CHAPTER - 2

MANUFACTURING PROCESS, POLLUTION GENERATION AND CONTROL SYSTEMS

2.1 Introduction

Shamli Distillery & Chemical Works shall be engaged in the production of 80 KLPD alcohol using molasses as the basic raw material. In the production of alcohol, a number of raw materials are used viz. molasses, water, Antifoam agents, Urea and H2SO4 and Enzymes are briefly mentioned in Table 2.1 and 2.2 for the existing 25 klpd distillery and after proposed 80klpd distillery. This chapter presents raw materials, manufacturing process, pollution generation, treatment of spent wash and its utilization to achieve zero discharge..

The distillery will use molasses as raw material in the production of rectified spirit. The process description of alcohol production is given below. The general layout plan of the process units and sugar plant is shown in Fig. 2.1, distillery plant layout as Fig. 2.2, bio gas plant area in Fig. 2.3 & Bio composting-area as Fig. 2.4.

2.2 Manufacturing Process for the Distillery Plants :

2.2.1 Unit I : Molasses Based Distillery

a) Molasses : Storage & Handling

Molasses is a by-product of the sugar industry and is generally stored in Steel tanks. It is either pumped directly into the Steel Storage Tanks or first unloaded in a Pit and then transferred into Storage Tanks. Sometimes, external cooling is done on these tanks to control the temperatures in Molasses Tanks. As per requirement of the Distillery, Molasses is pumped using positive displacement pumps and transferred to the Fermentation section. It is first weighed and then pumped into individual Fermentors through magnetic type flow meters. The Weighing is done generally with load cell based system having a counter for measurement of quantity of Molasses being processed in a given period of time. After weighment of Molasses, it is then pumped to the Molasses dilutor / broth mixer located alongside each Fermentor.

b) Hiferm : Fermentation

Yeast propagation :

Molasses is received into the yeast vessel and sterilized by steam. Yeast seed material is prepared and added to the yeast vessels by inoculating molasses with yeast. The contents of the yeast vessel are then transferred to the Yeast activation vessel. The purpose of aeration in the yeast activation is to allow time for the yeast cell multiplication.

Fermentation :

The purpose of fermentation is to convert the fermentable sugars into alcohol. During fermentation, sugars are broken down into alcohol and carbon - di - oxide. Significant heat release takes place during fermentation. However the fermentation temperature is maintained at 32 - 35 deg C by use of forced recirculation plate type heat exchangers.

The yeast growth critically required for the fermentation process is maintained with utilisation of Yeast Activation vessels which are maintained under aerobic condition and the aerated cell mass is transferred to the fermentors.

At the end of fermentation cycle, Wash is fed to the Wash Holding Tank and is pumped further to the distillation section.

The process flow diagram for fermentation section is given in Fig. 2.5.

c) Multipressure Distillation :

This process utilizes the following Distillation Columns for removal of Alcohol from wash and its further rectification and concentration.

Main columns comprise the Analyser Column, Degassifying, Aldehyde, Rectifier cum Exhaust column.

The Fermented wash from fermentation section is fed to the degassifying column, where uncondensable gases are removed and the alcohol from Wash is further separated by stripping process in the Analyser column. Alcohol-Water mixture is then concentrated in Rectification cum Exhaust column and draw of Rectified sprit (RS) is taken from the top segment of the Rectifier column. Analyser, Degasifying and Aldehyde columns operates under vacuum, while the Rectifier cum Exhaust column operates under pressure. The Fusel oils (HFO & LFO) are separated from the bottom segment of the Rectifier column, and Spent Lees is separated from the bottom of the Exhaust Column.

Impure Spirit is separated from the top of Aldehyde and Rectifier columns. The Rectified Spirit and Impure spirit streams are condensed, cooled and stored in the spirit storage section.

The process flow diagram for distillation section is given in Fig. 2.6.

2.3 Pollution Generation and Treatment for The Distillery Units

2.3.1 Liquid Waste Generation, Characteristics, Treatment and Disposal

2.3.1.1 Introduction

In the manufacturing process the spent wash is the bottom fraction from the distillation column. This is the water fraction of the fermentation broth remaining after the recovery of Alcohol. It is a dark brown coloured liquid and contains all the unconverted sugars, traces of Alcohol and the yeast (those added for fermentation as well as the amount produced as excess yeast.

This liquid stream is first cooled by heat exchanger with the fresh fermentation broth for the recovery of heat and then is treated.

Liquid effluents are mainly generated from process and fermenter. The quantity of process wastewater generated will be 12.6 kg or 12 litres for every litre of alcohol produced by the distillery. The spent wash generation from the distillery shall be max. of 1008 MTPD or 960 KLPD for 80 KLPD molasses plant.

It will be first treated in a Biomethanation System, which not only reduces the effluent load, but also produces methane rich biogas. Biogas has a high calorific value and is used to produce power in the boiler. The production of extra power from biogas improves the economics of the ethanol project. The effluent after biomethanation will be passed through Reverse Osmosis for volume reduction by 60-70% and used in the bio-composting plant.

