TECHNOLOGIES USED IN A SUGAR COMPLEX (SUGAR + POWER + BIO-ETHANOL)

India is the second largest producer of sugar in the world. Sugar Industry is the largest agro industry located in rural India. Sugarcane is the cash crop and its cultivation plays a vital role towards socio-economic development of farmer's fraternity through income and employment generation.

Needless to say, that sugar Industry is the back bone of rural economy in at least a dozen of states. We are using the latest Technology available to minimize cost of production thereby improving efficiency. Now-a-days we are moving towards the concept of Integrated Industrial Complexescomprising of Sugar Plant, Co-generation (Power) plants and Fuel-Ethanol Distilleries. Most of the latest Technologies being used at different stages may be listed as below (However, this is not the exhaustive list):

1. **BAGGASE DRIER UNIT**

The sugar Industry produces power for in-house consumption and the surplus power is sold to national grid. Improving the use of fuel i.e. Bagasse in the boiler is an important industrial approach for more earnings of the sugar industry. By use of Bagasse driers, boiler efficiency can be increased considerably on account of reduction of Bagasse moisture.
Few Companies in India have indigenously developed Bagasse Drier units to reduce moisture of Bagasse to maximum possible extent before being fed to the boilers. The system uses Flue gases as the heating media for drying of Bagasse i.e. waste heat recovery concept.

Generally, Moisture of Bagasse coming out of the last Milling tandem remains about 49 – 50 %. After installation of Bagasse Drier, it has been reported that factories have achieved a drop of about 8- 10% of Bagasse moisture i.e. final bagasse moisture after drying comes to the tune of 40- 42%. Boiler Efficiency

increase by about 4% thereby resulting in significant improvement in Steam/Fuel ratio.

2. MOISTURE CONTROL UNIT (MCU)

Moisture % Bagasse plays a very important role in Milling and Plant efficiency. Lot of work has been done in this field. As compared to Bagasse Drier units, MCU is an arrangement developed with a view to reduce moisture content of Bagasse to some extent.

Moisture Control Unit is showing promising results and hence may be used as a tool to improve overall profitability of the plant.

"Moisture Control Unit" is designed to reduce moisture of bagasse coming out from discharge nip of each mill which results in additional drainage ofjuice and reduces final bagasse moisture. This ultimately improves overall performance of whole tandem in terms of overall mill extraction and final moisture% Bagasse.

PERFORMANCE / RESULTS ACHIEVED/REPORTED

1. Averagereduction in Moisture % Final Bagasse by 1.5-2 units whereas peak reduction achieved 2.5 -3.5%.
2. Increase in RME.
3. Steam to Bagasse Ratio is reported to increase by about 3%.

ADVANTAGES OF MOISTURE CONTROL UNIT ARE:

1. Reduction in moisture % final bagasse.
2. Increase in Juice drainage at discharge nip, particularly at heel clearanceof trash plate.
3. Allow to increase imbibition% fibre. This helps to reduce bagasse pol and moisture % bagasse can be maintained even after increase in imbibition.
4. Controlling Re-absorption of Juice in mills.
5. Increase in overall mill extraction, RME.
6. Extraction of juice even at uncompressed cane mat at discharge nip incase of lower crush rate.
7. Elimination of Juice spitting from discharge nip of mill.
8. Reduction in moisture % bagasse will increase GCV of bagasse whichincreases boiler efficiency and steam to bagasse ratio significantly.

9. More export of power.
10. No need of external additional electrical drive.

3. HIGH PRESSURE BOILERS

The fact that increase in boiler pressure increases the steam fuel ratio is anestablished one. This increase in steam fuel ratio is mainly due to high inlet temperature of feed water by regenerative heating (Regenerative Cycle Efficiency is higher than the cycle efficiency without regeneration) and higher boilerefficiency due to the design parameters of high pressure boiler. In general, the system efficiency or the power plant efficiency is more in case of high pressurecogeneration than that of low pressure, keeping other system routes same.

It is observed from the observations that the power production at 125 ata boiler pressure is almost 3 times than that at 45 ata.

