Manufacturing Process of molasses based distillery

BY

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Manufacturing Process of molasses based distillery

Production of alcohol comprises broadly 3 sections, viz.

(i) Fermentation

(ii) Distillation and

(iii) Effluent treatment and disposal.

The fermentation consists of following steps;

1. **Molasses weighing -**Weighment of molasses will be carried out either through a load cell based system or through a direct flow meter system both with totalizing provisions.
2. **Dilution**
3. **Yeast Propagation**
4. **Pre fermentation and**
5. **Fermentation**

DILUTION

The first operation, which is carried out on molasses is dilution. In dilution operation molasses, from the storage tank is diluted with raw water. The diluted molasses is used for subsequent unit operations i.e. yeast propagation & fermentation. The dilution ratios required for yeast propagation and fermentation are different. For requirement of yeast propagation, molasses is diluted to keep the sugar percentage of 8 – 9% while for fermentation molasses is diluted to keep the sugar 16-18%.

Yeast Propagation

Sacchromyce ceriviseae sp is the yeast used for molasses fermentation. Yeast is unicellular living organism. The growth of yeast takes place by division of one cell into two, two cells into four and so on, if sugar solution is provided for its growth. Two types of fermentation process are generally observed during fermentation.

Aerobic Fermentation:

Aerobic fermentation takes place in presence of excess oxygen and in this process, the yeast growth remains optimum. Ethyl Alcohol production is less, because most of the sugar gets converted into water, carbon dioxide and yeast during fermentation. Aerobic fermentation is suitable for yeast propagation, with the main objective to achieve the growth of yeast cells.

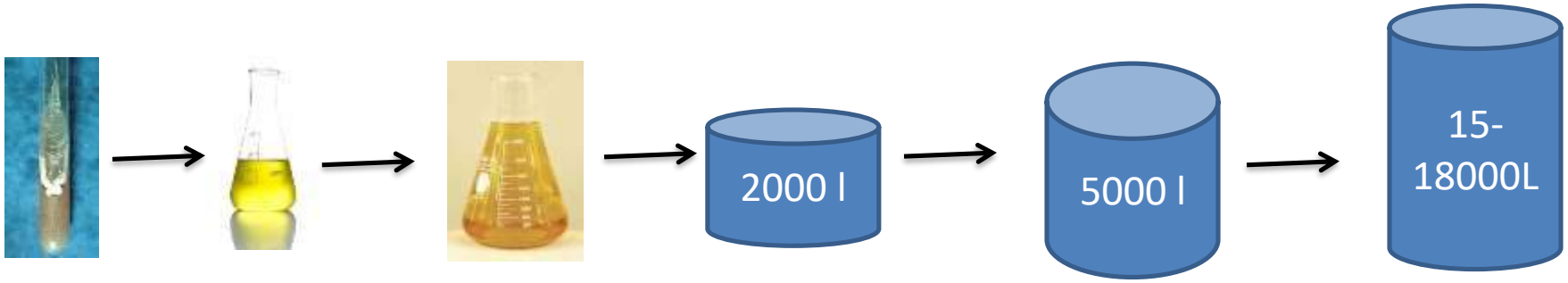
Anaerobic fermentation

Anaerobic fermentation occurs in absence of Oxygen. Under anaerobic condition the sugar gets converted into ethyl alcohol and carbon dioxide. Yeast growth is less in the anaerobic process. Hence, this process is suitable for ethyl alcohol production, but not yeast propagation.

Yeast Propagation

Yeast propagation is being done in aerobic condition and it is slated in the laboratory strictly under hygienic conditions. To start with, a few yeast cells are added to the sterilized diluted molasses the entire sugar contain in solution is exhausted. The contents of test tube are then transferred to a volumetric flask and made up to 250 ml with sterilized diluted molasses. The solution is left for further growth of yeast. After yeast growth is achieved in 250 ml solution, it is further made upto 1 liter with sterilized diluted molasses. The process is repeated till 20 liters of solution containing yeast biomass is obtained.

Further, yeast propagation is carried out in the yeast vessel in the fermenter house. The 20 liter of yeast solution obtained from laboratory is propagated to required volume through various stages in yeast vessels of capacities 100 l, 500 l, 2000 l and 5000 l from the yeast vessels the yeast biomass is fed to the pre-fermenters, in which diluted molasses is added in the pre-fermenters, aerobic conditions are maintained by means of submerged aeration to maximize yeast production. The capacity of Pre-fementer vessels ranges from 15000 L to 18000 L.



