buffer tank we maintain the COD of spent wash feed about 105000-115000 by addition of raw water & mixing of digester overflow. From buffer tank we fed the same to the bottom of digester. Maintain the digester pH 7.3 to 8.5 & buffer tank pH 6.5 to 7.5.Maintain the digester temperature 36-39°C & buffer tank temperature 40-42°C.

There are two phase of reaction:
Phase I- in Buffer tank: - Acetic acid formed.
Phase II- in Digester:- Acetic acid break down in methane & CO2 $C_6H_{12}O_6+H_2O+2(O)$ $2CH_4+4CO_2+2H_2$

The effluent while treatment inside the digesters produces a mixture of Carbon di-oxide and Methane (40:60%) termed as Biogas, which is collected in the gas holder unit installed separately near the digester, through the overhead pipeline coming from the top of digester. From the gas holder the gas is send to Boiler where it is used as fuel.
Under shutdown Bio Gas is burnt in the flare stack.
The treated overflow from the digester comes out to aeration tank to remove the interrupt gases. The Treated effluent then flows from aeration tank to R.O holding tank no-1 & overflow of the same taken in R.O. holding tank no-2. (Feed For R.O Plant)

xi) Reverse Osmosis (RO) Plant
RO Plant is basically utilized for reducing Effluent volume. The stepwise process is described as under:The treated spent wash (T.S.W.) is pumped from R.O holding tank no 2 to the acid dosing tank where the addition of acid is done to maintain pH of the treated effluent from 7.8 to 7.2.From there the treated wash is pumped to the filters (viz sand filters and Mash filters). The suspended matter present in the wash gets arrested in the filters. Then filtered effluent is passed through the HPA membranes system which is two in numbers and installed in parallel fashion. From both of these membranes systems the effluent is separated into two streams i.e. Reject and Permeate. Permeate is the part of effluent which is separated to colourless water. It is collected in the Permeate collection tank equipped with the degasification unit. Here degasification of permeate is done and then it is send to the plant for other uses. The reject of both the system is again passed through the 3rd set of HPA membranes system installed in the series of other two. In this 3rd system the reject is again treated by which more permeate is recovered, and is send to the permeate collection tank. The reject coming from High Pressure Pump No. 3 is send to Lagoon, from where it is used in Bio-composting to lead the Zero discharge. By this means clear water i.e. 45-50% of the total effluent is recovered in form of permeate and the rest part 50 % as Reject and in this way 50-55 % volume of the total effluent is reduced.

xii) BIO Composting
Distillery meets out the standards of Zero liquid discharge by adopting Bio-compost process. In this process the reject of R.O. plant which is collected in Lagoon. The Brief description of the process is as follows:
The basic raw material used for bio composting is press mud which is purchased from the adjacent sugar mill. The press mud is transported from sugar factory to press mud storage yard and stock for the entire year is maintained. The press mud from press mud yard is shifted to bio-compost yard in a standard manner. In this manner, the press mud is stacked in triangular shaped linear fashion with the height of 1.2 – 1.5 metre and width of 3.0 metre. This is called as windrow. A gap of 3 metres is kept between the two windrows for the running of aero tiller. The press mud in the windrow has around 70% moisture content. The windrow is kept idle for two days and moisture is allowed to reduce to 60%. Aero tiller is a machine with automatic-drive and used for spraying effluent and mixing/aeration of press mud laid in form of windrow for bio-composting. Bio composting is an exothermic biological process hence the heat evolves out resulting in an increase in temperature and decrease in moisture level of the windrow hence the temperature and moisture content of the windrow is recorded on daily basis. When the moisture level comes at 55% and temperature around 65 ^{0}C then effluent is added to raise the moisture. The moisture is maintained in between 50% - 60% during the process. The Aero tiller machine is operated daily to mix the effluent and to aerate the press mud to stimulate

microbial activity. This process runs daily up to 50 days. Eventually the rise in temperature stops which indicates that the Bio-composting process is complete and the press mud has converted into bio compost. Now this bio-compost is allowed to keep idle and regular machine is operated over it for the reduction of moisture and it is left when the moisture level comes near 35%. The total Bio compost cycle takes a period of maximum 60 days.

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