4. AUTOMATION

Sugar Manufacturing Process can be controlled and automated using a Distributed Control System (DCS). Some of the Automation generally used in the sugar Industry are as follows:

a) Bagasse belt conveyor speed control,
b) Mill drive speed control,
c) Boiler operation control,
d) Turbines Operation control,
e) Raw Juice Flow control,

f) Juice flow Stablisation system,
g) Process Temperature control,
h) Juice pH control,
i) Chemical dosing system,
j) Vacuum pans feed control,
k) Pumps operation,
l) Water flow meters – to monitor and reduce water consumption
m) SHHW system
n) Melting and Molasses conditioning

5. STEAM ECONOMY DEVICES

Central Flashing System: Condensate is flashed from one effect to anotherthrough Central Flashing Device to effectively recover the additional heatand reduce overall consumption of vapors.

Condensate Heaters: Excess heat in condensate was to be recoveredwhich otherwise is wasted in atmosphere at boiler station.

Direct Contact Juice Heaters: use of Direct Contact Juice Heaters forLow temperature approach and easy maintenance.

Molasses Conditioners for direct contact heating of molasses under vacuumfor perfect dissolution of crystals.

Super Heated Wash Water System: For Batch Centrifugal Machines byspray shot of hot water, which was heated by live steam, replaced byPTHE using 2nd body condensate and heated by 1st body condensate andachieving temperature 110 to 112^0 C.

Sugar Melting: Traditionally B & C sugar is melted by using hot waterand steam. Instead Sugar Melter was designed to use hot water/superheated wash water to melt the sugar to minimize the steam consumption.

Pan Washing: Washing is crucial for the efficient Batch Pan Operations toavoid Massecuite circulation and formation of secondary grain. GenerallyExhaust Steam is used for washing purpose. Instead use of vapors ofEffect 1 for this purpose has gained popularity.

Supervisory Control & Data Acquisition (SCADA) for controlling process parameters automatically for Energy Saving.

Vapor Line Juice Heaters were planned to recover heat from waste vapors going to condensers.

Waste Heat recovery System for melting of Sulphur at Sulphur Furnace.

6. ENERGY CONSERVATION:

VFD operated A.C. motors have been selected which are having the followingadvantages:

i. Most efficient (99%)
ii. Most energy saving
iii. Torque will be constant from low speed to full speed
iv. Power factor will be near to unity
v. Less harmonic
vi. Power quality will be improved due to better power factor and less harmonic
vii. Less maintenance cost

Other Energy Efficient Measures employed:

☐Full automation at Mills, Boiler, TG Set and refinery section.

☐VFD at cane carrier, truck tippler, boiler ID fan. P

☐Planetary drives in boiling house for all crystallizers, Magma Mixers, Pugmill etc.

☐Hydraulics cane unloaders.

☐Fibrizor drive changed with H.T. motors.

☐Installation of energy efficient super gravity plant for Raw sugar Production.

☐A triple effect falling film pressure evaporator.

☐The cascade type vertical continuous pans for A, B & C massecuite boiling.

☐Continuous cooling crystallization under vacuum.

☐Measuring all hot water added in the plant and then optimization.

☐Flash heat recovery system of all condensate including clarifier flash.

☐All Molasses heating and conditioning by non condensable gases.

☐Tubular/ PHE heaters for condensate heat utilization.

☐Direct contact heaters for syrup, melt heating and molasses conditioning.

☐Melt Concentrator for raising the melt brix up to 74+

☐Evaporator Bleeding for raising the syrup brix up to 70+

☐Replacement of water addition with juice / molasses where ever possible.

☐Replacement of Robert bodies with falling film evaporator at IInd and IIIrdeffect.

☐Seed magma for A and B massecuite.

☐Reduction in Auxillary steam consumption at power plant

7. SHORT RETENTION CLARIFIERS

MAIN OPERATING FEATURES:- The main features of this clarifier are as follows.

- Retention time of juice in clarifier is 45 - 50 minutes only.
- Requires Constant feed of sulphited juice at a Temperature of 103 – 104^{o}C
- Flash tank- the role of flash tank is very important for mud setting because it requires complete flashing of vapour through its chimney.
- Dose of flocculent must be automated with juice flow.

ADVANTAGES:

- Less Turbidity of Clear Juice
- Better Transmittancy of clear juice
- Good clarification is achieved with less retention time.
- Less retention time hence less risk of sucrose inversion loss.