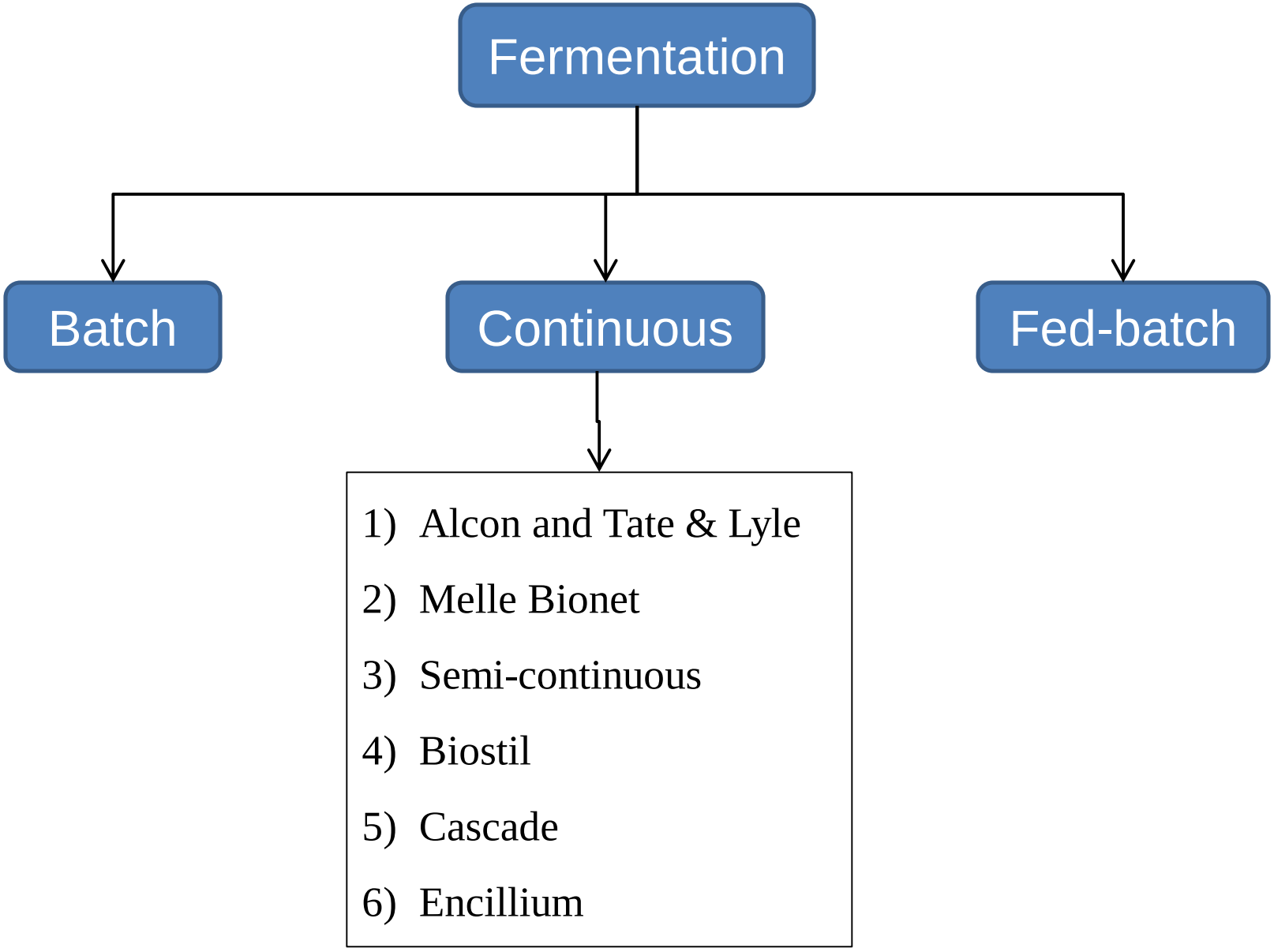
Fermentation

Fermentation is carried out in the fermentation vessels under controlled conditions of temperature and pH. The propagated yeast biomass is transferred to the main fermenters keeping volume at 10 to 15% of the total fermenter volume. The rest is filled with diluted molasses. After filling the fermenter, it is left for fermentation. This process occurs under anaerobic condition. Under these conditions, the glucose molecule breaks down to produce ethyl alcohol and carbon dioxide. The time required for completion of the fermentation process is 15 – 20 hours. The fermentation process is understood to be completed when the effervescence stops. Other measurement like specific gravity etc., are also taken to assess the completion of fermentation process.

Fermentation is an exothermic reaction. Hence, the temperature rises during the fermentation process. To maintain the temperature at 36 degree C., the fermenter vessels are required to be cooled with fresh water, through plate type heat exchanger.

The yeast sludge along with solids present in molasses is collected at the bottom of the fermenter vessels. These solids need to be removed to make the fermenter vessels ready for another batch of fermentation process. The sludge is washed off by water. The washed sludge called fermenter washing constitutes a waste along with some alcohol.

The fermenter washing is centrifuged in a high speed centrifuge machine, which separates solid and liquid the liquid containing some alcohol is sent for distillation while the solid contained biomass and other solid is sent for bio-composting.


Fermentation
Batch
Continuous
Fed-batch
1) Alcon and Tate & Lyle
2) Melle Bionet
3) Semi-continuous
4) Biostil
5) Cascade
6) Encillium

Batch fermentation

- All necessary medium components and the inoculum are added at the beginning.
- The products of fermentation, whether intracellular or extracellular, are harvested only at the end of the run.
- The concentration of medium components are not controlled during the process.
- As the living cells consume nutrients and yield product(s), their concentrations in the medium vary along the process.
- The affecting factors, such as pH and temperature, are normally kept constant during the process.
- The optimum concentration of raw materials can be decided only according to the initial concentration.

Continuous fermentation

- One or more feed streams containing the necessary nutrients are fed continuously.
- The output stream containing the cells, products and residues is continuously withdrawn.
- A steady state is established for the process.
- The culture volume is kept continuous by maintaining an equal volumetric flow rate of feed and output.
- Need for cleaning is minimized as a continuous culture concentration is maintained in the fermenter.
- Continuous fermentation systems require good quality of molasses and are susceptible to contamination.

