

Ocean Thermal Energy Conversion (OTEC)

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Renewable
Energy Sources

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* What is heat engine?

* What is the maximum efficiency of HE?

$$\eta_e = \frac{T_h - T_c}{T_h} = \frac{\Delta T_0}{T_h}$$

* Function of source temperature and sink temperature.

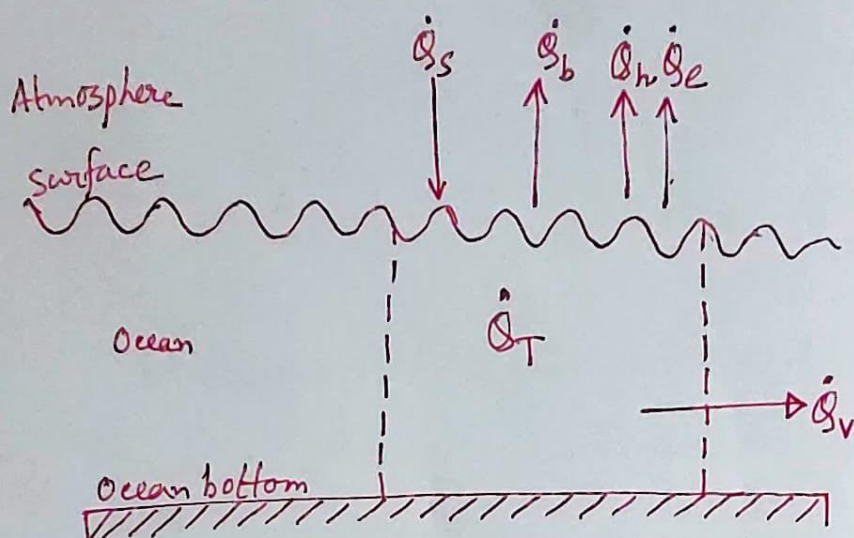
* How ~~can~~ the ocean can be ~~be~~ heat reservoir i.e. heat source and heat sink?

The world's largest solar energy collector is ocean water.

* The solar energy absorbed by the ocean heats up the surface water, despite the loss of heat energy from the surface ~~due~~ due to black radiation, evaporation, conduction and convection.

* The cold water from the higher latitudes is carried by ocean currents along the ocean bottom from the poles towards the equator, displacing the lower-density water above and creating a thermal structure with a large reservoir of warm water at the ocean surface and large reservoir of cold water at the bottom, with a temperature difference of 22°C to 25°C between them.

The ocean energy budget



$$\dot{Q}_T = \dot{Q}_s - \dot{Q}_b - \dot{Q}_h - \dot{Q}_e - \dot{Q}_v$$

\dot{Q}_T = rate of heat gain/lost

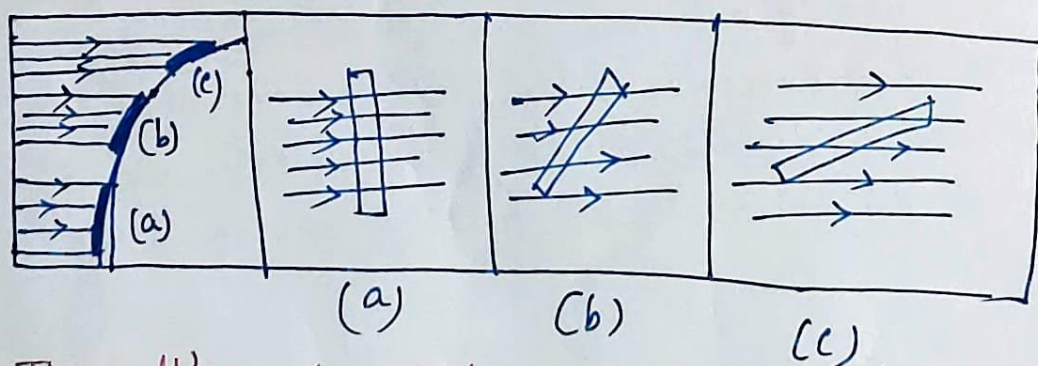
\dot{Q}_s = rate of absorbed heat by ocean from incoming solar radiation.

