DPR on Expansion of Sugar, Cogen & Ethanol Plant

At
Bambawade, Tal - Shahuwadi,
Dist. Kolapur, Maharashtra

Prepared for
M/s. Athani Sugars Limited.
Vishnuannagar, Post – Navalihal 591 234,
Tal-Athani, Dist – Belgaum, Karnataka
Preamble

Shri Shrimant Balasaheb Patil is the Chairman and Managing Director of the factory. He entirely devote to towards establishment of lift irrigation schemes and brought hundreds of acres of dry land under irrigation, enabling farmers to grow commercial food crops and raise their standard of living. During the year 1993-94 &94-95 he observed that abundant quantity of cane growing in Athani Taluka was not entirely crushed by Ugar Sugar works Ltd, as a result the farmer were terribly suffered to find alternative sugar factory to send their cane. To overcome this problem he took bold decision to establish a sugar factory in Athani Taluka. Mr. Patil with the kind co operation of the farmer and with help of devoted workers successfully established 2500 TCD Sugar plant at Madhabavi in Athani Taluka during 2001. Subsequently factory has expanded the crushing capacity form 2500 TCD to 4500 TCD during 2005-06 season.

The factory has also installed 60 KLPD distillery and 24 MW cogeneration plant.

Recently, ASL has taken Udaysinhrao Gaikwad SSKL on lease basis for 22 years starting from year 2014-15. The leased unit is situated at Bambawade, Tal – Shahuwadi, Dist – Kolhapur, Maharashtra and will be known as ASL Unit – II.

ASL Unit II has installed sugarcane crushing capacity of 2500 TCD. Now, the company is proposing to expand sugarcane crushing capacity from 2500 TCD to 8000 TCD, install new cogeneration plant of 35 MW and distillery/ethanol plant of 80 KLPD. This is in the view of excellent cane availability in the nearby area.

Company Profile

As already mentioned Mr. Shrimant B Patil, age 58 years, has been the Chairman & Managing Director and the driving force of the Athani Sugars Limited. He has vast experience in Sugar industry. He has completed Bachelor of Science (Agricultural) from Rahuri University.

The promoters of ASL are already successfully operating their sugar unit at Vishnuanna Nagar, Tal- Athani, and Dist – Belgaum.

The factory performance at Vishnuanna Nagar unit is as follows:

<table>
<thead>
<tr>
<th>Year</th>
<th>Cane crushed in tons</th>
<th>Season days</th>
<th>Sugar produced in tons</th>
<th>Average recovery of sugar % cane</th>
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<td>137</td>
<td>649454.0</td>
<td>10.51</td>
</tr>
</tbody>
</table>
The Promoters & Technical Team

As already mentioned Mr. Shrimant B Patil, age 58 years, has been the Chairman & Managing Director and the driving force of the Athani sugars Limited. He has vast experience in Sugar, ethanol and power industry. He has completed agricultural sciences from Rahuri University.

Mr. Shrinivas Patil and Mr. Yogesh Patil are the whole time directors of ASL.

Proposed Project Scheme

Sugar Factory at Bambawade will be expanded from 2500 TCD to 8000 TCD (expansion of 5500 TCD) by modernizing and adding new machineries. The required sugarcane is partly available in the nearby area and balance sugarcane is being developed and the development work is in full swing.

ASL is proposing to install new cogeneration plant of 35 MW to cater total requirement of steam and power. Surplus power will be fed to MSETCL grid.

ASL is also proposing to install 80 KLPD distillery / ethanol plant. This plant is expected to operate for 270 days per year.

Technology Used and Environment Protection

Addition in the ETP plant will be made to cater the additional effluent generated from the sugar & cogen plant. Advance technologies will be used like ESP so as to maintain the safe environment. Distillery will operate on molasses as feed stock during season and on saved / purchased molasses as feed stock during off-season. With 45% fermentable sugar in molasses one ton of molasses, will yield 265 lit of total spirit or 255 lit of ethanol. To produce either BISTIL or Continuous fermentation system can be used. Both have their own advantages and disadvantages. Now a days’ Continuous fermentation system is mostly used due to its simplicity and produces quality product. The process will primarily use continuous fermenters, multipressure distillation along with molecular sieve technology to produce good quality RS, ENA and Ethanol. Multi-stage evaporation will be used to reduce the spent wash quantity from 8-10 liters to about 2.5 liter. Such concentrated spent wash will be burnt in the boiler (Incineration boiler technology). There will insure zero pollution discharge from distillery.
Technical and Financial Viability of the Project

With sustained raw material availability for the project on long term basis and best technologies available to produce excellent quality of various products technically project is feasible. Market for these products is excellent with very good price.

Financial viability of the project is worked out and shows excellent financial feasibility. Assumptions made are on conservative side and any increase in the crushing of the sugar mills and increase in prices of the final product will enhance the viability further.

Conclusions

Hence, considering sustained availability of raw material, excellent market and price for finished products, flexibility of producing variety of different products with market and price trend makes this project extremely feasible. Hence, it is recommended to go ahead with the project. This project will be win-win situation for promoters, financial institutions and farmers in this area.
# Project Brief

| Name of the Promoter company | Athani Sugar Limited  
| Athani  
| Athani Sugars Limited  
| Bambawade, Tal - Shahuwadi,  
| Dist. Kolapur, Maharashtra |

| Factory Site |  
|  

| Constitution & Type | Public Limited Company  

| Products & By Products | 1. Sugar  
| 2. Cogeneration power  
| 3. Alcohol conforming to ISI grade – I 323  
| 4. Anhydrous alcohol confirming to ISI 321  
| 5. ENA confirming to ISI 6613  
| 6. Fusel oil  

| Installed Capacity of the Project | 8000 TCD Sugar (Addition 5500 TCD Expansion)  
| 35 MW cogen plant (New)  
| 80 KLPD distillery plant (New)  

| Working days per annum | Sugar plant : 160 days  
| Cogen Plant: 210 days  
| Distillery Plant: 270 days  

| Raw material requirement per annum | Sugar cane : 1280000 MT  
| Bagasse : 358000 MT  
| Molasses : 85000 MT  

| Steam requirement per Hour | 135 MT for sugar  
| 190 MT for total cogen  
| 25 MT for distillery  

| Power Requirement Per Hour | 8400 kW for Sugar  
| 1200 kW for distillery  

| Water requirement per Day | 232 m³/day sugar plant  

| Financial requirement Total | Rs 378 Cr  

| Cost of Environment Protection | Rs. 160 lakh per annum  

PROJECT LOCATION, LAND AND INFRASTRUCTURE

The sugar plant of ASL is located at Bomawaade, Tal Shahuwadi, Dist. Kolhapur of Maharashtra State. The plant is at a distance of 35 km from Kolhapur city.

The site is 1 km away from Kolhapur-Ratnagiri highway. Nearest district is Kolhapur (35 km) which is also nearest airport. Nearest railway station is at Kolhapur.

Nearest water source for the plant is Warana river which is 3.5 km away from the plant. A pipeline is laid for the water supply to the plant.