The sewage generated from the colony and sanitary blocks shall be treated in septic tanks and applied on to soak pits and used for irrigation of green belt. Non-process effluents shall be treated and used for irrigation.

2.3.1.2 Water Requirement and Water balance :

Water is required in the process, for dilution, yeast propagation and fermentation, Boiler feed water and non-process water use such as cooling for fermenters and condensers, bottling of liquors, washing, domestic, sanitary, gardening etc. The water requirement of various units will be 710 m3/day in the process, 600 m3/day soft water makeup for cooling towers,

216 m3 DM water for RS dilution, 40 m3/day make up DM water for boiler, 30 m3/day for bottling of liquor and 60 m3/day for uses such as drinking, Sanitary, Floor/Bottle Wash, etc. Boiler feed water is treated before feeding to the boiler in the DM plant. The water used in heat exchanger is cooled by cooling tower and is recycled.

Initially, the process & other requirements including steam generation, Blending & Bottling, domestic use etc. are estimated as 2773 m3 of water, which will be reduced to 1277 m3/day with plant stabilization and recycling. Hence, the plant would require 1277 m3/day of fresh water for its various operations.

The water balance diagram of the 80 KLPD molasses based distillery is given in Table 2.3 shown in Fig. 2.7.

The water requirement will be met from existing tube wells already dug at site.

The water requirement for the 25 klpd plant operation is 650 m3/day.

2.3.2 Adopted Wastewater Treatment System to Achieve Zero Discharge in case of Distillery Units

2.3.2.1 Approach to Effluent Treatment

Presently, for the treatment of effluent generated from the distillery, SDCW are taking Bio gas, Reverse Osmosis Plant, Bio composting route as per the guidelines of the Central Pollution Control Board. The same route will be adopted for the treatment of expanded capacity of the distillery.

2.3.2.2 ECOMET -BIOMETHANATION:

The conventional Bio-gas followed by RO followed by Bio-composting route includes the primary effluent treatment plant comprising Anaerobic treatment i.e. Bio-methanation that helps in recovering maximum Bio-Gas from the plant, with appreciable reduction in BOD and COD values.

Spent wash can also be anaerobically digested in a closed digestor by methogenic bacteria to generate methane gas. This gas is a valuable by-product which can be used as fuel. This process also results in saving of appreciable quantity of Fuel along with reduction in BOD and COD values by 85% and 65% respectively. The Process description is as below:

Anaerobic biomethanation system uses a specially designed **Mixed Tank Reactor**, (MTR) called Biodigester, to convert organic matter into useful energy in the form of Biogas. The biological process of conversion takes

place at mesophilic temperature in a controlled atmosphere ensuring maximum conversion efficiency & production of biogas.

Following are the salient features of the system.

1. Pre-settling:

Before entering the Biodigester, the spent wash, effluent from distillery unit, is received into a suitably designed spent wash Pit to enable settling of suspended solids in spent wash pit. The properly designed pre-settling system ensures consistent operation by reducing the solid built up in the Biodigester. The settled solids are removed periodically from the pit for further disposal.

2. Temperature control:

The spent wash is pumped to Biodigester, via heat exchanger. The heat exchanger is designed to maintain the spent wash temperature in the range of 36 – 40 ^{o}C. using cooling water. The same heat exchanger can be used for heating the feed during winters, if required.

3. pH control:

Spent wash pH is adjusted to 6.5 – 7.0 by recycling part of the treated effluent.

4. Mixing in Biodigester:

Mixing is done by re-circulation of biomass using scientifically designed mixing system & further enhanced by gas propagation. Efficient mixing helps microorganisms to reach fresh food in favorable living condition & convert organic matter into Methane & Carbon dioxide. Various sample points are provided in the Biodigester to measure the concentration of sludge in the Biodigester. Drain points are provided to drain the sludge from Biodigester.

5. HRT & SRT:

Biodigester is designed for 16 to 18 days of hydraulic retention time, which is required for achieving design parameters while reducing the effects of shock loads & making the process sturdy. The digested effluent from Biodigester flows to a Parallel plate clarifier via degassing pond. The entrapped gases in the digested effluent are released in degassing pond.

The sludge is settled in the parallel plate clarifier, which is recycled to increase solid retention time in the Biodigester. The supernatent liquid from

clarifier is sent for further treatment. Excess biomass & sludge is removed from the bottom of Bio digester regularly to sludge drying beds for disposal.

6. Gas Collection & handling:

The biogas produced in Bio digester is collected from top of the Bio digester & flows to the gasholder. The gasholder acts as intermediate gas storage & pressure control device. A biogas is transferred to the boiler house by using Biogas blowers. The flare unit is provided for excess gas burning.

7. Safety System:

For safe operation, Flame Arrestors are provided on gas lines to protect the Bio digester from backfire & pressure relief valves are provided on Bio digester to protect from excess pressure or vacuum.

8. Control System:

The smooth & safe operation of the system is ensured by controlling pH, temp. Volatile acidity & alkalinity by following the operating instructions using various control features provided.

2.3.2.3 Reverse Osmosis Plant

The proposed system is based on Cross-Flow Membrane (CFM) filtration technique and is designed for removal of organic acids from evaporation condensate of a bio-ethanol complex.

