Solar Water Distillation System

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What is Distillation?

- *Distillation* is a process wherein a liquid or vapour mixture of two or more substances is separated into its component fractions of desired purity, *by the application and removal of heat*.
- Process of vaporizing a liquid, condensing the vapor, and collecting the condensate in another container.

  Liquid → Vapor:

  Vapor → Liquid
- Liquid and Vapor always in equilibrium.

  Liquid  Vapor

Different Types of S.W.D

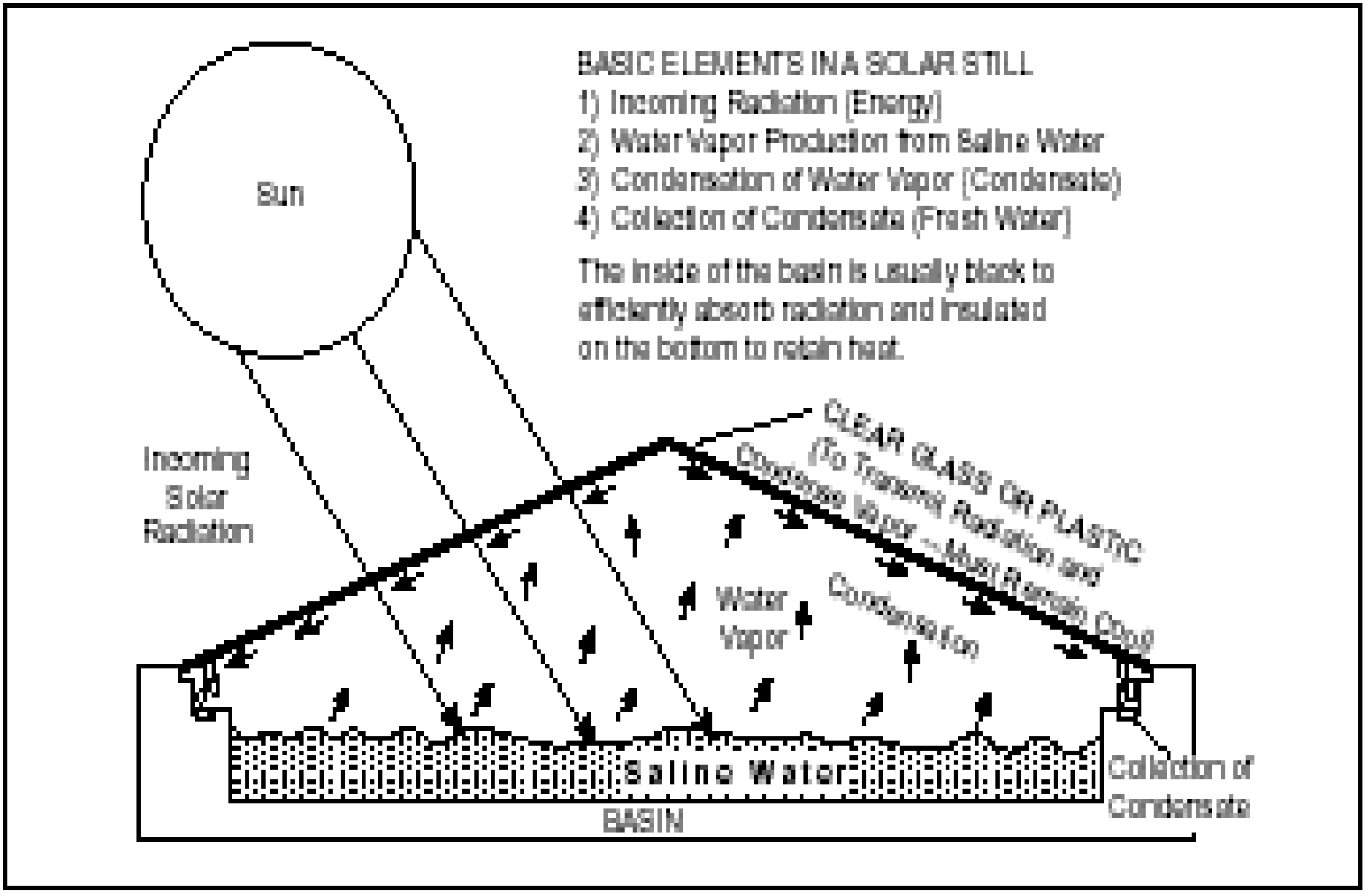
- Multiple-effect basin SWD
- Wick SWD
- Emergency SWD
- Hybrid designs SWD

Properties of Water

- Product Water
- Feed Water
- Brackish Water
- Sea Water
- Artificial Seawater

Solar Still

The incident solar radiation is transmitted through the glass cover and is absorbed as heat by a black surface in contact with the water to be distilled. The water is thus heated and gives off water vapour. The vapour condenses on the glass cover, which is at a lower temperature because it is in contact with the ambient air, and runs down into a gutter from where it is fed to a storage tank.