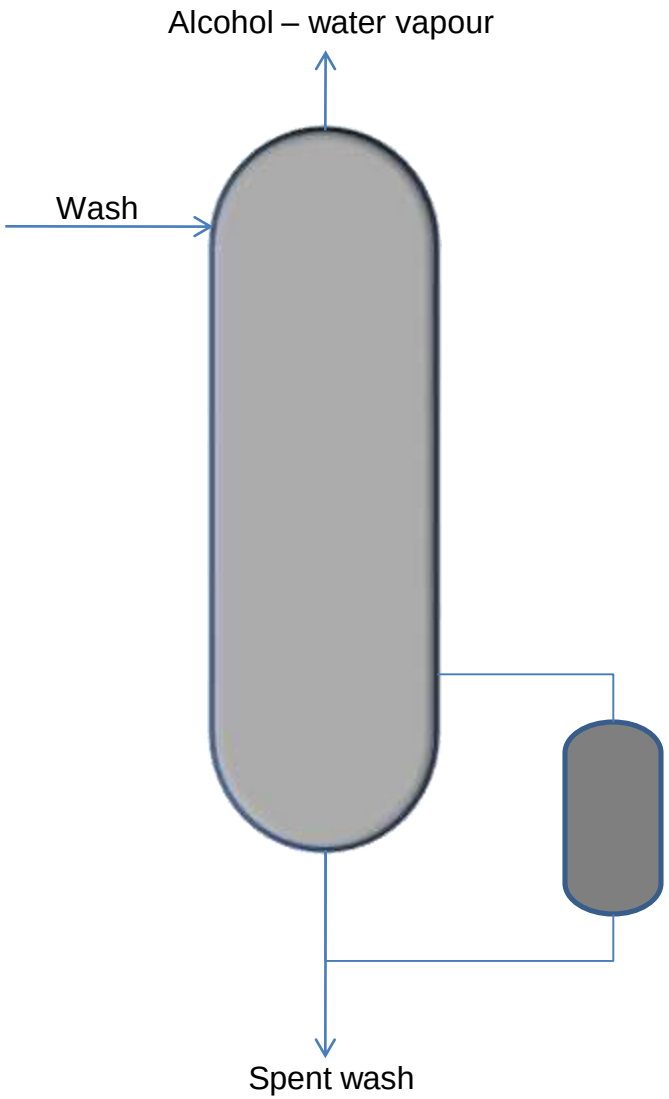
Fed-batch fermentation

- ✓ Nutrient or raw material is fed intermittently.
- ✓ After the first filling, the inoculum is added.
- ✓ After a small retention time, filling is continued.
- ✓ Fermentation starts right after the first filling and continues along the process.
- ✓ At the end of the process, fermenter is emptied and the product is obtained.
- ✓ It is currently the most popular mode of fermentation amongst the distilleries in India.

Distillation

1. Analyzer Column
2. Degasifying Column
3. Pre Rectification cum stripper column
4. Extractive distillation column
5. Recovery Column
6. Rectifier cum Exhaust Column
7. Simmering Column
8. MSDH column

Analyzer Column



•In this column **preheated fermented wash** is stripped off from **all volatile components**, including ethyl alcohol.

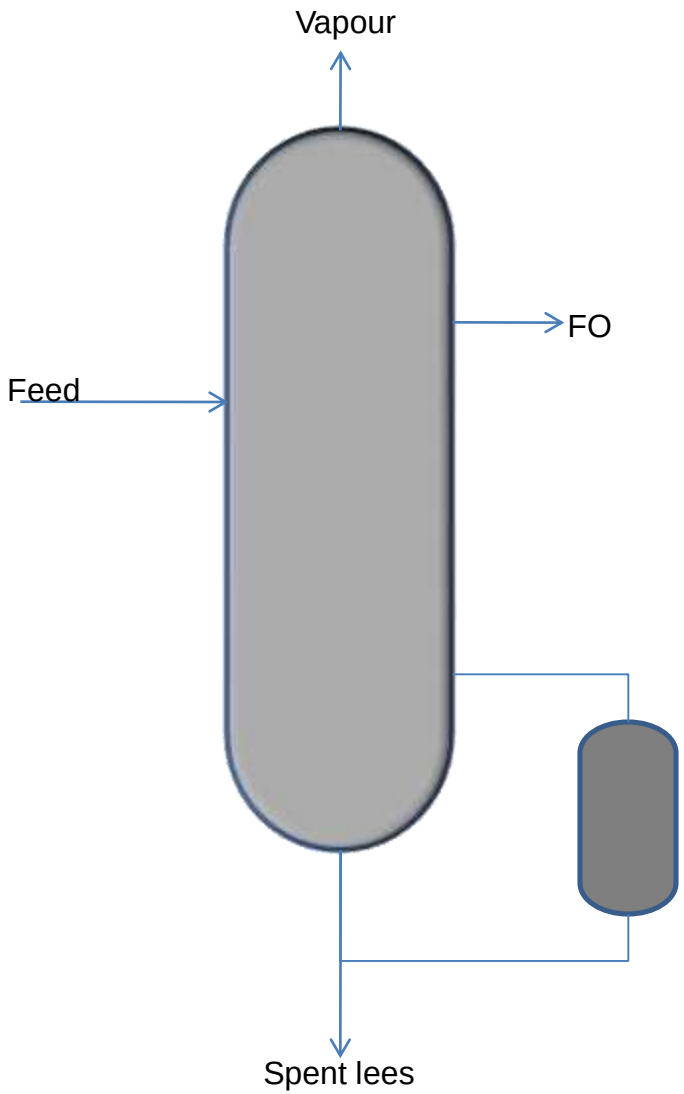
•From **bottom, spent wash is drained and sent to ETP**.