Total land of 80 acres is available at the site. Land available is sufficient to in-house proposed expansion. Necessary facilities such as roads, street lights and green belt etc are also established.

RAW MATERIAL AND SUSTAINABILITY OF PROJECT

Sugar Plant

Raw material for the plant is sugarcane is available in ample quantity for the plant. The sugar factory requirement at 100% capacity is 12.80 lakh MT. Sugar factory is situated in the sugarcane growing area close to various sources of water in command area. More than 14 lakh ton sugarcane is available for the plant in the villages in command area within 40 km radius.

Cogen Power Plant

Bagasse is the main source of fuel that will be available from the sugarcane crushing of 12.80 lakh MT. This is purely green source of fuel and will not pose any pollution to environment. The plant will operated for about 210 days per annum with 160 days in season and 50 days in off-season.

Distillery/Ethanol Plant

Average percentage for molasses recovery is taken as 4.5%. With sugarcane crushing of 12.80 lakh MT the total molasses available will be 57600 MT. With own molasses the distillery plant can operate for 185 days out of 270 days planned. For balance days of operation molasses of about 27400 MT shall be procured from nearby mills. Hence, raw material for the plant will be available on sustainable basis over the long period and sugar factory will not face any problem on this front.
Plant Design Basis, Balances and Process

Sugar Plant

Present sugar crushing capacity is 2500 TCD and will be expanded to 8000 TCD. Sugar factory will be tuned to achieve more efficiency along with low steam and power consumptions. Following parameters and their basis are considered while designing the plant.

1. Crushing Capacity:
   - Plant Capacity - 8000 TCD (On 22 hr basis)
   - Crush rate - 364 tch
   - Gross Season Duration - 160 days

2. Quality of Cane
   - Pol % cane - 14%
   - Average Fibre - 14%

3. Sugar plant performance
   - Reduced mill extraction - + 96
   - Reduced boiling house recovery - + 90
   - Imbibition (Water+Centrate) - 220-250 % of Fibre
   - Average moisture % mill wet bagasse - Not more than 48%
   - Steam Consumption - 38-40 % on Cane

4. Product Sugar - Plantation white
   - Manufacturing Process - Double sulphitation

5. Sugar quality:
   - Type - Plantation White Sugar
   - Pol - 99.8 % max
   - Moisture - 0.04 % max
   - Colour, ICUMSA units - < 70 ICUMSA.

6. Byproducts generation
   - Bagasse production – 30 % on cane
   - Molasses production – 4.5% on cane
   - Press mud production – 4% on cane

To achieve the parameter advanced technologies with power saving equipments will be erected. Two major sections milling and boiling house will be focused for achieving performance and accordingly the design parameters are set.

Milling Plant

In milling section following modifications and additions will be required.

1. Addition of new cane unloaders and feeder tables
2. Modification of cane carrier to suit 364 TCH crushing
3. Replacement of fibrizor with motor
4. Addition GRPF and one mill along with motors
5. Modification in rake carriers to suit new mills
6. Modification of juice screen
7. Modification in inter-rake carriers
8. Modification in bagasse elevator
9. Replacement of suitable juice pumps

Above modifications and additions in respective equipments are required to be done to achieve 8000 TCD crushing.

Boiling House

1. Replacement of juice flow meter and weighing scale to suit flow
2. Addition of new juice heaters along with suitable piping
3. Addition of juice sulphiter of suitable capacity
4. Sulphiter juice pumps
5. Modification/addition of juice clarifier
6. Addition/replacement of juice pumps
7. Addition of vacuum filter
8. Addition and rearrangement of evaporator sets with suitable piping
9. Addition of syrup sulphiter
10. Addition of vacuum pans
11. Modification in spray pond
12. Addition of crystallizers
13. Addition of centrifugal machines
14. Suitable additions and modifications in sugar house.
15. Expansion of Effluent treatment plant to suit treatment of additional generated effluent

All the equipments installed will be suitable to maintain high efficiency and State and Central pollution control norms.

Sugar Manufacturing Process

Sugarcane:
Cane is harvested at the field quality cleaned cane is transported to the factory cane yard.

Cane Yard:
Cane is weighed at the yard without error. Yard balance is maintained as equal to 2-3 hours rushing rate with respect to the factory capacity. Spillage of cane may be avoided. If tops are more, it may be removed. If there is any error in cane weighment, it should be corrected then and there.

Cane Carrier:
Weighed cane is unloading into the cane carrier by mechanical means. Overload to the cane carrier may be avoided by using feeder table for uniform feeding.

Mill House:
The weighed cane is fed to cane carrier with the help of cane un loaders. The cane carrier takes the cane to milling units via kicker, chopper, leveler, and fibrizor. The kicker controls the height of cane blanket in the carrier. The chopper and leveler cut the cane in to small pieces. And finally the fibrizor or shreds the cane pieces. This is called prepared cane. The milling unit has four mill tandem
each mill consist of three rollers namely feed, top and the discharge. Prepared cane is fed to first mill and from first mill primary juice (without any addition of water) is extracted. The bagasse coming out from the first mill is fed to second mill and so on. The last but one mill the imbibition water at the rate of 250-275% on fiber with temperature 65-70 0C is added. The lighter juice extracted from the last mill is added to previous mill and the juice extracted in that mill is passed to the previous mill. Thus the system is known as compound imbibition system is followed for getting good mill extraction. The roller RPM is maintained 4.5 –5.0 and the hydraulic pressure is maintained at 108 – 200 kg/cm2 g for better extraction. About 95-96% of sucrose is extracted in the mill juice from the cane. The final solid called Bagasse goes to boilers and juice goes to processing section through DSM screens. The final output bagasse from fourth mill contains 2.2% of sugar and 50% moisture. This bagasse is supplied to the boiler unit through rake elevators.

**BOILING HOUSE:**
Clarification, Evaporation and Crystallizations are taking place in the Boiling House.

I. CLARIFICATION:

a) Juice Weighing Scale:
Mixed juice form the mills is weighed accurately with automatic juice weighing scale and discharged into raw juice receiving time. Filtered juice from vacuum filter is also added with raw juice in the raw juice tank.
Mixed juice pH -5.2 – 5.4
Mixed juice dirt % -0.30-0.40%
To correct the error in weighment of juice weight of juice per tip is checked every day. Clarification is nothing but removal of maximum and coloring matter from raw juice to get clear juice to produce better quality sugar minimum final molasses purity. Whenever the time permit apart from clearing period, raw juice tank should be washed and sand deposited in the raw juice tank should be removed to avoid carryover of the sand to the process. Ortho phosphoric acid is added to maintain 275-325 ppm of phosphate in raw juice before clarification.

b) Raw juice heater (Primary juice heater):
Raw juice is heated to 65 - 70 degree C. by second or third vapor in order to avoid Inversion, to kill microorganisms and for better reaction with of lime and SO2 gas at the reaction vessel i.e., maximum formation if calcium sulphate may be more at this temperature and thereby maximum absorption of coloring matter and other non-sugar with calcium sulphate may be more.