BASIC ELEMENTS IN A SOLAR STILL
1) Incoming Radiation [Energy]
2) Water Vapor Production from Saline Water
3) Condensation of Water Vapor [Condensate]
4) Collection of Condensate [Fresh Water]
The inside of the basin is usually black to efficiently absorb radiation and insulated on the bottom to retain heat.
Sun
Incoming Solar Radiation
CLEAR GLASS OR PLASTIC
(To Transmit Radiation and
Condense Vapor -- Most Remain Cool
Water Vapor
Condensation
Saline Water
BASIN
Collection of Condensate

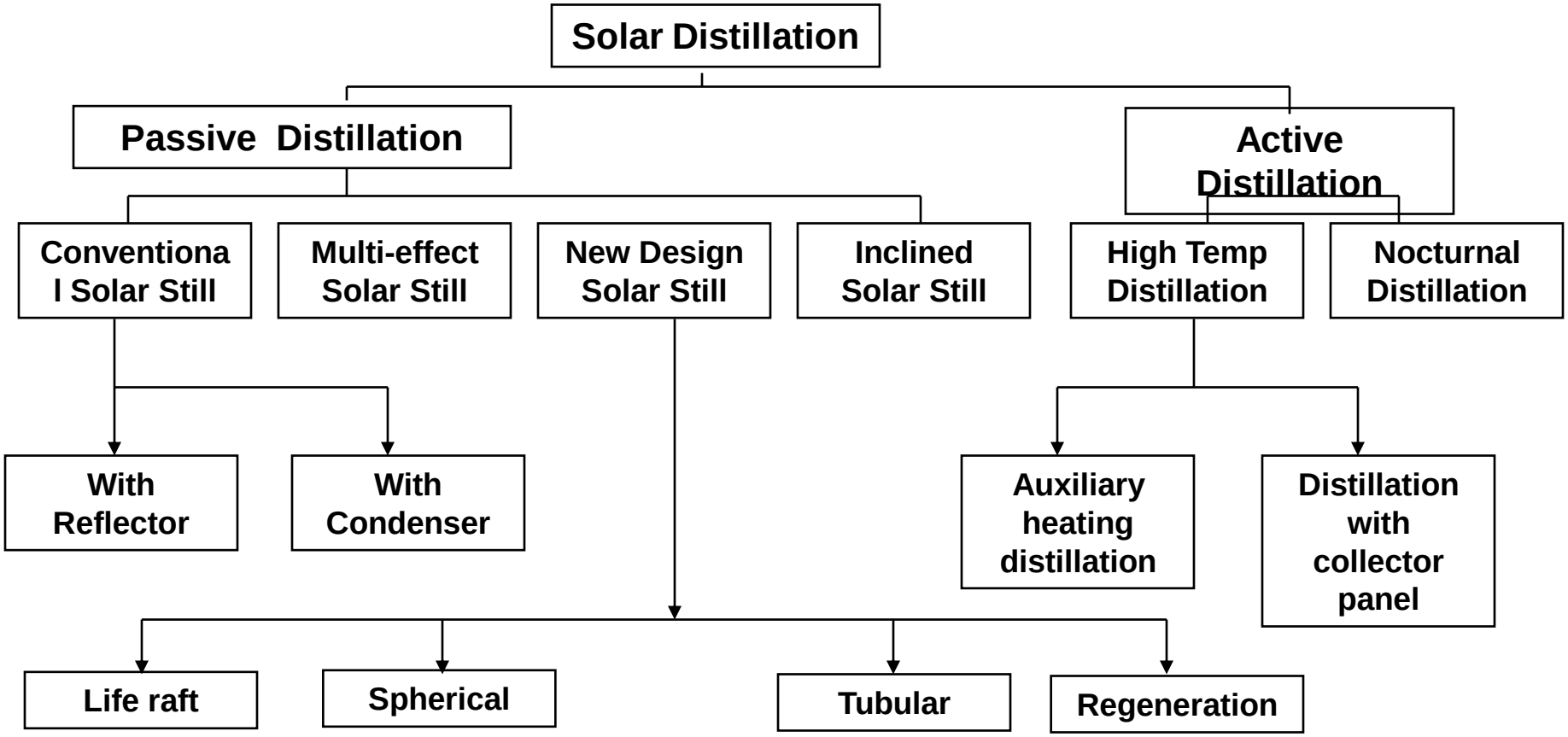
Different type of Solar Still

- Schematic of a solar still
- Plastic rooftop solar still
- Light-weight Collapsible solar still
- Horizontal concentric tube solar still
- High performance solar still
- Cylindrical Parabolic still
- Stationary double-basin still with flowing water over upper basin
- Tilted wick solar still

Parameters Affecting the Output of a Solar Still

- Effect of Wind Velocity
- Effect of Water Depth
- Effect of Ambient Air Temperature
- Effect of the Gap Distance
- Effect of Number of Covers
- Other Effects