•This column generally **has a degasser section on the top**, which **removes all dissolved gases** in the fermented wash.

•This column is generally **operated under vacuum** to eliminate the **chance of scaling and reduce energy** requirement.

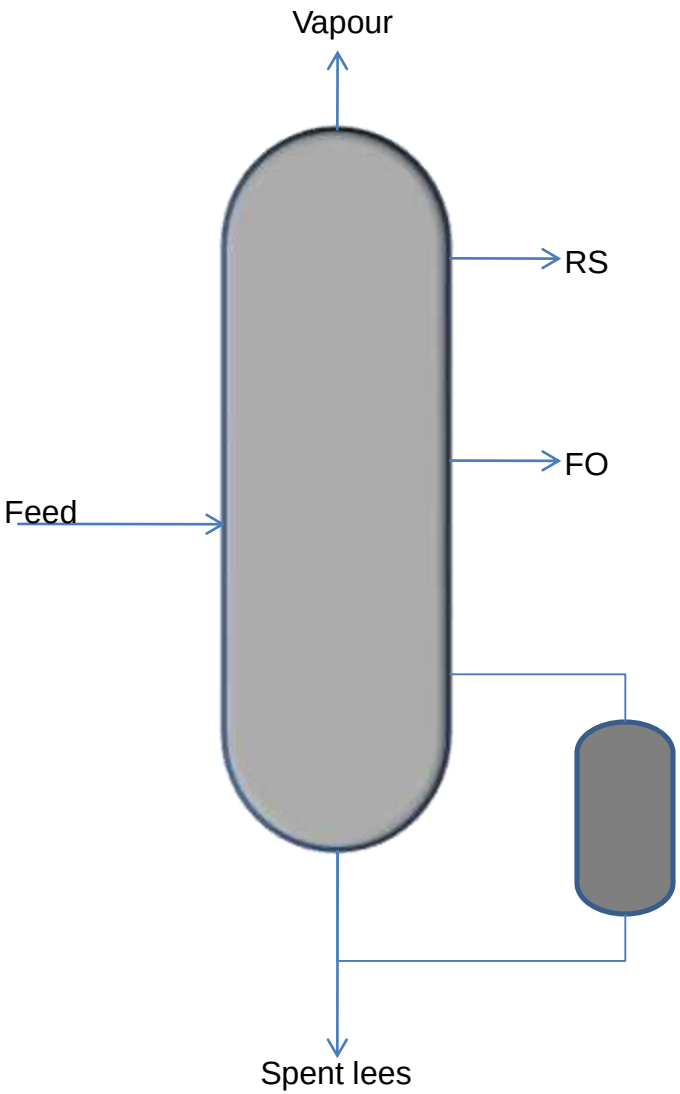
•The vapors (45% to 55% ethanol vapors) of this column are condensed and fed to prerectifier column.

Pre-rectifier Column



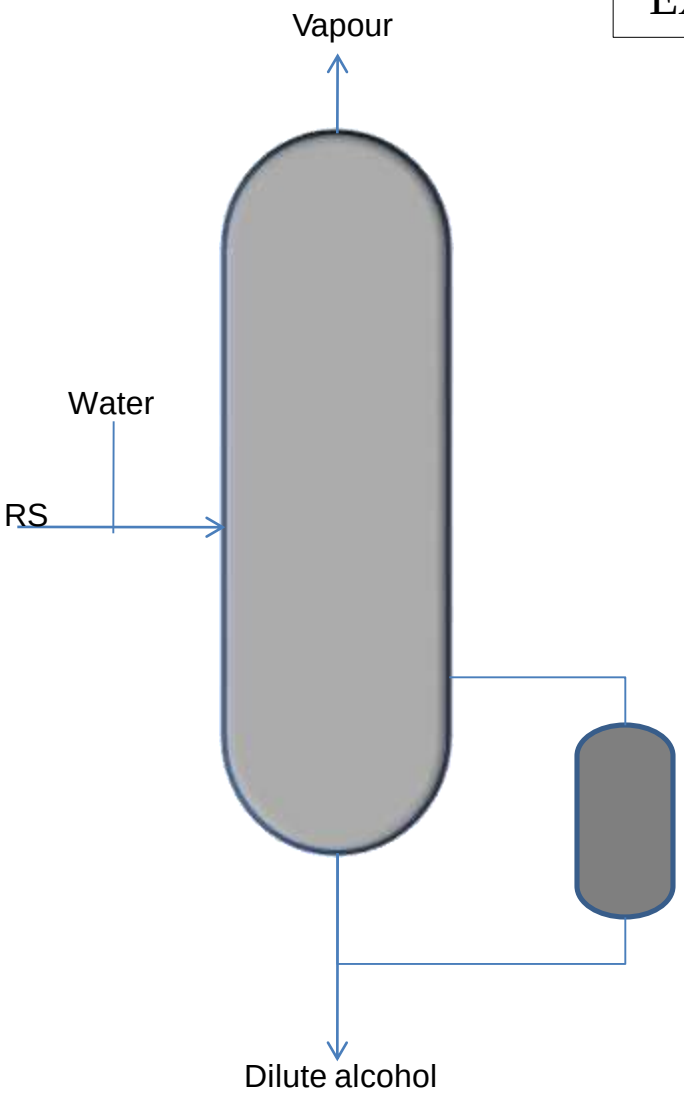
- In this column the heavier alcohols (fusel oil) are separated and collected from top middle draw.
- It is operated under vacuum.
- The main product is drawn off from the top side of the column.
- Bottom product of the column is called spent lees.