- Less temperature drop due to less juice holding volume and less heat exposed area.
- Compact mud formation for achieving better filter/decanter performance.
- Less formation of colouring matter due to reduced risk of heat exposure.
- Wide range of application for clarification of cane juice, secondary juice, filtrate juice, sweet sorghum and beet juice.
- Can be used at higher capacity with minor modifications

8. DECANTER SYSTEM FOR MUDDY JUICE TREATMENT

Construction

The Solid bowl decanter technology has gained wide application in industries like oil, dairy, chemical, water and sewage treatment etc. and is in existence for more than a century all over the world.
The growing awareness of power for sustainable growth of sugar industry in fact has been a driving force to look out for alternative technologies requiring less power and diverting more than 1.0% cane of bagasse for additional electric power generation.

Technology

Unlike the conventional centrifugal machine used for separating sugar crystal from mother liquor either in batch or continuous where mother liquor by application of centrifugal force passes through the screen openings, the decanter although is centrifugal machine does not have any perforations over the rotating basket. The basic principle of using centrifugal force for solid/liquid separation is universally remains the same. The only difference is that the insoluble solids when subjected to centrifugal force get separated from liquid towards inside surface of bowl and are continuously pushed towards discharge end by a rotating helical scroll. The cake is continuously discharged through discharge ports fitted with tungsten carbide bushings. The decanted juice is continuously taken out through a concentric opening.

9. FALLING FILM EVAPORATORS

These are comparatively newer evaporators & have gained popularity in sugarindustry due to their short retention time, working at high temperature,

betterheat transfer coefficient & low energy consumption. Falling film evaporationis among the most cost-efficient and energy-saving evaporation methods.It is especially well suited to give low energy consumption. A falling filmEvaporator may consist of one or more liquid stages in a series. If a numberof stages are used, the concentration of dry solids will be increased throughthe plant. This gives lower average concentration which reduces the need forheating surface, which in turn means low energy consumption compared toa single liquid stage plant. Falling film distribution generally is based arounduse of a perforated plate positioned above the top tube plate of the calandria.

Spreading of liquid to each tube is sometimes further enhanced by generatingflash vapor at this point. The falling film evaporator does have the advantagethat the film is 'going with gravity' instead of against it. This results in athinner, faster moving film and gives rise to an even shorter product contacttime. The liquid film starts to boil due to the external heating of the tubesand is partially evaporated. Residual film liquid and vapour is separated in the lower part of the calandria and in the downstream centrifugal dropletseparator. It is essential that the entire film heating surface, especially in thelower regions, be evenly and sufficiently wetted with liquid. Where this is notthe case, dry spots will result that will lead to incrustation and the build-upof deposits. For complete wetting it is important to have a well designed and a suitable juice distribution system.

The primary advantage of falling-film evaporators are:

- Relatively low cost
- Large heating surface in one body
- Low product hold-up
- Small floor space requirement
- Good heat transfer coefficients at reasonable temperatures

The primary disadvantages are:

- High headroom requirement
- Recirculation is usually required.

10.FALLING FILM PLATE TYPE EVAPORATORS

In the plate type of evaporators the coil usually made up of copper oraluminum is embedded in the plate so as so to form a flat looking surface.Externally the plate type of evaporator looks like a single plate, but inside itthere are several turns of the metal tubing through which the fluids flows.

The advantage of the plate type of evaporators is that they are more rigid as the external plate provides lots of safety. The external plate also helps increasing the heat transfer from the metal tubing to the substance to betreated. Further, the plate type of evaporators are easy to clean and can be manufactured cheaply. The heat exchanger consists of a frame plate (Head), a pressure plate (Follower),a carrying bar, a lower bar and a column. Tightening bolts are used to pressthe plates together. This is depending on the type of heat exchanger and canbe different in some applications. The plate package consists of plates with agroove along the rim of the plate and around the ports. The number of platesis, as well as size and dimension, dependant on the thermal output required.Depending on the application stainless steel or titanium plates might be used.The groove provided in the plates holds the special gasket. The purpose of this gasket is to prevent intermixing of the media and leakage to the outside.