Classification Of Solar Distillation System



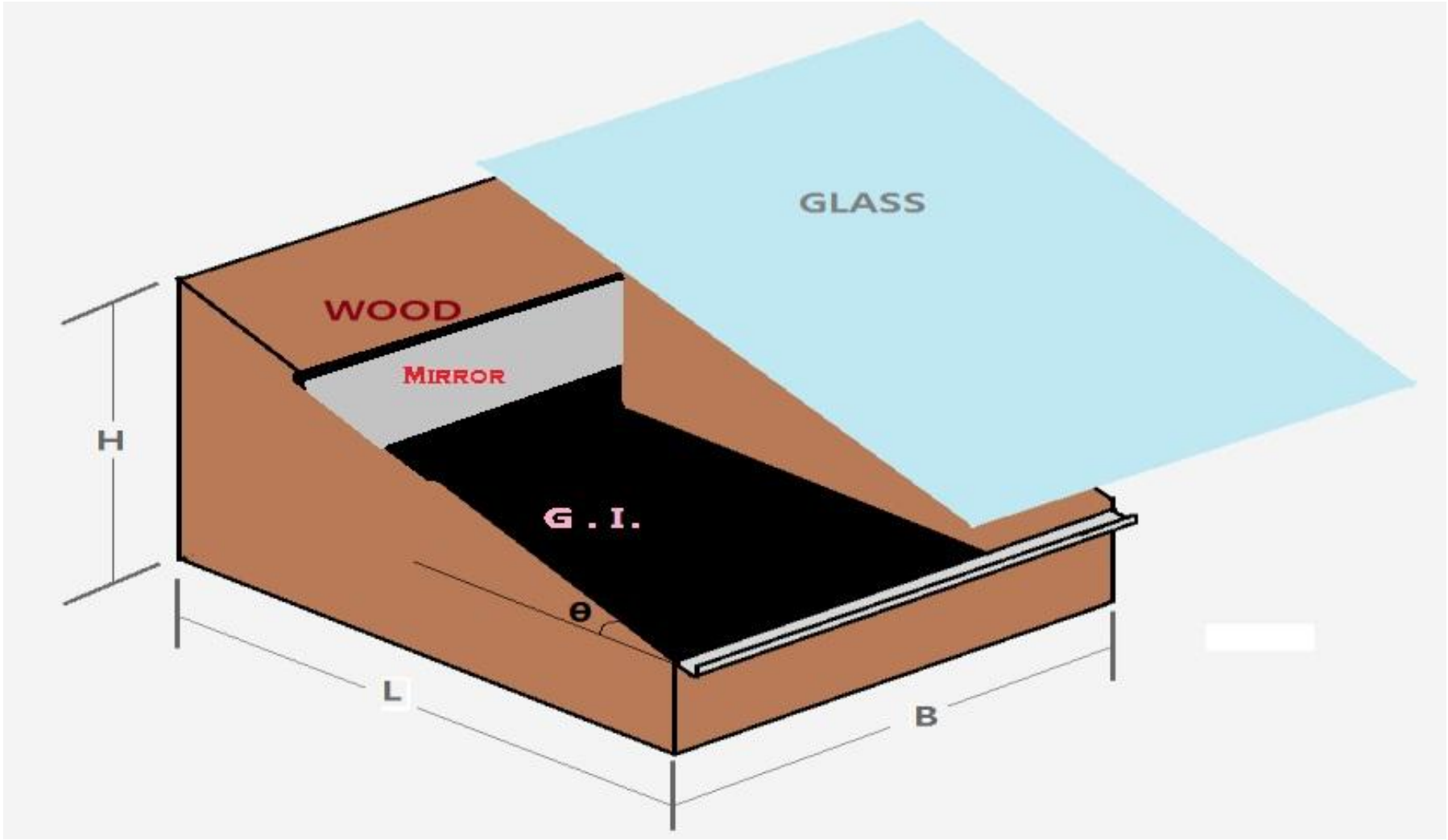
Construction & Working

There are two types of construction for the solar water distillation plant. They are as follows:

- Basin Type: It consist of shallow, bracken basin of saline/impure water covered with a sloping transparent roof solar radiation that passes through the transparent roof heats the water in blackened basin. Thus evaporating water which gets condensed on the cooler under side of the glass and gets collected as distillate attached to the glass.

- Wick Type Solar Still: It consists of a wick instead of a basin. The saline/impure water is passed through the wick or absorbed by the wick at a slow rate by capillary action. A waterproof liner is placed between the insulation and the wick. Solar energy is absorbed by the water in the wick which gets evaporated and later condensed on the underside of the glass and finally collected in the condensate channel fixed on the lower side of the bottom surface.