Rectifier Column



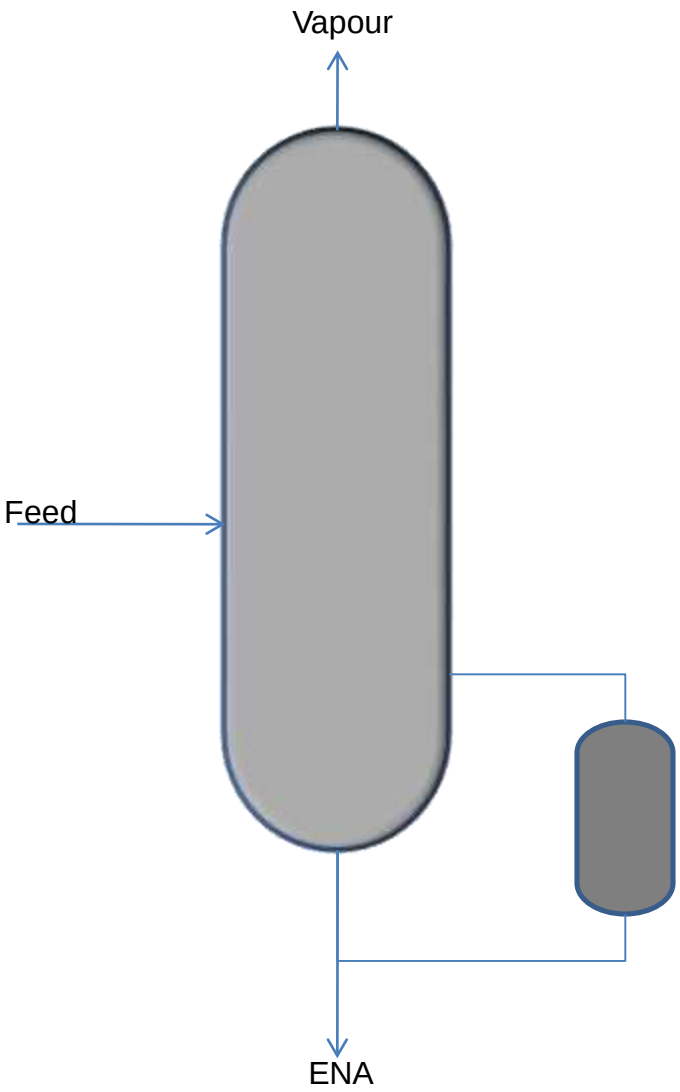
- This column operates under elevated pressure.
- Rectified spirit, the first alcoholic product, is drawn from this column.
- The bottom product, spent lees, is used in the process of fermentation.
- Fusel oil and technical alcohol are also drawn from this column.

Extractive Distillation Column



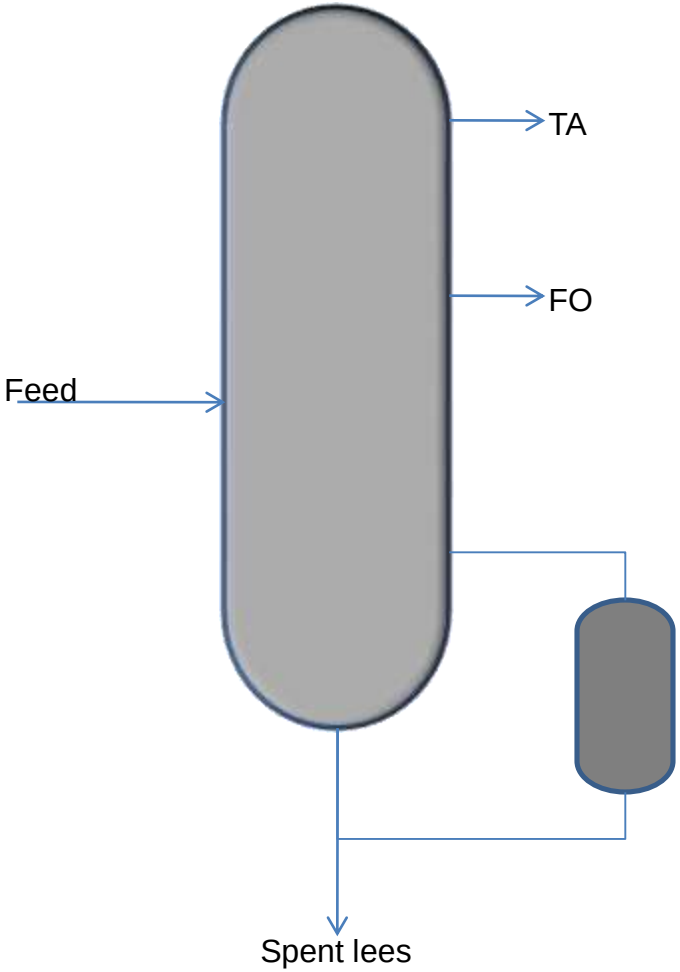
- In this column DM water is used as an extractant to dilute the rectified spirit.
- Water is added to change the relative volatility of the undesirable components to obtain a product clear of smell.
- Water is added in the ratio of 1:9.
- It is operated at atmospheric pressure.
- Bottom product is fed to the simmering column for further concentration.