c) Juice Sulphiter (Reaction Vessel):
Raw juice at 65-700C is mixed with milk of lime to raise the pH to 9.2 - 9.5 and then SO2gas is passed to reduce the pH to 7.3 - 7.4. This condition should be maintained to remove maximum non-sugar and coloring matter from the juice. The retention time of the juice sulphitation may be in the range of 10-12 minutes. Brix of the milk of the lime added into the juice may be in the range of 8-10 brix. Milk of lime should be washed and sand deposited in the raw juice tank should be removed to avoid carryover of the sand to the process. Ortho phosphoric acid is added to maintain 275-325 ppm of phosphate in raw juice before clarification.

d) Treated juice heater (secondary juice heater):
Treated juice from juice sulphiter is again heated to 1.2 - 1.40C to get its point at the treated juice heater by vapor from SK 1 and if necessary by exhaust as correction heater. Depending upon the brix % of the mixed juice, the temperature may be maintained in the juice heater.

e) Clarifier (Dorr):
Juice from treated juice heater is pumped through splitter box into the clarifier for setting is nothing but removal of coloring matters and non-sugar as solids (Flocks) from juice to get clear juice. Splitter box is used to reduce the velocity of juice before going to the clarifier and to release the air from
the juice. Settling aid 0.4-0.8 ppm (magno flock) is also added into the clarifier to increase the settling rate of mud and to get the better quality clear juice. Clear juice is taken as overflow method to avoid the carryover of mud through the clear juice. Outlet clear juice pH may be maintained 7.0 - 7.1 with the temperature of 97-98 degree C. Clear juice should be free from colloids (suspended matter) and bagacillo (or) any mud particles and it may be highly transparent and golden yellow color. If phosphate content is below 100 ppm in clear juice, Ortho phosphoric acid may be added externally in the clear juice to maintain 100 - 110 ppm of phosphate in order to get spongy nature of scales in the evaporation, for easy removal. Muddy juice from the bottom of the clarifier may be taken continuously to the vacuum filter mud level in the clarifier should not be above 2 cores. When the setting problem occurs in the clarifier, rate of crushing should be reduced and after satisfying the settling problem, crushing may be continued.

f) Vacuum Filter:
Muddy juice is taken to the vacuum filter to remove juice and mud as filter cake. This day done by proper washing with hot water of 65-70 0C. and with 16-20 inches of vacuum. The filter juice is turbid in nature and taken to raw juice tank for processing. The moisture % filter cake may be 70-75% and pol% may be 1.8 - 22% addition of bagacillo to the muddy juice should be free from sucrose.

II. Evaporation:
Evaporation is nothing but the maximum removal of wash water from clear juice to concentrate the clear juice from 12- 13 brix to 55-60 degree brix% Clear juice is having 12.5-13.5% solids and 86.5-87.5% water. Out of 87% water nearly 75-80% of water has to be removed as vapors in the evaporators which consist as follows: -
- Double effect vapor cell - quadruple effect evaporator (or) Quadruple effect evaporator (or) Quintuple effect evaporators It is possible to evaporate nearly 80% water from clear juice only when juice evaporated in multistage evaporators in a serious manner.
  a) Clear juice Heater:
Clear juice is at 97-98 degree C. is heated in clear juice heater to 110-115 degree C. by exhaust before taken to semikestner in order to maintain before evaporation i.e. semikestner to produce maximum vapors at higher temperature 110-112 degree C to using for juice heater and pan boiling without using exhaust. It is for better steam economy.
  b) Semi-kestner (1):
Clear juice from clear juice heater is heated by exhaust to around 120 degree C and the vapor produced in SK-1 may be having 0.3-0.4 Kg/cm2 g. pressure at 110-112 degree C. This vapors is taken for C massecuite boiling in pars and for treated juice heater nearly 28-30% water is evaporated in SK-1.

III. Quadruple Evaporators:
I Evaporator:
SK juice is heated in first evaporator by exhaust. The temperature of vapor inside the body may be 102-103 degree C nearly 12-14% of water is evaporator in first evaporator. This vapor is used to heat the juice from second evaporator.
II Evaporator:
Juice form first evaporator is heated in II evaporator by first evaporator vapor. The vapor temperature in second evaporator may be 92-94 degree C. This vapor is again used to heat the juice in third evaporator. Nearly 12-14% water is evaporated here.
III Evaporator:
Juice from second evaporator is heated in third evaporator by the vapor from second evaporator. The temperature of vapour in the third evaporator may be 82-83 degree C. The vacuum in the body may be 12-14 inches. The vapor is used to heat the juice from fourth body. Nearly 12-14% water is evaporated in third evaporator.

IV Evaporator: (Last Body):
The juice from third evaporator is heated in fourth evaporator at 25-26 inches Vacuum to reduce the boiling point of syrup thereby to reduce the color formation and to reduce inversion losses. Third evaporator vapor is used to heat the juice in fourth evaporator. The concentrated juice from fourth evaporator is called as un-sulphited syrup.

Retained time of the evaporators may be 25-35 mts.

e) Syrup Sulphitation:
Un-sulphited syrup may be having high coloring matter and coloring content. In order to reduce this to the minimum unsulphited syrup should be sulphited by SO2 gas as double sulphitation for better bleaching. The sulphited syrup should be PH - 4.6-4.8 Brix% - 55-60 Color - Golden yellow, free from colloids (or) any suspended Matter to have highly transparent The retention time of syrup sulphitor may be 8-10 mts. For better bleaching In order to have uniform bleaching of syrup chocking of SO2 gas lines if occurs should be cleaned then and there. Sulphited syrup is taken to supply tank for storage before use it for pan boiling. Sulphur purity should be above 99.5%

III CRYSTALISATION:
Crystallization is nothing but the formation and developing of pure sucrose Crystals by taking sucrose molasses from the syrup (or) any other molasses. In order to get pure sugar crystals to the required grade and to get the minimum final molasses purity multi massecuite boiling is practiced. Based on crystal size massecuite purity. A massecuite, B - massecuite and C - massecuite are boiled as standard three massecuite boiling.

A- Massecuite Boiling: It consists of two steps.
a) A-Footing preparation
b) A-massecuite preparation
a) A-Footing:
A - Light molasses, melt, syrup and B-Seed magma is taken to prepared A - Footing material while curing A - Footing may be having Brix% - 88-90 Purity - 88-90 Crystal Size 350-450 microns with uniform crystal size.
A - Footing may be prepared for boiling three (or) four A - Massecuite Boiling.
A - Massecuite:
One third of A - Footing may be taken and boiled with A - Light molasses melt and syrup to get A - Massecuite. At the feed stage, A - massecuite may be having Brix% - 93-95 Purity - 84-86 Crystal Size 700-800 microns with uniform crystal.