Construction of Solar Water Distillation (Project)



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- The base of the solar still is made of G.I. box of dimension (100 x 100 x 50 cm). This box is embedded into another box of wood shown in figure. Here length L, Breath B, Height H and at opposite side . This also contains same box of thermocol inside it between the G.I box and wooden box. The channel is fixed such that the water slipping on the surface of the glass will fall in this channel under the effect of gravity. glass can rest on G.I plate .This completes the construction of the model. The holes for the inlet of water, outlet of brackish water and outlet of pure water is made as per the convenience. We have made the outlet of brackish water at right bottom of the model (seeing from front of the model), outlet of the pure water at the end of the channel and inlet at the left wall above the outlet.

Details of Different Parts of the System

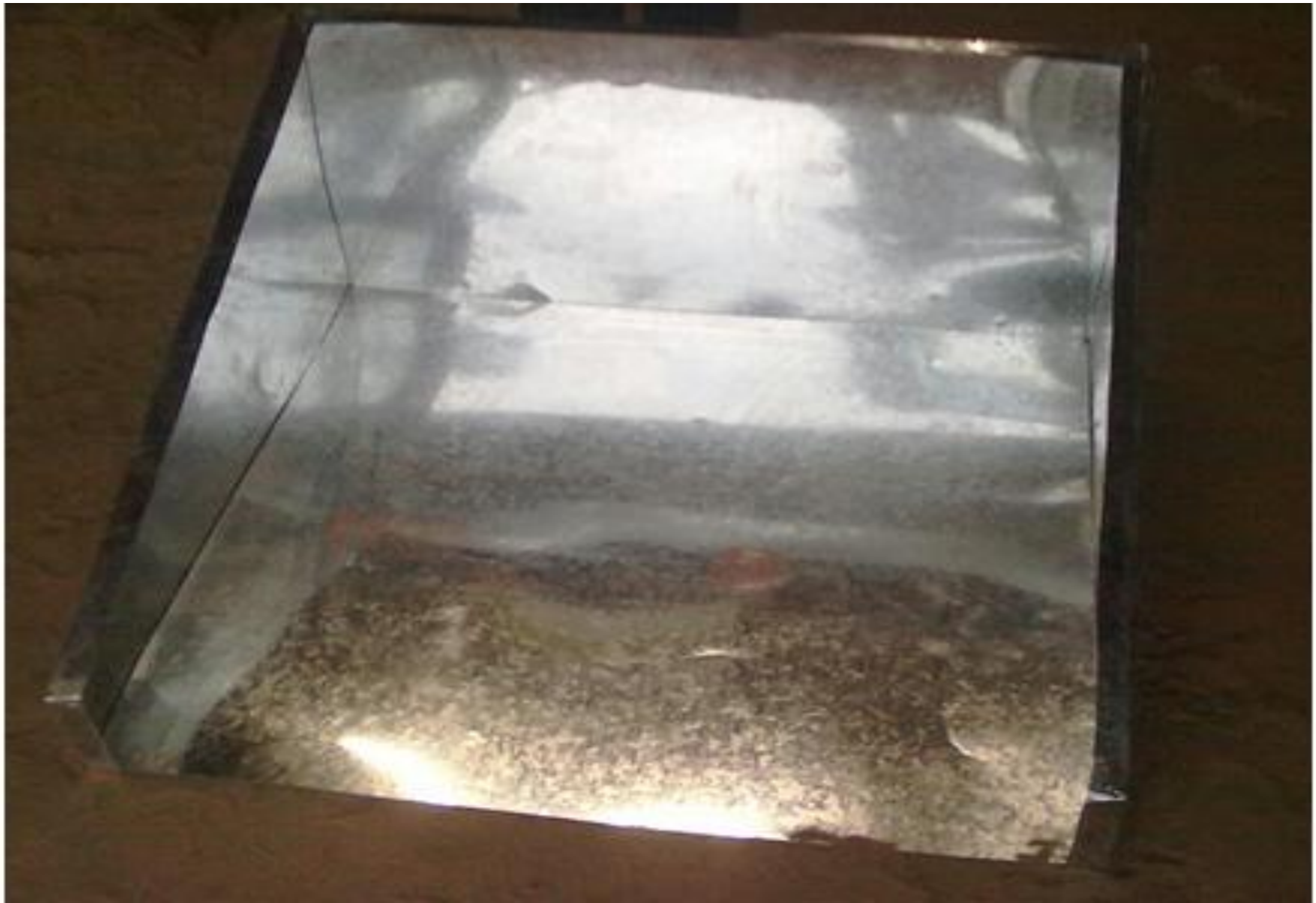
Basin:

It is the part of the system in which the water to be distilled is kept. It is therefore essential that it must absorb solar energy. Hence it is necessary that the material have high absorbtivity or very less reflectivity and very less transmitivity. These are the criteria's for selecting the basin materials.

The basin materials that can be used are as follows:

1. Leather sheet,
2. Ge silicon,
3. Mild steel plate,
4. RPF (reinforced plastic)
5. G.I. (galvanized iron).

G.I PLATE BASIN



Side Walls:

It generally provides rigidness to the still. But technically it provides thermal resistance to the heat transfer that takes place from the system to the surrounding. So it must be made from the material that is having low value of thermal conductivity and should be rigid enough to sustain its own weight and the weight of the top cover.

Different kinds of materials that can be used are:

1) wood,
2) Concrete,
3) Thermocol,
4) RPF (reinforced plastic).

For better insulation we have used composite wall of Thermocol (inside) and wood (outside).

SIDE WALL MADE BY WOOD

Top Cover:

The passage from where irradiation occurs on the surface of the basin is top cover. Also it is the surface where condensate collects. So the features of the top cover are: 1) Transparent to solar radiation, 2) Non absorbent and Non-adsorbent of water,3) Clean and smooth surface.

The Materials Can Be Used Are:

- 1) Glass
- 2) Polythene.

We have used glass.

TOP COVER MADE BY GLASS

Channel:

The condensate that is formed slides over the inclined top cover and falls in the passage, this passage which fetches out the pure water is called channel.