Simmering Column



- This column is operated under high reflux and vaccum
- Methanol, diacetyl and mercaptans are separated from the top of the column.
- The final product, i.e., extraneutral alcohol (ENA) is obtained as bottom product.

Recovery Column



- Fusel oils along with the condensates of analyzer and ED column are fed to this column for concentration.
- A technical alcohol is taken out from the top of the column.
- Fusel oils are drawn off from upper trays
- Bottom lees is drained off.
- It is operated at atmospheric pressure.

Molecular Sieve Dehydration System

- Molecular sieve technology works on the principle of pressure swing adsorption.
- Molecular Sieve is nothing but synthetic Zeolites typically 3 Angstrom Zeolites. This material has strong affinity for water.

•They adsorb water in cold condition and desorbs water when heated. This principle is used to dehydrate ethanol.

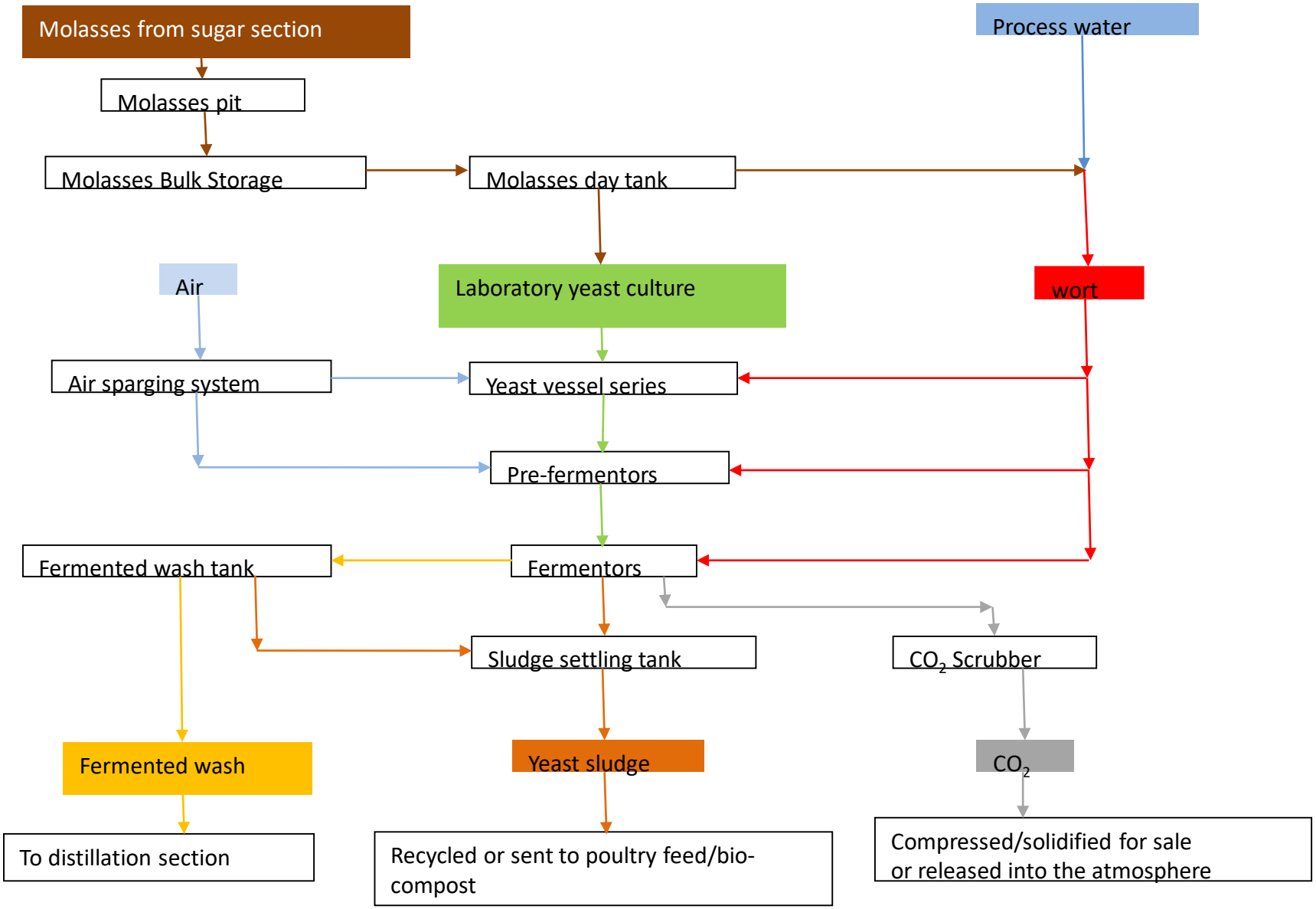
•The crystalline structure of zeolites is complex and gives this material the ability to adsorb or reject material based on molecular sizes.

