19-10-2023
Thursday

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1) Zeroth law of thermodynamics

→ The zeroth law of thermodynamics states that if 2 systems are both in thermal equilibrium with a third system, then the two systems are in thermal equilibrium with each other.

→ Thermal Equilibrium: State in which there is no net heat flow between 2 systems, i.e.: the 2 systems are at the same temperature.

→ Zeroth law can also be stated as:

> 2 systems are in thermal equilibrium with each other if and only if they are at the same temperature

First law of thermodynamics

→ First law of thermodynamics gives the principle of energy conservation, i.e.: energy can neither be created nor destroyed, it can be converted from one form of energy to other.

→ The energy can be classified such as heat, work and internal energy

→ Energy efficiency:

$$\eta_{en} = \frac{(\text{energy output})_{\text{desired}}}{(\text{energy input})_{\text{required}}}$$

Second Law of Thermodynamics:

→ Second law of thermodynamics gives an insight on direction of spontaneous process or the maximum energy conversion efficiency.

→ Kelvin-Planck Statement:
It is impossible for a cyclic heat engine to produce net work output operating in a single thermal reservoir

→ Clausis Statement:
It is impossible to construct a cyclic device which transfer heat from low temperature thermal reservoir to high temperature thermal reservoir without any external effect.

Third Law of Thermodynamics:

→ Third law of thermodynamics states that the entropy of a system at absolute zero is constant.

→ Absolute zero: Lowest possible temperature, at which all molecular motion ceases.

→ Entropy: Measure of disorder of system, so at absolute zero, the system is in its most ordered state, and hence has lowest possible entropy

→ Third law of thermodynamics has several implications such as:

(a) It is impossible to reach absolute zero in a finite number of steps

(b) It is impossible To create a perpetual motion machine

2) Given:

→ Date: December 1

→ Time: 0900 h (local apparent time)

→ Location of collector: New Delhi (28°35'N, 77°12'E)

→ Tilt of collector with horizontal = 36°

→ collector is pointing due north

To calculate:

→ Angle made by beam radiation with normal to a flat plane collector

Calculations:

Since collector is pointing due north

$\gamma = 0°$

$\Rightarrow \delta \text{ (in degrees)} = 23.45 \sin\left[\frac{360}{365}(284+n)\right]$

$\Rightarrow \delta = 23.45 \sin\left[\frac{360}{365}(284+335)\right]$

$\Rightarrow \delta = -22.1077$

At 0900 h (local apparent time), $\omega = 45°$

$\cos\theta = \sin(-22.1077)\sin(28.58-36) + \cos(-22.1077)\cos 45 \cos(28.58-36)$

$\Rightarrow \cos\theta = 0.0486 + 0.6496$

$\Rightarrow \cos\theta = 0.6982$

$\Rightarrow \theta = \cos^{-1}(0.6982)$

$\boxed{\theta = 45.7172°}$

3)