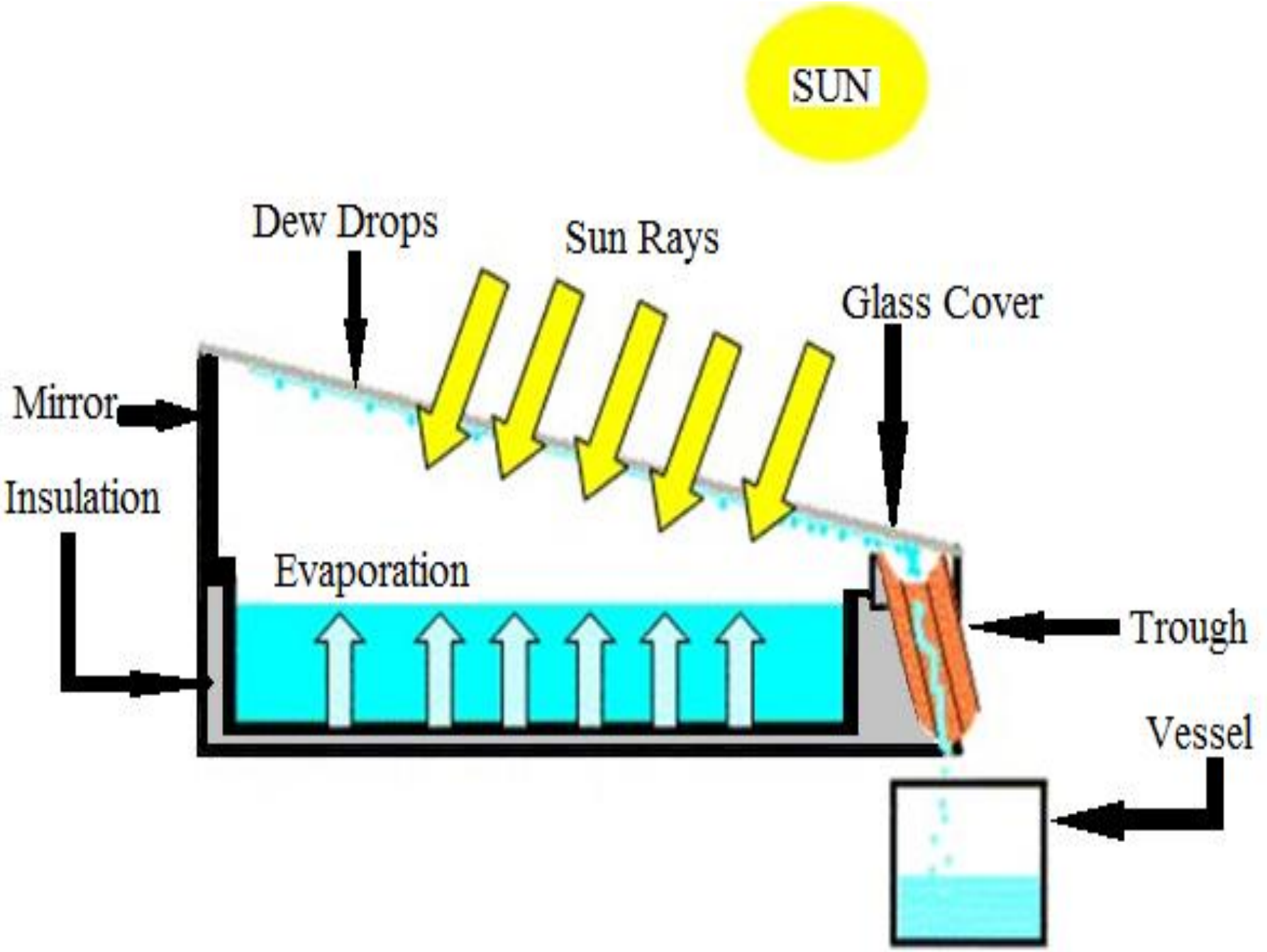
The materials that can be used are:

1) P.V.C.
2) G.I.
3) RPF.

P.V.C PIPE CHANNEL

Working

- Water to be cleaned is poured into the basin. The glass cover allows the solar radiation to pass into the basin, which is mostly absorbed by the blackened base. This interior surface uses a blackened material to improve absorption of the sunrays. The water begins to heat up and the moisture content of the air trapped between the water surface and the glass cover increases. The heated water vapor evaporates from the basin and condenses on the inside of the glass cover. In this process, the salts and microbes that were in the original water are left behind. Condensed water trickles down the inclined glass cover to an interior collection trough and out to a storage bucket. Feed water should be added each day that roughly exceeds the distillate production to provide proper flushing of the basin water and to clean out excess salts left behind during the evaporation process.