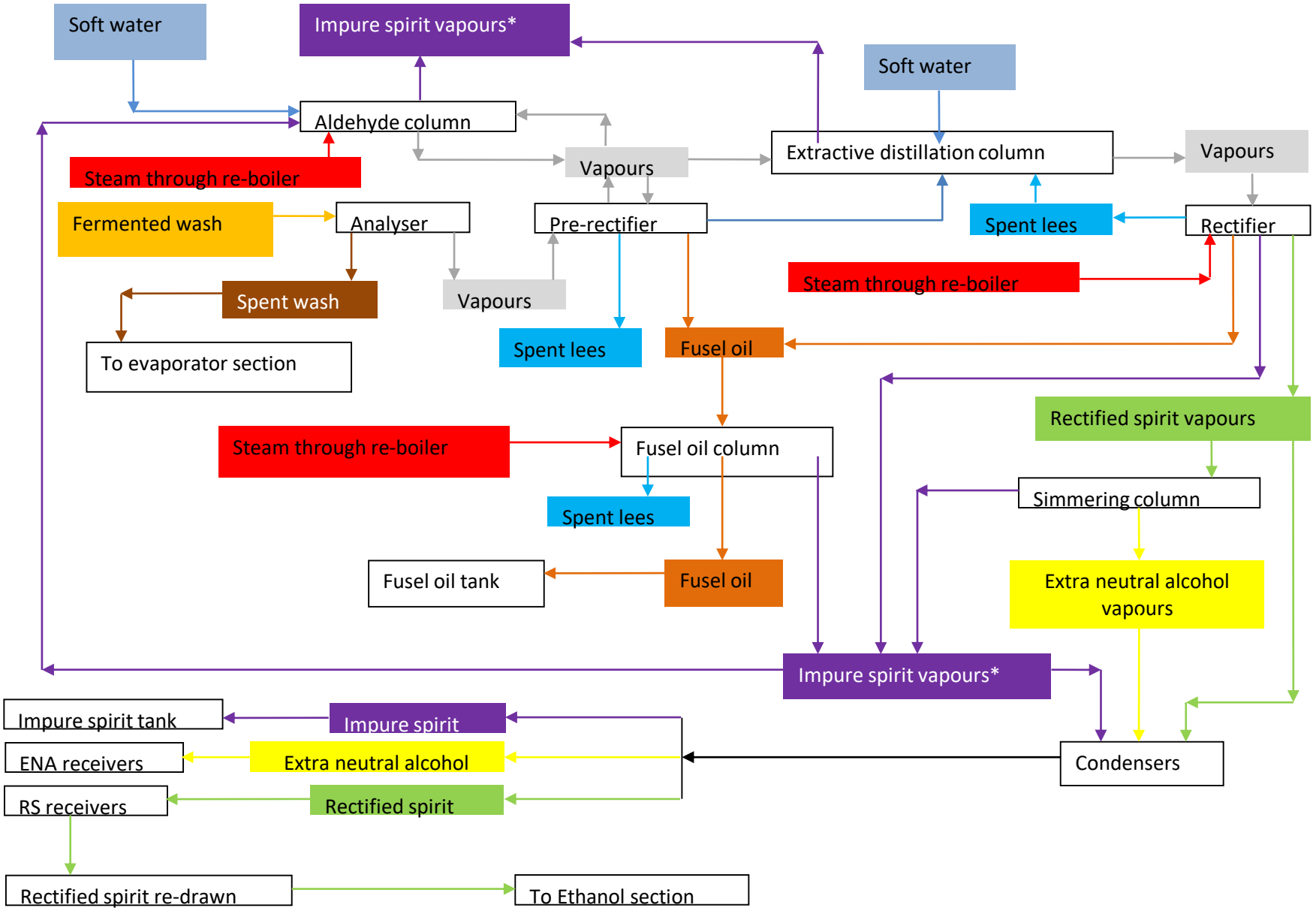
•The molecular sieve adsorbents developed for vapour phase, Ethanol dehydration are metal alumino-silicate with effective pores size opening of 3 Angstrom.