II. B-MASSECUITE BOILING
It consists of two steps:
1) B-Grain Preparation,
2) B- Massecuite Preparation
1) B-Grain Preparation:
A - heavy molasses is taken through conditioner and concentrated to 86-88 Brix and calculated quantity of slurry is fed into the pans. Sucrose nuclear form may be developed as grains. After
forming grains, graining should be established and should be hardened with movement water. Movement water may be hot water at 75-80 degree C or calendria water at 95-98 degree C. During hardening feeding materials except hot water should be avoided. After hardening movement water should be stopped. Feeding material of A-heavy molasses may be taking for further boiling. After attaining the required grain size 160 - 180 microns and after reaching the capacity of the pan, the mass is to be concentrated to 90-92- brix%. Then two third of grain may be transferred into B Vacuum crystallizer for further boiling and one third of the grain may be kept in the same pan for B-massecuite boiling.

B - Massecuite Boiling:
A-heavy molasses may be cut as mother liquor to develop the B-grain to the required size of B-massecuite crystals to 275- 325 microns. After getting the required size of the crystals after reaching the pan capacity-feeding materials may be stopped and the moss may be concentrated to 96-98-brix%. Then B-massecuite may be developed into B- Massecuite Cristalisers B-Massecuite may be having Brix% - 96-98 Purity - 68-70 Crystal Size - 275-325 microns

III C - Massecuite Boiling:
It contains two steps.
1) C-Grain preparation
2) C-Massecuite Boiling
1) C-Grain Preparation:
One third of A-heavy molasses and two third of C-lightmolasses may be taken through molasses conditioner and may be concentrated in the pans to 86-88 Brix%. After attaining the concentration required quantity of slurry may be introduced into the pall sucrose nuclio seed from the slurry may be formed as grain and the formed grain is to be harden. After establishing the grains, movement water (hot water or calendria water) is to be fed until the grains are to be well harder. Movement water is used to maintain the same super saturation co-efficient in the meta-stable zone throughout the hardening the process. During hardening except movement other molasses should not be given to the pans. After hardening the grains, C-light molasses if available or B-heavy molasses may be fed. After getting the required C-grain size 80-100 microns and after reaching the capacity of the pan the feeding material is to be stopped. The moss is to be concentrated to 90-92 brix%. Then two third of C-grain may be transferred into C-Vacuum crystaliser. One third of C-grain may be kept in the same C - pan for further boiling. The cutting grain should have Brix% - 90-92 Purity - 50-52 Grain size - 80-100 microns with uniform grains.

C- Massecuite Boiling :
One-third the C-grain in the C-pan may be developed further by taking B-heavy molasses to 140 - 160 microns. After attaining 140-160 microns crystals, B-heavy should be stopped and the boiling moss may be concentrated to 100 -101 brix% then the C-massecuite may be dropped into receiving C-massecuite crystallizer. The C - massecuite is having Brix% - 100-101 Purity - 48-50 Grain size - 40-160 microns with uniform grains

Note:
1. Pan boiling should be done only in meta-stable zone.
2. If falls grains are formed during, it should be dissolved by water and then boiling should be continued.
3. Required quantity of C-grain from vacuum crystallizers may be again taken to C- pan to boil C - massecuite.
4. Required quantity of B- grain from vacuum crystallizers may be again taken to B-pan to boil B - massecuite.
5. Required quantity of A-grain from vacuum crystallizers may be again taken to A-pan to boil A-massecuite.
6. Crystal % A - massecuite may be 50-52%
7. Crystal % B - massecuite may be 40-42%
8. Crystal % C - massecuite may be 30-35%

**Crystallizers:**
Massecuite dropped from pans are having 62-65 0C, which contains more sucrose in mother liquor. The sucrose from the mother liquor has to be defused and deposit on the exiting crystals for the further growth of crystals in order to get more crystal yield and minimum molasses purity.

**A - Massecuite Crystallizers**
A - Massecuite Crystallizers from pan is dropped as 60-65 0C in to A - massecuite crystallizer and cooled by air to 56-580C for 4-5 hours. Then the cooled massecuite is taken to A - centrifugal. During cooling of massecuite stirring should be there. A - massecuite cooling is done to increase the bagging % massecuite and to reduce the A - heavy molasses purity.

**B - Massecuite Crystallizers**
B - Massecuite from B - pan at 62-650C is dropped into B - massecuite crystallizer and cooled by air cum cooled water to increase exhaustion i.e., to increase crystal yield and to reduce the heavy molasses purity in order to avoid recirculation of molasses. B - massecuite may be cooled to around 8 hours to get the temperature of B - massecuite to 52-54 0C. stirring should be continued.

**C - Massecuite Crystallizers**
C Massecuite from pans at 60-650C is dropped into receiving C-massecuite crystallizer for air-cooling to 6-8 hours to get 56-580C. Then this massecuite is pumped to vertical crystaliser for further cooling. Stirring should be continued.

**Vertical Crystallizer:**
Vertical is used to cool the C-massecuite further to 40-420C by cold water in order to improve exhaustion i.e. to get more crystallizers and to reduce final molasses purity to the minimum. Stirring should be continued.

**Centrifugal Section:**
Centrifugal are used to separate the molasses from massecuite, to wash the sugar crystals and to dry the sugar crystals. Based on massecuite quality different types of centrifugal are used for curing.

**C - Massecuite for curing:**
Cooled C - massecuite from vertical crystaliser at 40-42 0C is re-heated by transient heated before curing to its saturation temperature 52 - 54 0C. This is for better purging (Separation) of final molasses from the crystals. Continuous centrifugal is used at 2000 RPM to separate final molasses from the crystal. Hot water at 50 -55 0C or diluted final molasses at 20 - 25 0 brix or cold water at 300C is used as lubrication for C -massecuite curing. In order to separate the final molasses in a better manner and to get better quality C - fore sugar and minimum final molasses purity. Optimum load may be maintained for better purging . C – fore sugar at 78 - 80 purity is mixed with C - light molasses at 56 - 58 purity to get C - fore magma mixture for C - after curing. Mesh size used may be 0.05 to 0.06 mm for C – fore centrifugal machine.

**C - After curing:**
Continuous centrifugal is used at around 1800 RPM to separate C - light molasses from magma and to get C seed purity above 97. Hot water at 75 - 80 0C or superheated wash water at 115 - 1200C is used to wash the sucrose crystals completely and easily to maintain the C- seed purity to above 97. C light molasses may be in the range of 56 - 58. Mesh size used for after centrifugal may be 0.06 mm. C - Seed obtained may be completely melt and taken for A - massecuite boiling.
B - Massecuite Curing:
Continuous centrifugal is used at around 1600 RPM. Hot water at 75 - 80 °C superheated wash water at 115 - 120 °C for washing of sucrose crystal. B - heavy molasses purity may be maintained in the range of 46 - 48 and B - seed purity may be maintained above 98 nearly 25% of B - seed may be used for A - boiling and remaining 75% of B - seed may be crystallized completely and taken for A - massecuite boiling. Mesh size used for B - centrifugal may be 0.06 mm or 0.09mm. Now a days, single curing is adopted in B -massecuite curing. According to the quality load may be adjusted. A - heavy molasses is separated then.