OUTSTANDING FEATURES

- Heating surface of up to 1,200 m^2 per unit, 3m^2 per cassette
- Compact design, simple operation
- Short residence time of the product in the unit
- Flexible performance adaptation capability by varying the number ofcassettes
- Booster solution does not require a separate trap

ADVANTAGES

- No loss of pan vapours.
- Use of low temperature and low pressure vapours.
- Low energy and water requirements.
- Outstanding overall heat transfer coefficient values.
- Low temperature differences across heating surface.
- Reduce scaling due to low temperature evaporation.
- Short residence time of the juice in each effect.
- Low juice colour formation.
- Light weight as compared to conventional evaporators.
- Minimum vapour piping and pumping.
- Easy maintenance.

11.HYDROJET CLEANING OF EVAPORATORS TUBES:

Generally, Evaporator bodies used for concentration of juice require frequent cleaning with a view to maintain their heat transfer co-efficient. Most common method of cleaning evaporator tubes is chemical cleaning (alkali or acid boiling) followed by mechanical cleaning with cutter and brushes. This method has its own merits and demerits including heavy load of effluents on ETP and reduction in usable life of equipments. The method of hydrojet cleaning of tubes can be adopted by sugar factories as per their suitability. Study need to be done to establish the viability of hydrojet cleaning method and comparative advantages over the conventional methods.

12.CONTINUOUS VACUUM PANS

Continuous vacuum pans have now established their position in the sugar Industry. They provide significant advantages such as minimal supervision, benefits to steam economy, better exhaustion, crystal uniformity, etc. The most important criteria for a successful Continuous Vacuum Pans areproduction of even crystal size, elimination or avoidance of encrustation, lumpformation and energy usage. Major advantages are:

- Improved product / crystal quality
- Energy efficiency
- Better exhaustion
- Operator and space savings
- Control simplicity

13. SUGAR REFINERY (DEFECO – MELT PHOSPHATATION FOLLOWED BY ION EXCHANGE RESIN)

India, primarily produce Plantation White Sugar (PWS) but for the last few years, owing to increased demand most of the factories have converted to the production of refined sugar using Defeco Melt Phosphatation followed by Ion Exchange Process. The whole process may be depicted as below:

a) Juice extraction
b) Clarification of raw juice by defecation employing heat, lime
c) Concentrating Syrup to 68-70 Brix
d) Production of washed raw of 99 to 99.3% Pol with 400-600 ICUMSA
e) Melting of washed raw to 60-65 Brix,
f) Clarifying by Phosphatation as Primary Decolourisation
g) Filtration through Multi Bed Filter to capture 5 micron particle
h) Secondary decolourisation by Ion Exchange Resin
i) Recovery of Brine from spent Brine to the tune of 90-95%
j) Recovery of Rinse water to recycle and reduce the load on ETP
k) Scum De-sweetening system for maximum recovery of sugar from Scum
l) Concentrating Melt in well-designed Evaporator up to 72 brix
m) Boiling of a refined Melt in Pan and also Recirculation of Molasses
n) Molasses from the refinery strike of about 90-92 purity or 1600-2000 IU Colour to be returned to raw sugar boiling.
o) Normal B & C boiling to recover maximum Sugar

14.EMERGING TECHNOLOGIES: (HIGH PRESSURE ABSORBENT)

(HPA) High performance absorbent is similar to powered activated Carbonas the mechanism of colour removal is adsorption for both. But there are many added advantages in HPA, which has a surface area of > 1500 m2/gm and additionally the pore structure has a better configuration allowingmore efficient adsorption in a sugar solution. Another important differencebetween normal PAC and HPA is, HPA has integrated specific chemical groupson its surface enhancing the capacity to remove the impurities that PAC has difficulty in removing. Due to above features HPA works better and removesthe same level of impurities at lower doses, makes it most cost effective and lesser solid to dispose.

HPA offers following advantages:

1. Membrane Filter operates at higher liquor brix up to 64-65 when compared to other filters that operate at 55-60 brix.
2. Single unit which does the coarse, fine filtration, de-sweetening, Squeezing,Drying and Cake discharging.

3. Single unit which dispose solid cake
4. Complete operation is in auto mode.
5. Sparkling sugar colour due to tight filtration.

15. WATER MANAGEMENT

The process of sugar production is a unique one, since the raw material (sugarcane) carries more fuel and water required for sugar processing. The sugar canecrop is about 70% water. This water is recognised as a resource, and is usedin our processes to minimise the use of fresh water from the river. The excess fuel available in the form of fiber in sugar cane not only produces sufficientsteam and power required for sugar processing and distillation of molassesbut also produces excess power which is exported to state grids. The watercontent of sugar cane is adequate to meet the requirement sugar processingand excess available water can be utilised to meet the partial requirement ofCogeneration and distillery units.