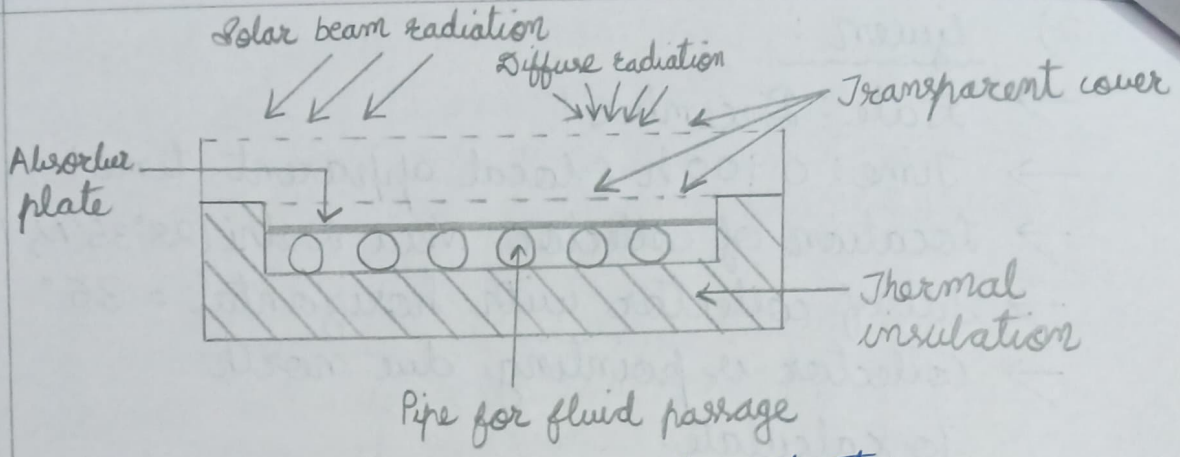

Fig: Flat plate solar thermal collector

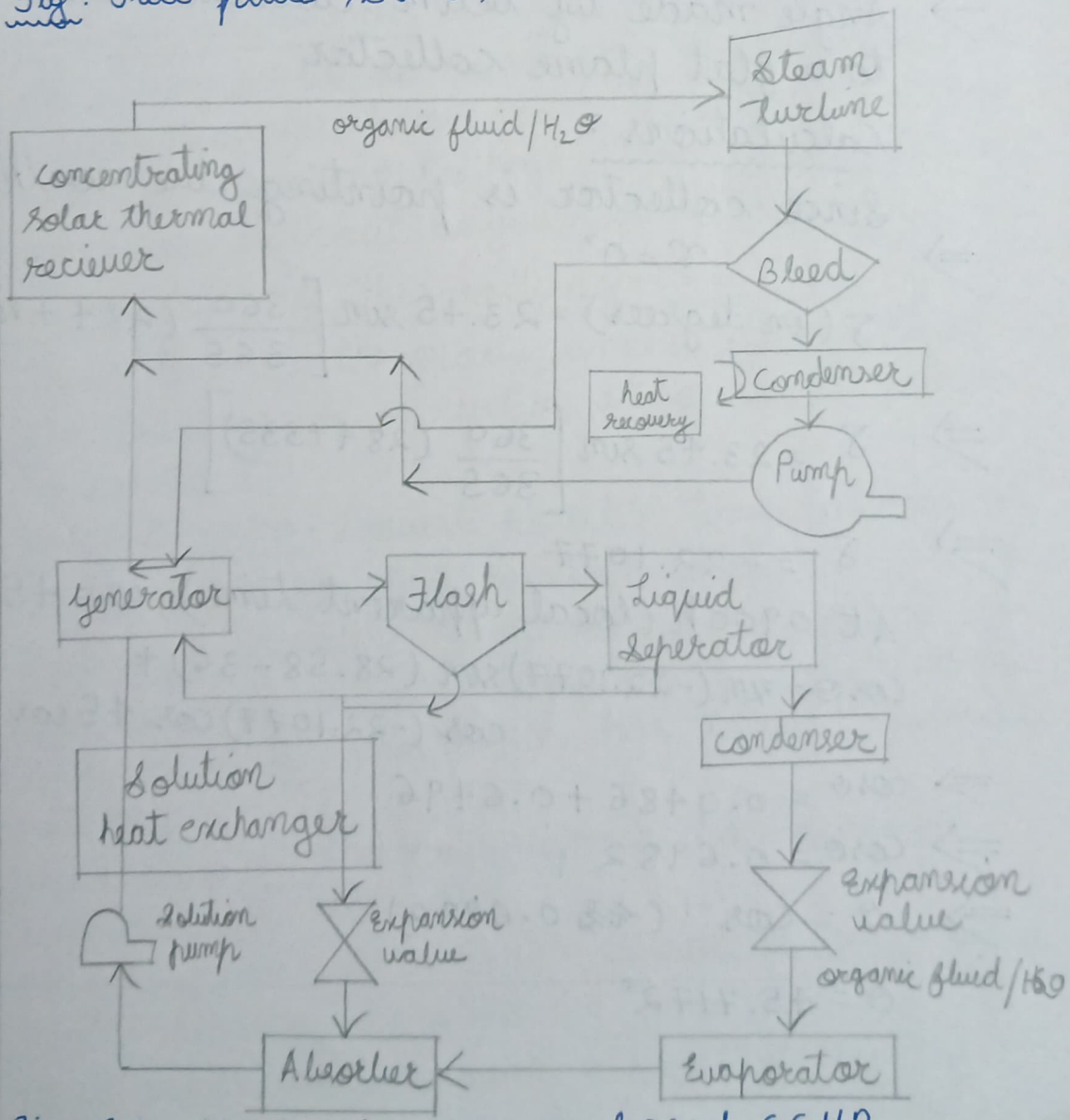