\dot{Q}_b = rate of heat loss by back radiation

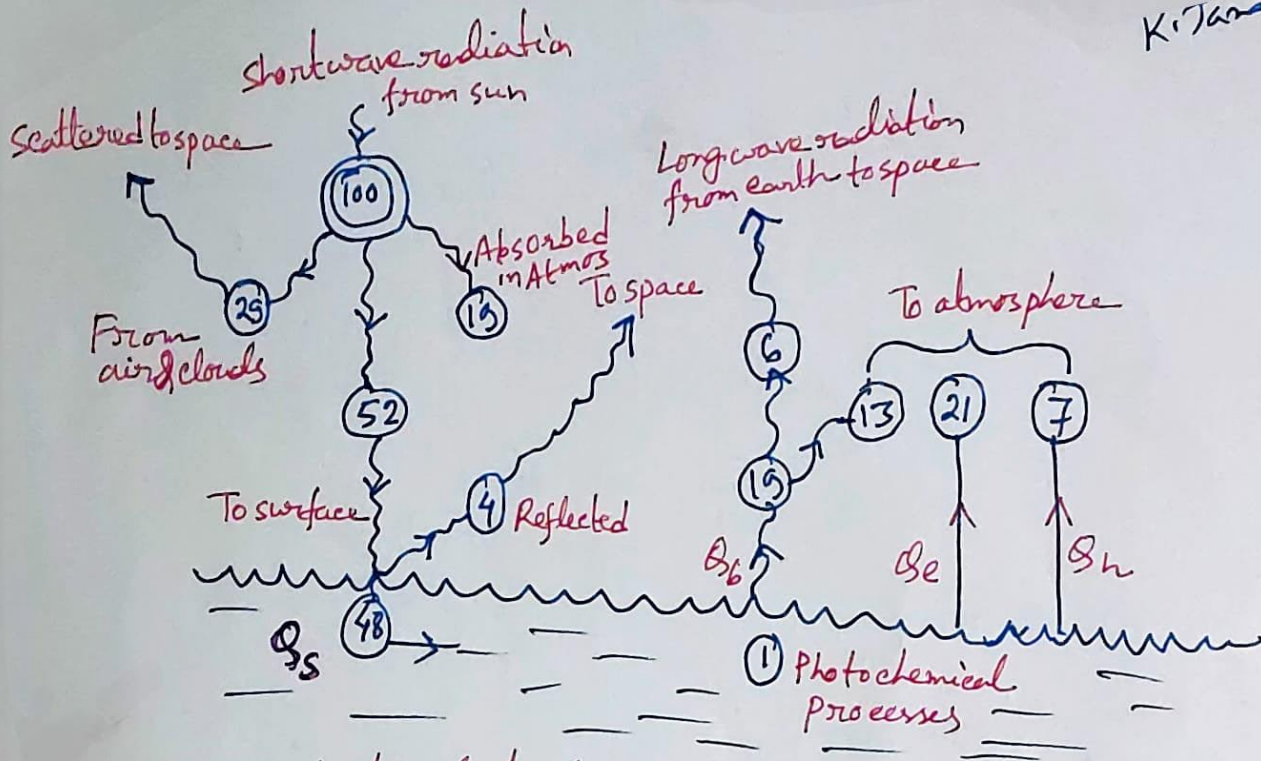
\dot{Q}_h = sensible heat loss by convection and conduction

\dot{Q}_e = rate of heat loss by evaporation from ocean surface.

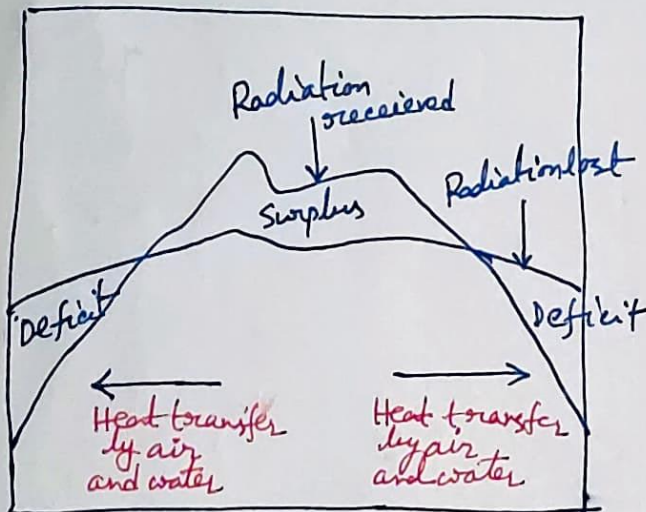
\dot{Q}_v = thermal energy transported by ocean currents.