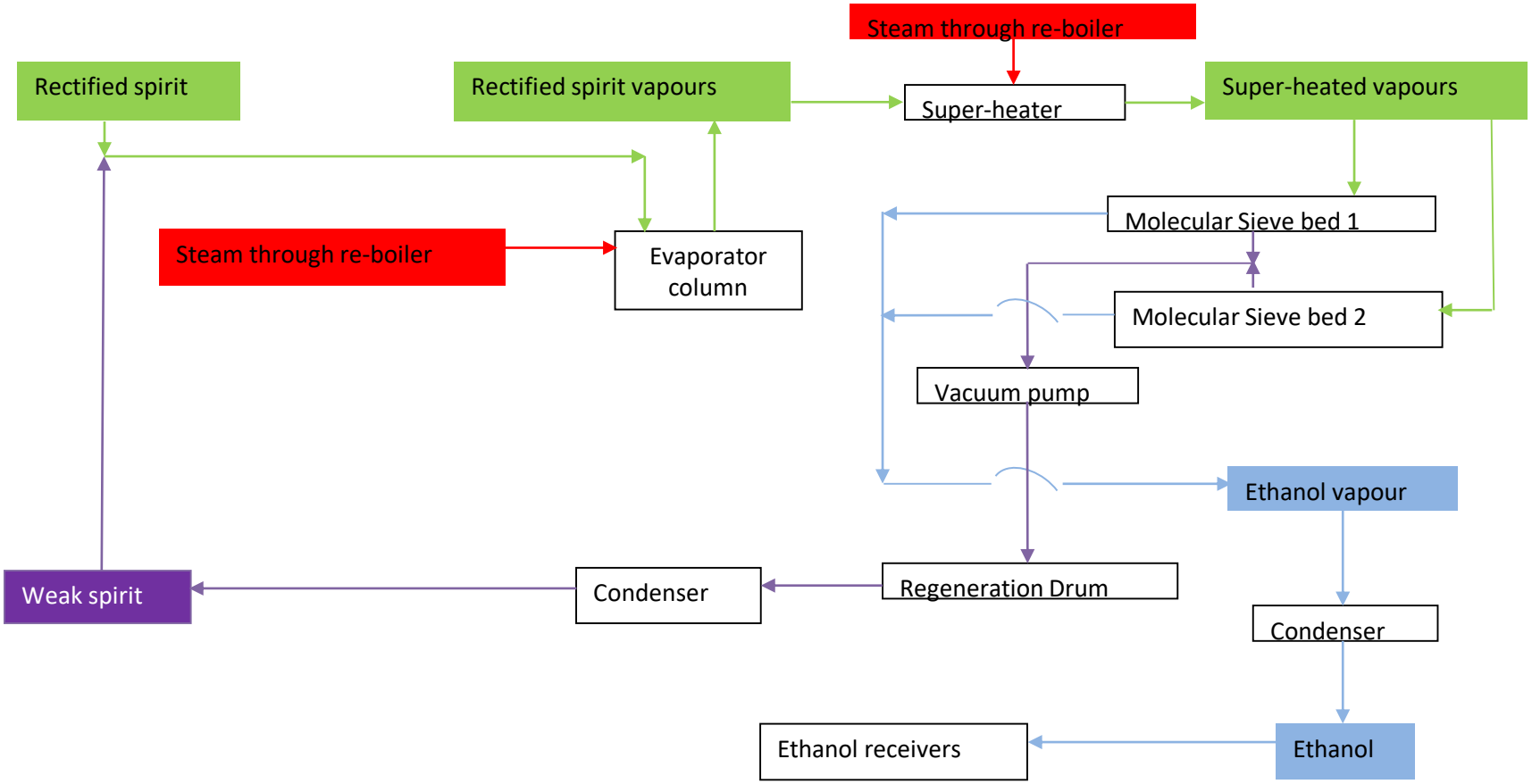
•During dehydration of ethanol, the water of hydrolysis fills the cavities or pores in the molecular sieve. The potassium form of molecular sieve has pore size of 3 Angstrom, the critical diameter of water molecules is 3.2A and Ethanol is 4.4 A.

Contd…

- In vapor phase, the gaseous water molecules are strong dipoles. They are drawn in to the pores and condense at the wall of pores, while ethanol being bigger in size passes through the bed without getting in to pores of molecular sieve.
- The life of molecular sieve is 5 to 7 years.
- RS is fed to the column for concentration and heating.
- The superheated vapour is fed to one of the sieve columns for adsorption of moisture.
- When the first sieve column gets saturated, the second is under operation.
- The first sieve column is cleared of the accumulated moisture by vacuum.
- Ethanol (99. 6 %) is obtained from the sieve column and is cooled.


Molasses from sugar section
Process water
Molasses pit
Molasses Bulk Storage
Molasses day tank
Air
Laboratory yeast culture
wort
Air sparging system
Yeast vessel series
Pre-fermentors
Fermented wash tank
Fermentors
Sludge settling tank
CO_2 Scrubber
Fermented wash
Yeast sludge
CO_2
To distillation section
Recycled or sent to poultry feed/bio-compost
Compressed/solidified for sale
or released into the atmosphere


Soft water
Impure spirit vapours*
Soft water
Aldehyde column
Steam through re-boiler
Vapours
Extractive distillation column
Vapours
Fermented wash
Analyser
Pre-rectifier
Spent lees
Rectifier
Steam through re-boiler
Spent wash
Vapours
To evaporator section
Spent lees
Fusel oil
Rectified spirit vapours
Steam through re-boiler
Fusel oil column
Simmering column
Spent lees
Fusel oil tank
Fusel oil
Extra neutral alcohol vapours
Impure spirit vapours*
Impure spirit tank
Impure spirit
ENA receivers
Extra neutral alcohol
Condensers
RS receivers
Rectified spirit
Rectified spirit re-drawn
To Ethanol section


Steam through re-boiler
Rectified spirit
Rectified spirit vapours
Super-heater
Super-heated vapours
Molecular Sieve bed 1
Steam through re-boiler
Evaporator column
Molecular Sieve bed 2
Vacuum pump
Ethanol vapour
Weak spirit
Condenser
Regeneration Drum
Condenser
Ethanol receivers
Ethanol

Thank you