Fig: Schematic of solar energy based CCHP

~~4) Biomass conversion to ethanol:~~

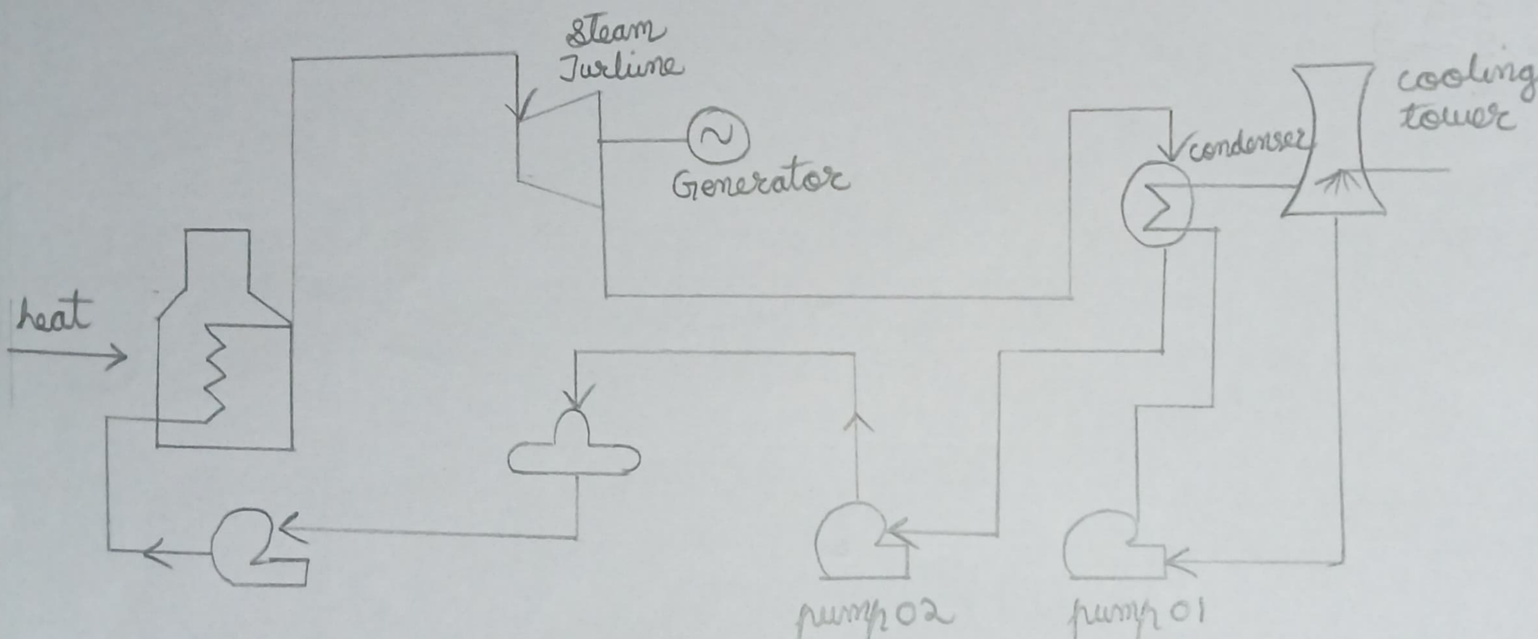