The condensate treated by such system can be reused back into the bio-ethanol manufacturing process as process water or cooling water make-up thereby reducing the requirement of fresh water as well as solving the question of waste disposal to a great extent.

The system is based on following principle operations :

1) Cooling & Neutralization
2) Membrane filtration of the neutralized stream to remove salts of acids
3) Recycle of treated streams back to process
4) Concentrated reject part disposal & part recycle to slop evaporation system

System typically recovers 65 to 70% of the Condensate as reusable water and has about 30 to 35 % reject. (These figures are based on input levels of organic acid which are mentioned ahead and will vary slightly based on changes in Feed Characteristics).

Description of Unit Operations and Processes:

Collection Tank:

Hot process condensate from the evaporation section and the hot spent lees from the distillation section are collected in a collection tank where these streams are get well mixed and referred to as combined effluent.

Combined Effluent Cooler:

Hot combined effluent from the collection tank is pumped using priming pump via plate heat exchanger which will be taken care in the evaporation section, where it is cooled to 35 ^{0}C before entering to static mixer using cooling water from the cooling tower.

Static Mixer:

The cooled combined effluent is then entered into a static mixer, where it is neutralized using caustic solution. Caustic solution is dosed using a dosing system consisting of dosing tank and dosing pumps. Dosing is controlled using pH sensor attached on downstream of the static mixer.

Cartridge Filter:

Neutralized combined effluent then enters into cartridge filter provided to arrest suspended solids in the effluent stream, if any. Bypass arrangement is provided to by pass the filter during maintenance of the filter

High Pressure Pump:

The clear effluent after cartridge filter is then pumped using high pressure pumps to the membrane modules for the treatment.

Membrane Skid:

Membrane skid consists of membranes housed in membrane housings. The feeding logistics to the various membrane housings depends on the scheme configuration. Permeate from the skid is collected in a permeate collection tank. Part of the reject from the membrane ETP is recycled back to the suction of high pressure pump whereas the balance is suitably discharged for further treatment.

Permeate Collection Tank:

Permeate collected from the membrane ETP is pumped using permeate transfer pump for it reuse in process/cooling tower or suitably discharged.

Part of permeate is used for flushing of membranes after membrane cleaning.

2.3.2.4 Biocomposting

Material Balance Of Press Mud And Spent Wash

The Central Pollution Control Board has issued a Protocol with alternatives for the utilization of distillery spent wash after treatment for biocomposting or burning after evaporation. The proposed molasses distillery shall generate 272,160 MT/year (1008 MT x 270 days) which will be subjected to biomethanation followed by Reverse Osmosis. After RO about 136,080 MT/year of reject shall be generated which shall require 37143 MT of press mud/biomass with 4 cycles of 60 days each per year. The requirement of press mud/biomass shall be met from two sugar mills which generate 54000 MT of press mud. About 17000 MT press mud is required for biocomposting at Pilkhani plant. The areas required for biocomposting, storage of press mud and finished product, and lagoon for one month storage of spent wash has been worked out as 15 acres shown in Fig. 2.4. The calculation of press mud requirement, utilization of spent wash and land requirement is given in Annexure 2.1.

The floor of land required for Compost area is prepared as per the Specifications laid down in the CPCB Protocol and shall have arrangement of leachate collection and surface runoff and its pumping to holding lagoon and laying of pipe network for automatic spraying of spent wash. SDCW has procured the Equipment and Machinery required for biocomposting as per the CPCB protocol.

2.3.3 Air Emission Sources and Control from Power Plant

There are no process emissions from the distillery. Air emission sources are boiler and D.G. Set. Boiler is for steam generation and D.G. set is for standby power generation. The boiler will be fired with bagasse available from sugar mill boiler and biogas from distillery. The steam generation capacity of the boiler is 12 TPH. The steam and power requirement shall be met from existing 12 tph boiler which has already been set up as part of 25 KLPD distillery at SDCW and two D.G. Sets.

Bagasse and biogas are a cleaner fuel and the emission loads shall be extremely low which will be controlled by providing an adequate stack height as per the specified norms of the UPPCB/CPCB/MoEF. Multicyclones and Bag filters for dust collection sufficient to achieve 50 mg/Nm^3 for SPM shall be provided as Air Pollution Control System.

Adequacy of Stack Heights

The fuels used for the boiler shall be Biogas and bagasse and HSD for the D.G. Sets. Adequate Stack heights are provided for as per the laid down norms for these emission sources.

2.3.4 Solid Waste generation and management

Solid Wastes are generated in the form of Fly ash and Biological sludge in the fermentation House and Bio gas plant. Estimated quantities of these solid wastes for the existing and proposed distillery shall be as below:

		Existing	For Expansion
Yeast Sludge	=	0.5 tpd	1.5 tpd
Boiler ash	=	1.2 tpd	0.8 tpd

Quantity of Fly Ash (MTPA)	Quantity of Biological Sludge (MT/Day)
~ 200 Tonnes	Approx. 10 Tonnes

The management of solid waste presents no problem as the above quantity of Biological Sludge and Fly ash so generated will be used in the process of Bio composting to make bio-compost.