Various Water conservation Techniques are used such as:

- Adopting closed loop recirculation of hot and cold water for various process needs
- Utilizing good quality condensate to meet various process requirements
- Carrying out cooling and treatment, if required, of good quality vapour condensates so as to use them in place of raw/fresh water.
- Minimizing any wastage of condensates and fresh water
- Adopting dry cleaning of floors
- Providing UGR's and lagoons of appropriate capacity for storage of different kind of waters

16. FINAL MOLASSES COOLING SYSTEM

The mother liquor from the last stage of crystallization, from which sugar cannot be economically recovered, is termed as final molasses.

Our aim should be to maintain proper conditions before and for storage of molasses i.e. both qualitative and quantitative losses are to be avoided, as from commercial angle molasses storage has vital importance in view of its revenue earning potential.

DRAWBACKS OF HIGHER FINAL MOLASSES TEMPERATURE

Many times it happens that even though total sugar in molasses is quite enough but the recovery of alcohol in distillery remains low. This might be due to high quantity of non fermentable reducing sugars. These are formed even at below7.0 pH and are the condensation products of amino acids and their amides with reducing sugars which ultimately form non fermentable reducing sugars.

They are formed by action of lime and heat and reduce Fehling solution giving positive rotation and thus showing high pol and so high purity reading of molasses.4.67% reducing sugars on dry basis contributes to 3.3 % pol. The conversion of this fermentable reducing sugars to non fermentable reducing sugars (NFRS) increase with rise in temperature of storage. At 35 – 40 deg C, the increase in this loss of fermentable reducing sugar is negligible. A rise of 10 ^{0C} is reported to have quadrupled the decomposition. Most rapid decomposition occurs at temp above 45^{0C} with the increase in nitrogen content in juice i.e. with the increase in amino acids and amides etc.

Moreover, the chemical transformation of amino acids and reducing sugars is an exothermic reaction resulting in release of heat and formation of CO_2. The heat increases the temperature of surrounding molasses and the reaction rate further increases at higher temperature. Thus, the temperature goes on increasing and ultimately results in molasses turning into black solid mass. This reaction is called Maillard Reaction.

Hence, proper cooling of Molasses should be done before storage to avoid such transformations resulting in huge losses.

It is expected that we can get a gain of about 1.5 – 2% TRS i.e. Recovery gain in Distillery by 0.9 – 1.0% by maintaining lower storage temperature and subsequently maintaining optimum conditions during storage of molasses.

17. DISTILLERY SECTION – MULTI PRESSURE DISTILLATION TECHNOLOGY

Latest used Technology for Distillation is Multi-Pressure (MPR) Distillationwhich applies various heat integration methods, for the optimal economicoperation of the plant.

Multi-Pressure Distillation system has seven distillation columns operatingat various pressure conditions. Heat energy from columns operating underhigh pressure is utilized for columns operating under low pressure tooptimize the operation for energy consumption.

Advantages of Latest Multi-pressure Distillation Technology

• Energy efficient Multi-pressure Distillation system with a steamconsumption of 2.2 to 3.2 kg/lit of total spirit (depending on mode ofoperation & end product)

• Optimal heat integration to conserve energy

• Vacuum operation nearly eliminates scaling problem in Wash columnand ensures better separation of impurities, which results into betterquality product

18. FERMENTATION EFFICIENCY

DESIGN OPTIONS FOR FERMENTATION

Mainly three types of fermentation processes are adopted in distilleries:

Batch fermentation - In batch fermentation, feed material is diluted toappropriate sugar concentration. Yeast is inoculated into this dilutedsubstrate and fermentation is allowed to take place.

Continuous fermentation - In continuous fermentation, feed is continuously pumped into fermentors and an equal volume of fermented mash flowsout continuously, for recovery of alcohol, into distillation. Yeast is inoculated only at the beginning of the fermentation cycle.

Fed batch fermentation - Fermentation tank is charged by a small amountof liquid (water/substrate) before inoculation. Substrate is added in acontrolled way until the tank reaches its working volume

Effective yeast management and yeast strategy will enhance FermentationEfficiency and profits. Yeast is a minor cost (less than 1%) but can influenceoverall cost of production to a great extent.