Fig: Schematic of biomass based Rankine cycle power generation

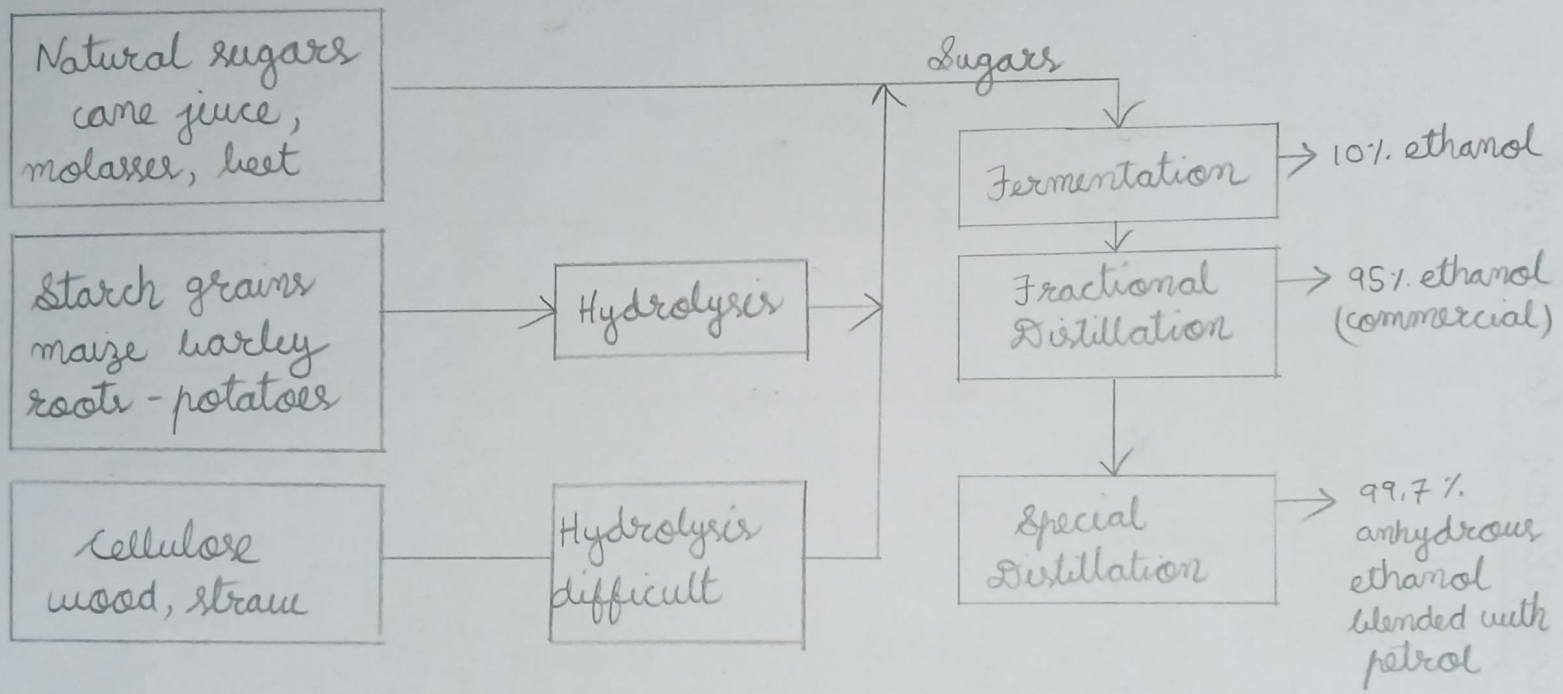

Fig: Schematic of biomass conversion to ethanol