A - Heavy massecuite curing:
single curing is adopted in A massecuite boiling first superheated wash water at 120 - 1250C with 5 - 6 kg/cm² g. Crusher is used for complete washing of molasses layer around the sucrose crystals. The molasses obtained by washing is known as A - light molasses. A - light and A -heavy molasses separator should be all right. Otherwise mixing of these molasses finally take place. This may affect the quality of B - massecuite or A - massecuite. Superheated wash water is used not only for washing and purifying of crystals but also self-drying of sucrose crystals. The sugar discharge from the A - machine may be having the temperature of 75 - 80 °C and massecuite of 0.5 - 2.0%.

Sugar Hopper:
Sugar discharged from the machine is having higher temperature and moisture content. This may not be bagged as it is. Hence, this sugar is to be dried and cooled to 38 - 40 °C. Hot air blower at 90 - 95 °C is used to dry the sugar crystal and cold air blower is used to cool the sugar to 38 - 40 °C. Lumps breaker is used in the second hopper to break the lump sugar is there, it should be removed from the end of the hopper before going to the sugar elevator.

Sugar Elevator:
Cooled sugar from the hopper is taken to the sugar grader by sugar elevator buckets.

Sugar Grader:
Sugar is distributed over distribution box and sieved through grader to get different size of crystals for bagging separately with respect to its grade. Mesh size 8, 14, 20, 26 or 28 mesh may be used in the grader.

Sugar Bin:
Sugar from the grader is grader is stored in the sugar bin before bagging.

Sugar Weighment :
Sugar from the sugar bin is weighed automatically and bagged. The bagged sugar is stitched and taken to sugar godown.

Sugar Go-down:
Bagged sugars are stored in the godown for storage the humidity of godown should be 55 - 60 degree humidity. Sugar should have color below 100 ICUMSA sucrose % above 99.5% Ash% 0.04 - 0.05
Sugar Process flow diagram is given below

- Cane Weighing
- Cane Uploading
- Cane Preparation
- Milling
- Juice Weighing
- Receiver
- Juice Heating
- Clarifier
- Juice Heating
- Evaporator
- Syrup Sulphitor
- Syrup
- Syrup + Seed
- Pan
- Crystallizer

- Baggase to Boilers
- Hot Water
- Phosphate Slurry
- Press Mud
- SO₂ Gas

White Sugar Cooling grading, weighing, bag stitching & Godown
Cogen Plant

Presently there is no cogen plant. During expansion of sugar mill, cogen plant of 35 MW will be installed and old boiler and turbine will be dismantled and will not be used.

New cogen plant will provide sufficient steam and power for 8000 TCD crushing. The cogen boiler will be having 110 kg/cm² pressure, 190 TPH and 540 °C steam temperature. The additional power of 24 MW will be exported to grid. ESP will be installed to avoid air pollution.

Steam Balance

<table>
<thead>
<tr>
<th>Sr no</th>
<th>Description</th>
<th>Season</th>
<th>Off-season</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Total steam generated</td>
<td>190</td>
<td>120</td>
</tr>
<tr>
<td>2</td>
<td>Steam utilization</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sugar process</td>
<td>135</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>Steam to auxiliaries</td>
<td>35</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Steam to condenser</td>
<td>20</td>
<td>95</td>
</tr>
<tr>
<td>3</td>
<td>Total utilization</td>
<td>190</td>
<td>120</td>
</tr>
</tbody>
</table>

Power Balance

<table>
<thead>
<tr>
<th>Sr no</th>
<th>Description</th>
<th>Season</th>
<th>Off-season</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Total power generated</td>
<td>35</td>
<td>35</td>
</tr>
<tr>
<td>2</td>
<td>Power utilization</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sugar process</td>
<td>8.4</td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td>Power to auxiliaries</td>
<td>2.1</td>
<td>2.7</td>
</tr>
<tr>
<td></td>
<td>Power to other (office, colony etc)</td>
<td>0.5</td>
<td>0.4</td>
</tr>
<tr>
<td>3</td>
<td>Power Export</td>
<td>24</td>
<td>31.7</td>
</tr>
</tbody>
</table>

List of Equipments for cogen and brief Technical Specifications:

<table>
<thead>
<tr>
<th>Sr no</th>
<th>Description</th>
<th>Capacity</th>
<th>Brief Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Boiler with ESP, TPH</td>
<td>190</td>
<td>110 kg and 540 deg C temp</td>
</tr>
<tr>
<td>2</td>
<td>Turbine MW</td>
<td>35</td>
<td>108 kg and 530 deg C temp</td>
</tr>
<tr>
<td>3</td>
<td>Generator and auxiliaries</td>
<td>35</td>
<td>To suit steam turbine configuration</td>
</tr>
<tr>
<td>4</td>
<td>Total electrical distribution system with distribution transformer for sugar</td>
<td>35</td>
<td>Suitable capacity transformers will be installed to supply power to sugar plant</td>
</tr>
<tr>
<td>5</td>
<td>Power evacuation system</td>
<td></td>
<td>To suit power evacuation of 24</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Water treatment plant</td>
<td>MW in season and 31.7 MW in offseason</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Cooling tower</td>
<td>Suitable water treatment plant will be installed</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Plant DCS system</td>
<td>8400 m³/hr</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 cells of 2800 m³/hr</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Fuel and ash handling system</td>
<td>Shall be added to the level of automation required</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>ETP</td>
<td>Suitable fuel and ash handling system will be added</td>
<td></td>
</tr>
</tbody>
</table>

**Cogeneration Process:**
Cogeneration is a process that simultaneously produces two or more forms of useful energy, such as electric power and steam. It harnesses the thermal and electrical energy that is released as part of the production process in various industries. When a fuel is burnt to generate heat, and that heat is exploited in a thermo dynamic cycle to produce electricity, a great deal of energy is wasted. This wasted energy (which can be up to two-thirds of the energy content of the fuel) emerges as heat. If that heat can be utilized for space heating, for making hot water or in a manufacturing process, it could reduce the amount of additional energy needed for those purposes. This makes the economics of cogeneration extremely favorable.

**Benefits of Cogeneration**
Cogeneration offers higher efficiency and lower waste on the one hand, and greater fuel flexibility and lower costs on the other. However, with the benefit of new technology a much wider range of industries, from sugar to chemicals to textiles, is employing cogeneration. Its potential is just beginning to be realized. Cogeneration utilize the available energy in more than one form, they use significantly less fuel input. The cogeneration reduces energy costs and offers fuel flexibility. It also protects a company from the effects of power cuts and improves the quality of power. And finally, it reduces wastes.

**Technologies of Cogeneration:**
Cogeneration can be implemented in many ways. Small diesel engines, gas turbine plants with waste heat boilers, combined cycle cogeneration stations, biomass-based plants can be used to provide heat as well as generate electricity. There are two types of cogeneration plants. Topping cycle: Primary fuel is used to produce electricity, and thermal energy which is the by-product is then used for process heating. Bottoming cycle: Primary fuel is used to produce heat which is required for the process at high temperatures and hence, power is generated through a suitable waste heat recovery system.
Distillery Plant

Presently there is no distillery installed. Considering the volatility of the sugar prices and rising costs, distillery needs to be installed for the value addition to molasses and for additional revenue generation. This will help to pay better price to farmers and will also help to reduce pollution by supplying ethanol for blending purpose.