SUN
Dew Drops
Sun Rays
Glass Cover
Mirror
Insulation
Evaporation
Trough
Vessel

Result And Discussion

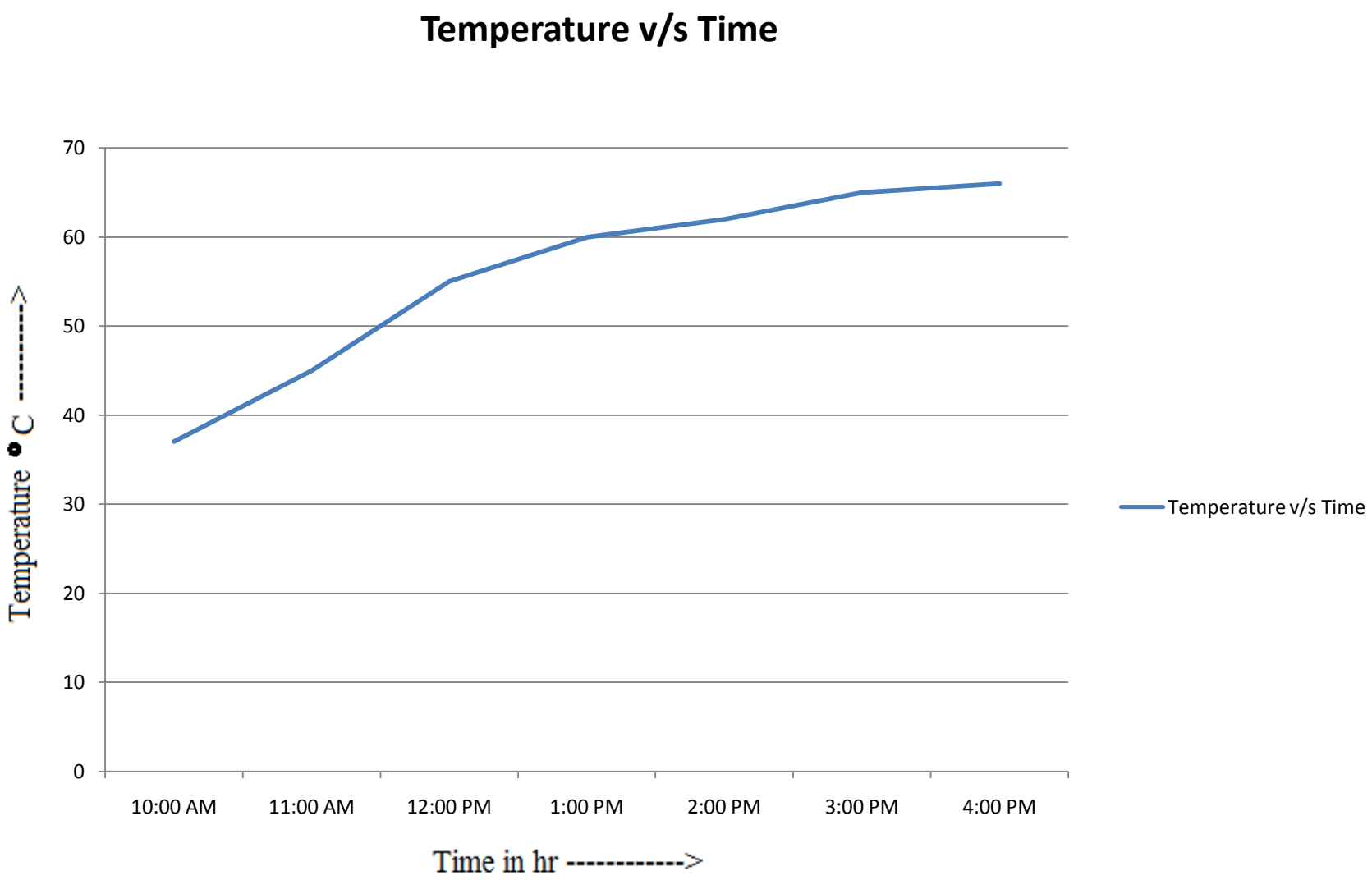
Readings taken for Distillation

Time	Temp. of Water(c)	Distilled Water Collected (ml)
10:00 am	37	-----
11:00 am	45	-----
12:00 am	55	100
1:00 pm	60	400
2:00 pm	62	800
3:00 pm	65	1100
4:00 pm	66	1500