19. MOLECULAR SIEVE DEHYDRATION TECHNOLOGY

Absolute alcohol is an important product required by industry. As per IS Specification it is nearly 100% pure / water free alcohol. Alcohol as manufactured is rectified spirit, which is 94.68% alcohol, and rest is water. It is not possible to remove remaining water from rectified spirit by straight distillation as ethyl alcohol forms a constant boiling mixture with water at this concentration and is known as azeotrope. Therefore, special process for removal of water is required for manufacture of absolute alcohol.
The latest process used for dehydration of alcohol using **molecular sieves** is as follows:

MOLECULAR SIEVE DEHYDRATION:

The salient features of the process are given herewith:

I) Dehydration with Molecular Sieve Process

The rectified spirit from the rectifier is superheated with steam in feed super-heater. Super-heated rectified spirit from feed super-heater is passed to one of the pair of molecular sieve beds for several minutes. On a timed basis, the flow of superheated rectified spirit vapor is switched to the alternate bed of the pair. A portion of the anhydrous ethanol vapor leaving the fresh adsorption bed is used to regenerate the loaded bed. A moderate vacuum is applied by vacuum pump operating after condensation of the regenerated ethanol water mixture. This condensate is transferred from recycle drum to the Rectified Column in the hydrous distillation plant Via Recycle pump. The net make of anhydrous Absolute alcohol draw is condensed in product condenser and passed to product storage.

The life of molecular sieve may be around five to seven years. However, the operating cost is considerably less than **azeotropic distillation**.

MOLECULAR SIEVE ETHANOL DEHYDRATION TECHNOLOGY FOR FUEL ETHANOL

Most of the ethanol dehydration plants for production of absolute alcohol are based on Azeotropic distillation. 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 of ethanol dehydration but it is now known to be a powerful carcinogen.

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, 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.

20.SPENT WASH INCINERATION TECHNOLOGY

Incineration may be defined as rapid destruction of polluting organic material to small volume of sterileash.

Revenue generation by power export is higher than Bio- composting.
So far Incineration Boilers are hooked up with back pressure Turbines, now –a-days these are associated with Condensing cum extraction Turbine as to maintain powerexport during fluctuations in steam/slope.

21. COMMERCIAL PRODUCTION OF CARBON DIOXIDE IN DISTILLERIES

During Fermentation of Sacchariferous (sugar containing) materials or hydrolysed amylaceous (starch containing) materials, the mono Saccharides are converted into Ethyl Alcohol and carbon Di-oxide. It is a common practice for most of the distilleries to let outthe CO2 in atmosphere. This is a wasteful method of disposing this valuable by – product of the fermentation Industry.
Several methods have been developed to recover CO2 from a mixture of air and CO2 which have been adopted on commercial scale. These are as follows:

i. Sodium Carbonate Process
ii. Potassium Carbonate Process
iii. Ethanol Amine Process

The Advantages of Recovering CO_2 in a Distillery are:

i. A waste product of distillery converted into wealth
ii. Recovering CO_2 and compressing it into cylinders in the form of liquid CO_2 or converting it into Solid carbon Dioxide (dry ice), will arrest environmental imbalance likely to develop due to too much CO_2 getting into atmosphere
iii. By utilizing CO_2 for various Industrial processes/products, the revenue to the distillery may go up.

22. TREATMENT OF SPRAY POND OVERFLOW FOR REMOVAL OF SULPHATE:

Spray pond overflow contributes to major part of a sugar factory effluent. Now, with stringent CPCB norms, it becomes imperative to treat spray pond overflow water for removal of Sulphate. Technologies available are yet to establish themselves as cost effective and efficient in the long run. There is need to study the available technologies and develop a suitable cost effective technology.

23. REPLACEMENT OF CONVENTIONAL CONDENSERS BY AIR COOLED CONDENSERS:

Technological advancements worldwide suggest that conventional condensers can be replaced by air cooled condensers. This technology uses air cooled condensers for creating vacuum in Evaporator and Pans meaning thereby that there will be no need of water and spray pond for creating vacuum. It will not only eliminate the problem of spray pond overflow (which will directly reduce effluent quantity) but also reduce water consumption. Study needs to be done for the viability of such system at a large scale, its suitability in sugar industry, power consumption parameters, installation and operational cost etc.