Distillery will run on own molasses produced as feed stock during season and on purchased/saved molasses during off-season. Ethanol yield of 255 liters is considered for molasses required quantity as detailed in table below.

<table>
<thead>
<tr>
<th>Sr no</th>
<th>Item</th>
<th>Own/procured molasses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cane crushing per day in MT</td>
<td>8000</td>
</tr>
<tr>
<td>2</td>
<td>No of season day</td>
<td>160</td>
</tr>
<tr>
<td>3</td>
<td>Total cane crushing</td>
<td>1280000</td>
</tr>
<tr>
<td>4</td>
<td>Molasses production in MT</td>
<td>57600</td>
</tr>
<tr>
<td>5</td>
<td>Ethanol production per day</td>
<td>80000</td>
</tr>
<tr>
<td>6</td>
<td>Molasses required per day in MT</td>
<td>314</td>
</tr>
<tr>
<td>7</td>
<td>Molasses required for 270 days</td>
<td>85000</td>
</tr>
<tr>
<td>8</td>
<td>Molasses needs to be procured per year in MT</td>
<td>27400</td>
</tr>
</tbody>
</table>

To handle the spent wash generated from the distillery plant, incineration boiler will be installed. In this boiler 80% of concentrated spent wash and 20% of coal will be used as fuel.

The incineration boiler will have following specification:
Boiler pressure – 45 kg/cm2
Steam flow – 25 TPH
Steam temp – 490 C
Steam Balance for distillery

Total steam generation – 25 TPH
Steam required for distillery and evaporator – 22 TPH
Steam to auxiliaries – 3 TPH

Power balance for distillery

Total power generated from distillery turbine – 3 MW
Power required for distillery – 1.2 MW
Power required for boiler auxiliaries – 0.4 MW
Surplus power available for export – 1.4 MW

Distillery Process

**a) Fermentation**
Cane Molasses, a waste generated from cane sugar manufacturing process is used for the production of ethyl alcohol. Molasses contains about 50% total sugars, of which 30 to 33% is cane sugar & the rest are other reducing sugar. These sugars present in the molasses are subjected to the action of yeast of the species saccharomyces cerevisiae, a living unicellular microorganism belonging to class fungi. Diamic sucrose undergoes decomposition due to metabolic activities of yeast and monomeric invert sugars such as glucose and fructose are produced in inversion process. Fermentation of these total invert sugars in the molasses broth gives ethyl alcohol and carbon dioxide. This is an exothermic (heat evolving), biochemical reaction brought about by the action of certain enzymes secreted by the yeast. For bringing out above biochemical reaction requires proper & careful handling of yeast, optimum parameters like pH, temperature & substrate concentration to be maintained in the fermenter vessels which results into effective conversion of sugars to alcohol. This process is carried out in main fermenter vessels.

The Process can be divided into following heads:
- Raw material handling
- Yeast propagation
- Fermentation
- Post wash clarification

**RAW MATERIAL HANDLING**

Molasses from the bulk storage tank located in the sugar manufacturing unit premises is pumped into a molasses day storage tank T-108 to earmark and ensure a day’s provision. Between the passages of these two tanks it is filtered to remove any grit or macro size foreign substances by a basket filter/strainer. T-108 tank bottom is connected to the suction of a pump no .P 101-A/B via lines 13016-MOL no.13018-MOL, 13019-MOL. It is delivered to tank no.T-109 by this pump via lines.13023-MOL, 13024-MOL. T-108 has a dedicated bottom drain via line no.13016-MOL. Tank T-109 is meant for weighing the molasses in batches before it is delivered.
in the process. The 24 hours count of molasses used and alcohol produced will give us the figure of overall process efficiency. A flow control valve FCV-1 is located on this delivery lines. This valve shall switch ON/OFF to deliver a determined quantity of molasses in the tank no.T-109 / process per hour. From tank T-109 weighed quantity of molasses shall be sent to Tank T-110 called weighed molasses receiving tank via line 13025-MOL. The bottom of the tank T-110 is connected to the suction of the pump P-101 C via a line no.13026-MOL. By this pump the weighed molasses shall be served in the process via line no.13027-MOL. This line joins a common header line 13028-MOL which distributes molasses to yeast propagation section and line 13027-MOL meeting the molasses demand of fermentation section.

YEAST PROPAGATION SECTION
As explained earlier that the molasses is diluted with water to achieve a specific desired sugar concentration and it is subjected to the action of yeast in the fermenters. Yeast cells secrete enzymes which convert these sugars in molasses to ethyl alcohol. In order to fulfil the fullest capacity of a given alcohol plant the yeast employed has to process many tonnes of molasses into alcohol in shortest time. The width of a single yeast cell is around 1-5 microns and the length is around 20-30 microns. It is practically found that we have to maintain a population of around 300-450 million live and viable yeast cells per millilitre of molasses broth in the fermenters. It is not feasible and economic to add the required huge mass of yeast externally on day to day basis. Yeast cell has got an inherent property to multiply (reproduce) itself asexually by forming buds on its cell wall in shortest time. These buds detach, form a new adult cell and give rise to multiple cells by budding. This property of yeast to meet the required yeast population in molasses broth in the fermenters is utilized. The yeast propagation section is meant for generating an active yeast biomass of selective yeast breed by way of reproductive multiplication. This section serves as yeast catering unit for fermenters. The section includes a set of four vessels progressively connected in series namely yeast culture propagation vessel number 1, vessel number 2, number 3 and fourth and final vessel called a prefermenter. All of these vessels are equipped with supply of clean sterile air, water and molasses feed. All these utilities are to be added in a measured quantity to each vessel as the vessels are equipped with individual flow metres for the same. Also a cooling jacket and plate heat cooler is provided to cool the contents of these vessels. Yeast acts best at temperature range 270 c to 320 c in our case. Pure and cultured yeast of precisely defined characteristic grown/preserved in the test tubes holding slanted synthetic media is used. The yeast formed as colonies on this slanted medium is further propagated in the laboratory under strict sterile condition successively in a 500 ml, 1000 ml and 2500 ml culture flasks using an ideal synthetic medium. The final and finished culture flask from the laboratory culture preparation is transferred aseptically to the yeast culture vessel no.1 in the plant which is holding around 100 litres of clean and low sugar content molasses medium. Clean and sterile air is passed through the vessel content continuously as yeast needs oxygen for reproduction process. Yeast multiplies in this vessel. After around 12 to 18 hours it can obtain the desired concentration of yeast cells in the molasses broth say some 300-450 million cells per ml of broth. The broth rich in cell mass from vessel no.1 is now transferred to culture vessel no.2 holding around 750 litres of clean and low sugar content molasses medium. Clean and sterile air is passed through the vessel content continuously. After around 12 to 18 hours it can obtain the desired concentration of yeast cells in the molasses broth say some 300-450 million cells per ml of broth. The vessel no.2 contents
are now transferred to culture vessel no.3 having capacity around 1500 litres. Clean and sterile air is passed through the vessel content continuously. After around 12 to 18 hours we can obtain the desired concentration of yeast cells in the molasses broth say some 300-450 million cells per ml of broth. Finally the contents of third vessel are passed to the prefermenter to achieve similar cell concentration. Prefermenter volume is around 18000 litres. The loaded prefermenter rich with fresh yeast cell mass is transferred to the main fermenter. The cell mass continuous to grow in fermenter and attains a desired cell concentration. This cell mass is maintained in the fermenter throughout during the continuous cascade fermentation mode operation. Propagation in this mode is carried out only at the initial start up or inception of the process or after a prolong shut down resulting in emptying of fermenters. During the batch fermentation mode we can distribute the finished pre-fermenter between 2 main fermenters. We can recharge the pre-fermenter again immediately and cater the next two fermenters. In the outset itself we have discussed what fermentation section stands for. Four no. fermenters T-104, T-105, T-106 and T-107 have been installed in series. Each fermenter is equipped with sloping bottom and bottom drain, bottom and top manhole, sight glass, breather valve to release excess pressure, vent to release the gases evolved during fermentation process, individual plate heat cooler with pump to cool the fermenter contents and nozzles to feed molasses, water, air (in metered quantity through flow metres), antifoaming agent, nutrient etc. Fermenter section is connected to a yeast propagation section to receive the propagated yeast mass. The fermentation tanks are in progressive series, that is, the contents of first fermenter T-104 flow to T-105 to T-106 so on. However a provision is made to isolate these four tanks from each other to use each tank in a standalone status. The fermentation process can be brought about in two modes. (We have made this provision in the design) By continuous cascade type (recommended and preferred) or by batch type (route chosen if raw material molasses, water etc. is scanty)