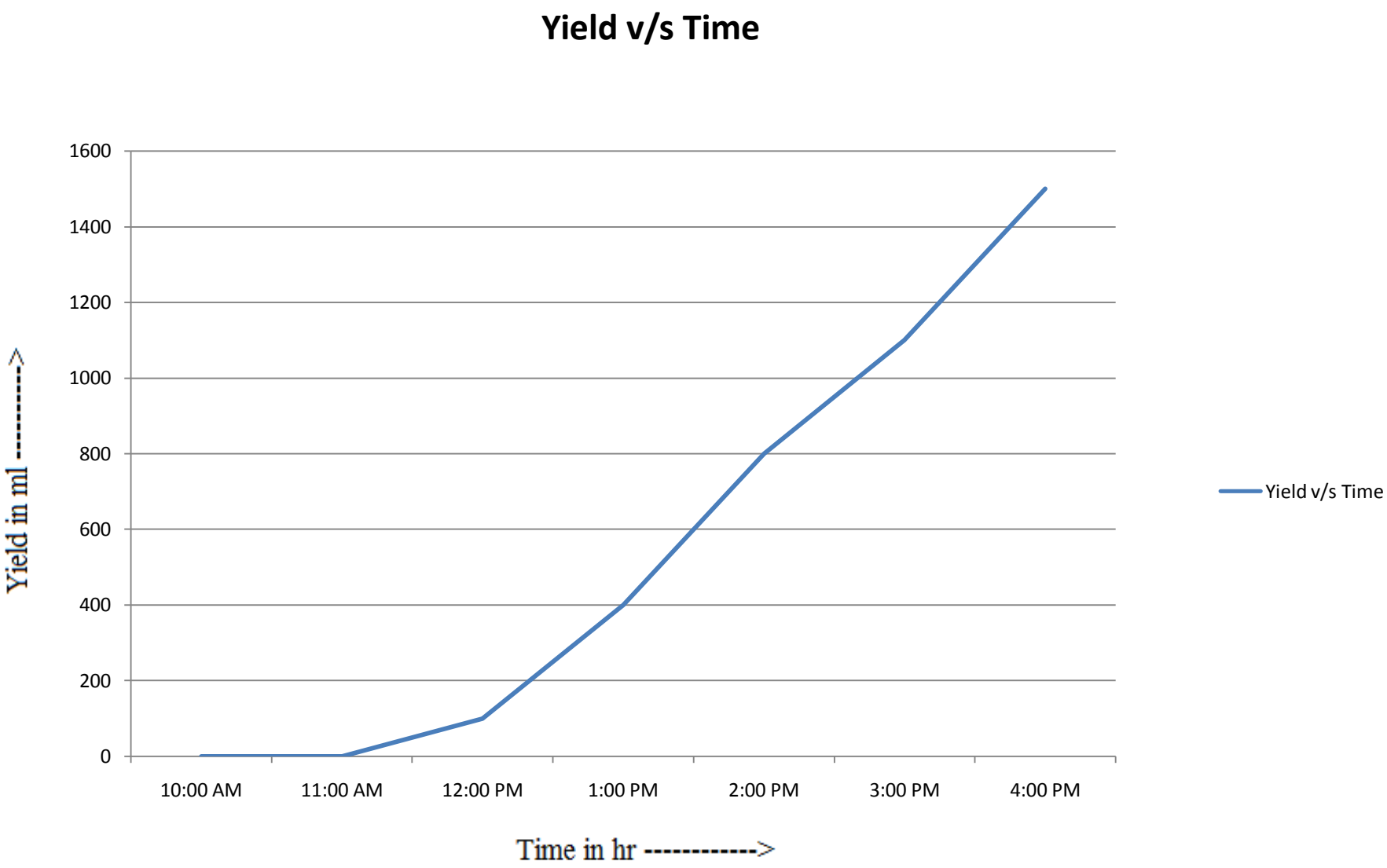
Observation

- Time taken for drop to come to channel = 1hour
- Time taken for drop to come out of channel = 0.5 hour
- Amount of brackish water poured initially = 30000 ml
- Amount of pure water obtained at the end of the exp. = 1500 ml
- Temp. Of the condensate = 29 C

Temp Variation During Process



Yield Variation During Process



Conclusion

- From the graph Yield v/s Time we can conclude that the increase in temperature and hence the evaporation is maximum in the period of 11:15 am to 1:30 pm. The maximum temperature achieved is 53^0C which is at 1:30 PM, and then the temperature decreases. The aim of our experiment was to get pure water from the brackish water available. The brackish water we have supplied was 14 litres and at the end of the experiment we got 1.5 litres. The experiment was carried out in summer season. Theoretically, the experiment should fetch out 2.33 litres. So the efficiency of the system is 64.37 %.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