CONTINUOUS CASCADE METHOD
In this mode the substrate i.e. molasses is fed and fermented continuously into the first three of four fermenters placed in series and the outflow of one fermenter is allowed to flow in the next fermenter progressively. Yeast mass is generated continuously in the first two fermenters. The diagram shown on the previous page illustrates this mode. The fermenters are cleaned and kept ready. The first fermenter T-104 is filled 1/10th of its total volume with dilute molasses of around 1040 S.G. Now the matured pre-fermenter is transferred to this T-104. The contents of the fermenter are kept undisturbed for around 2 hours to allow the nascent yeast cells of pre-fermenter to adapt itself. This is called as log phase. After two hours we start feeding this fermenter with molasses and water slowly. Yeast starts fermenting the molasses and simultaneously growing and multiplying itself now. The feed of molasses and water is so adjusted that around 4-5% residual sugar concentration is maintained thought in the fermenter broth. Air is supplied to the propagation broth continuously. The rate of feed is so employed that it shall take around 26-30 hours to fill the tank to its full capacity. This retention is given to generate the yeast mass to the desired count of 400-600 million cells per ml of broth in all the fermenters. The contents of T-104 are now with slow rate transferred to T-105 with adopting the same procedure followed for
first fermenter. This is followed till the last fermenter (except the last fermenter is not fed with substrate). From the last fermenter the final wash is drawn in the wash holding tank. After filling the wash holding tank the wash is sent for distillation at slow feed rate. This rate is gradually increased and set to desired feed rate for full capacity production. Concurrently the dilute molasses feed to the first three fermenters is increased to keep the fermenters and wash holding tank full to the capacity throughout. The sugar concentration of the molasses feed is so selected that it shall generate around 5.5% v/v alcohol in T-104 and around 2% v/v in T-105 and around 1.5% v/v alcohol in the third T-106 fermenter. Final wash shall have around 8.5%v/v alcohol concentration. Please note that contents of each fermenter are overflown to next fermenter. This operation of generation of yeast cells in the fermenter broth and fermentation of molasses to alcohol achieves a steady state and shall last month’s together. We shall corroborate the yeast population by serving intermittent doses of matured prefermenter to the T-104. Additives like urea and Di- ammonium Phosphate as a source of nitrogen are added in the fermenter as and when required.

Nitrogen addition favours fermentation rate and also prevents formation of impurities like higher alcohol during the fermentation. The upsurge of foam in the fermenter head space is controlled by addition of surfactants like surface tension. Every litre of alcohol produced generates about 270 Kcal of heat in the fermenters. This excess heat is removed by continuous circulation of the fermenting wash through external plate heat exchangers PHE 102/3/4/5 called the Fermenter Cooler. The fermenter temperature is always maintained between 320C, and 340C, the range optimum for efficient fermentation. The carbon Dioxide which is generated in the fermentation process carries along traces of ethyl alcohol up to 0.8% to 1% v/v. Before letting it in the atmosphere or recovering by purification it is passed through a carbon dioxide scrubber C- 11 whereby it is scrubbed by water. This water containing ethyl alcohol is returned back to the fermenter. This minimises the alcohol loss in the atmosphere via carbon dioxide evolution.

Batch fermentation
This is the old and out-dated method of fermentation. However it is followed under some exceptional conditions even now. We have made our fermentation section design versatile. It can handle the batch mode also. A clean and standalone fermenter is filled with dilute molasses to its around 1/10th capacity. A matured pre-fermenter is transferred to this. Contents are left undisturbed for around 1- 2 hours. Then the fermenter is filled rapidly to its full capacity within a span of 3-4 hours maintaining molasses gravity 1100 SG throughout. The fermenter is let alone. The fermentation will conclude within a span of 32 to 38 hours producing 8.5% v/v alcohol. This fermenter is distilled by drawing the wash directly to distillation. POST CLARIFICATION SYSTEM OF FERMENTED WASH BY GRAVITY SETTLING SYSTEM AND DECANTER. The post clarification of fermented wash is brought about by well-designed gravity settlers system. The fermented wash from the last fermenter (in case of continuous cascade fermentation) is collected in a sludge settling tank no.T-111. This tank has large conical bottom. The sludge and used yeast in the wash settles at the bottom cone of T-111. The clear wash is drawn by overflow from the top of this tank (leaving the bottom contents of tank
undisturbed) to a buffer tank to send to distillation section. The settled mass at the bottom of T-111 is diluted with water and sent to a sludge washing tank T-112. From this tank it is fed to a sludge decanter centrifuge D-101. The decanter separates the sludge mass which is discarded. The sludge free liquid from decanter recycled in the system for alcohol recovery. This helps in reducing the sludge in fermented wash allowing clear liquid to enter the distillation. This will minimise the scaling of the distillation columns as well as other equipment. This also avoids a caramalisation and charring of wash under distillation which imparts burnt and other off flavours to final product.

**Flexibility :**
This process accords tremendous flexibility to the operator. Process conditions and plant design can be varied to suit individual requirements of alcohol quality, effluent concentration and characteristics. This unit can give spent wash suitable for use in any effluent treatment process. More details of this feature of process flexibility can be supplied on request.

**b) Multi Pressure, Multi-Product Distillation (EQRS, EQENA, AA – Molecular Sieve) –**
The Distillation Plant offered is a Multi pressure Multi product distillation system with all prescribed auxiliary equipment and services as required to produce, as a minimum, the desired ethanol quality. The system consists of total 4 nos. column along with related condenser, coolers, pump, piping, etc.
The distillation columns provided are as follows:
1) Analyser column
2) Extractive distillation (Hydroselection) column
3) Rectifier column &
4) Recovery column

The above distillation system is run as below for following products:

- Export Quality RS : Analyzer Column (Atmospheric) Hydroselection column (Atmospheric)
  Rectifier (Pressure) Recovery column (Atmospheric)
While producing Export Quality RS, the hydroselection column is run at lower dilution. The analyser and Extractive Distillation column are run in vacuum. The overhead vapours of Rectifier are fed to the Analyzer reboiler. The product is drawn from the top of the Rectifier Column. The operation of Rectifier under pressure enables to operate the Analyzer under vacuum. The direct benefit of such Pressure Vacuum system results in energy saving and reduces down time in plant operation (cleaning of scales in Analyzer Column). This further ensures very good quality of product.

- ENA Column : Analyzer Column (Atmospheric) Hydroselection column (Atmospheric)
  Rectifier (Pressure)
The system is operated in the same manner as detailed for EQRS operation. However, the Extractive column is operated under higher dilution rate. In order to ensure the ENA quality, the
refining column is used in the system for further removal of traces of impurities. Recovery column is used in the system for further removal of traces of impurities.

- Anhydrous Alcohol: Analyzer Column (Atmospheric) Rectifier (Atmospheric)
The rectifier is operated under pressure. The overhead vapours of the Rectifier are used to heat the reboiler of the Analyzer. Part of the vapours of the Rectifier are sent to the superheater of the Molecular sieve plant. Superheated vapours are passed through the molecular sieve beds. Superheated vapours are passed through the molecular sieve beds for dehydration. The vapour passes through a bed of molecular sieve beds and water in the incoming vapour stream is adsorbed on the molecular sieve material and anhydrous ethanol vapour exists from the Mol Sieve Unit. Hot anhydrous ethanol vapour from the Mol Sieve Units is condensed in the Mol Sieve Condenser. The anhydrous ethanol product is then further cooled down in the product cooler, to bring it close to the ambient temperature. The two Mol Sieve Units operate sequentially and are cycled so that one is under regeneration while the other is under operation, adsorbing water from the vapour stream. The regeneration is accomplished by applying vacuum to the bed undergoing regeneration. The adsorbed water from the molecular sieve material desorbs and evaporates into the ethanol vapour stream. The mixture of ethanol and water is condensed and cooled against cooling tower water in the Mol Sieve Regenerant Condenser. Any uncondensed vapour and entrained liquid leaving the Mol Sieve Regenerant Condenser enters the Mol Sieve Regenerant Drum, where it is contacted with cooled regenerant liquid. The cooled regenerant liquid is weak in ethanol concentration, as it contains all the water desorbed from the Molecular Sieve Beds. This low strength liquid is recycled back to the Stripper / Rectifier Column for recovering the ethanol. The water leaves from the bottom of the column and contains only traces of alcohol.

**Special Features, Performance and Efficiencies**

Special features, Performance and Efficiencies of the project based on this process are as follows:

a) Distillery project
   - Truly continuous fermentation process with yeast recycling
   - Higher yields – yield of 247 ltrs of alcohol per ton of molasses containing 45% F.S. is guaranteed
   - Lower effluent generation – the process generates only 8 to 10 ltrs of effluent per ltr of alcohol produced (as against 14 to 15 ltrs per ltr of alcohol produced in case of other conventional processes)
   - Yeast recycle – In this process, the yeast is efficiently separated and fed back to fermenter. Therefore no fresh yeast is required to add every day. This also avoids loss of sugar due to yeast growth.
   - Weak beer recycle – this unique feature allows higher dissolved solid level in the fermenter broth which not only makes process infection resistant but also reduces water and steam consumption.
   - Requires only on fermenter and hence very less floor area for the plan Performance and Efficiencies
Fermentation efficiency will be between 90% and the distillation efficiency will be 98.5%. These efficiencies are based on stable operating conditions and quality of raw material used.

b) Extra Neutral Alcohol
- The ENA produced will be of quality better than IS 6613-1972, specs for neutral spirit for alcoholic drinks. Rectified spirit as per IS 323 Grade I will be the raw material.
- Re-distillation efficiency will be 98.5%.

c) Anhydrous Alcohol
It is a mature and reliable technology capable of producing a very dry product. However, its high capital cost, energy consumption, reliance on toxic chemicals like benzene, and sensitivity to feedstock impurities, has virtually eliminated the use of azeotropic distillation in modern ethanol plants. Benzene has been used as entrainer of choice for ethanol dehydration but it is now known to be a powerful carcinogen.

Some of the advantages of MOLECULAR SIEVE technology for ethanol dehydration are as follows:
1. The basic process is very simple, making it easy to automate which reduces labour and training requirements,
2. The process is inert. Since no chemicals are used, there are no material handling or liability problems which might endanger workers,
3. Molecular sieves can easily process ethanol-containing contaminants, which would cause immediate upset in an azeotropic distillation system. In addition to ethanol, a properly designed sieve can dehydrate a wide variety of other chemicals, thereby providing added flexibility in future operating options,
4. The molecular sieve desiccant material has a very long potential service life, with failure occurring only due to fouling of the media or by mechanical destruction. A properly designed system should exhibit a desiccant service life in excess of 5 years,
5. It can be configured to function as a stand-alone system or to be integrated with the distillation system. This lets the customer make the trade-off between maximum operating flexibility versus maximum energy efficiency,
6. If fully integrated with the distillation system, a steam consumption rate only slightly above the absolute theoretical minimum for the separation can be achieved,
7. A properly designed molecular sieve can reliably dehydrate 160 – proof ethanol to 190 + proof, making strict control of rectifier overhead product quality unnecessary.

Advantages of System:
- Minimal Labour.
- Stable operation.
- Near theoretical recovery.
- Steam consumption minimized by multi-stage preheating to permit substantial heat recovery and reuse.
- An advanced control system, developed through years of experience, to provide sustained, stable, automatic operation.
- Consistent excellent product quality maintain
  - The AA produced will be of quality 99.8% v/v.
  - The feedstock quality, ethanol 95% v/v.

Advantage of incineration boiler method:
- Concentrated spent wash will be fed to boiler as fuel in 70:30 proportion with coal this less fuel requirement
- Zero spent wash discharge in ensured
- Being separate boiler and turbine, distillery can be run smoothly and efficiently
- Pollution due to distillery effluent can totally be avoided

**Manpower for factory as whole**
Existing factory has manpower of 540. The additional expansion of sugar and installation of distillery and cogen will require extra manpower of 200. The total manpower requirement will be 740.

**Proposed Sugar ETP Scheme**