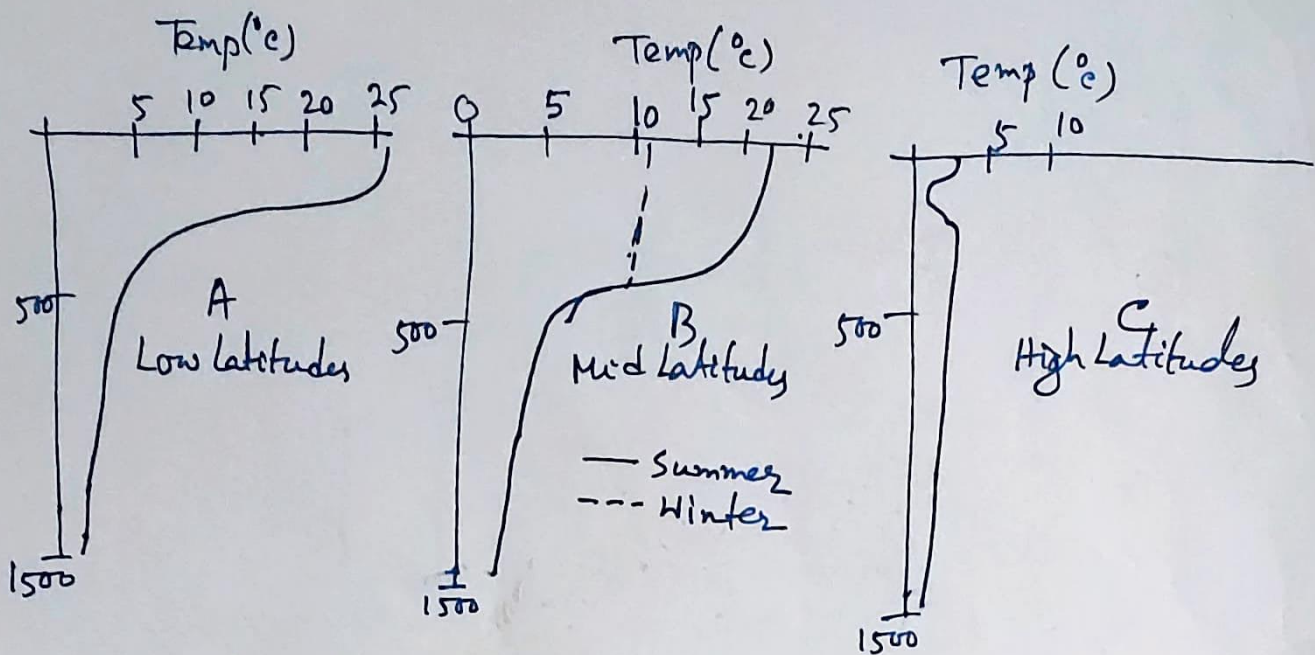
The earth's surfaces that are equal in size at different latitudes receive different levels of solar radiation because of different angles at which sunlight strikes the earth.



The average heat budget of the ocean in terms of 100 units of incoming radiation, associated disturbances in the atmosphere and reflection from the surface.

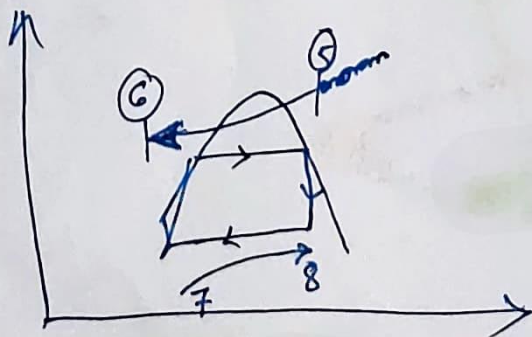
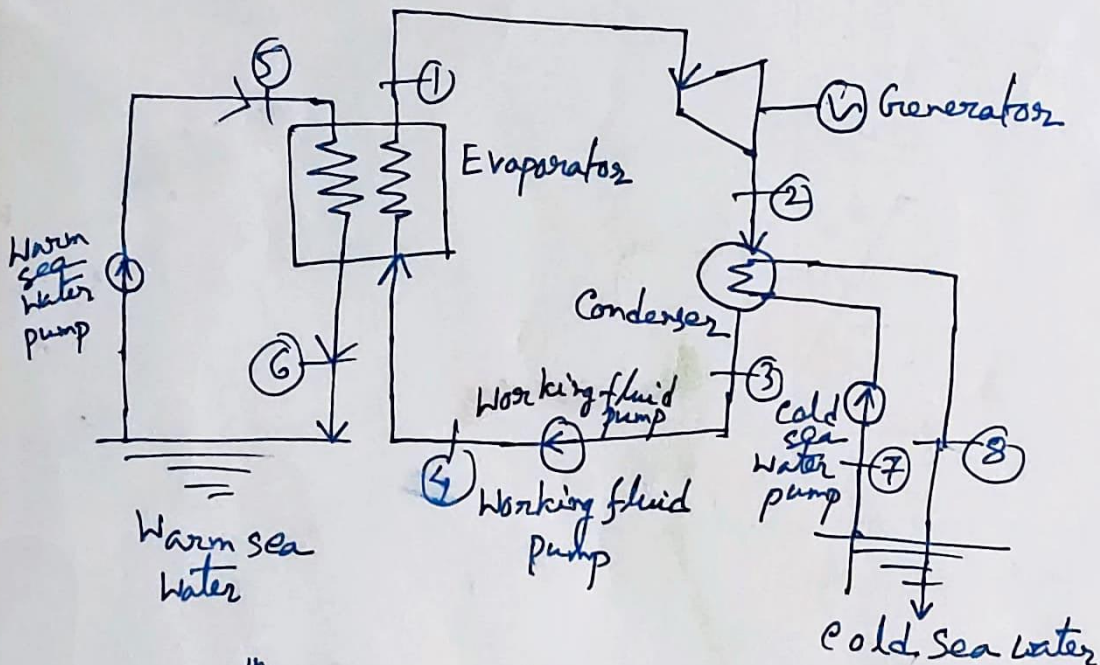


Comparison of the amount of radiation received at different latitudes



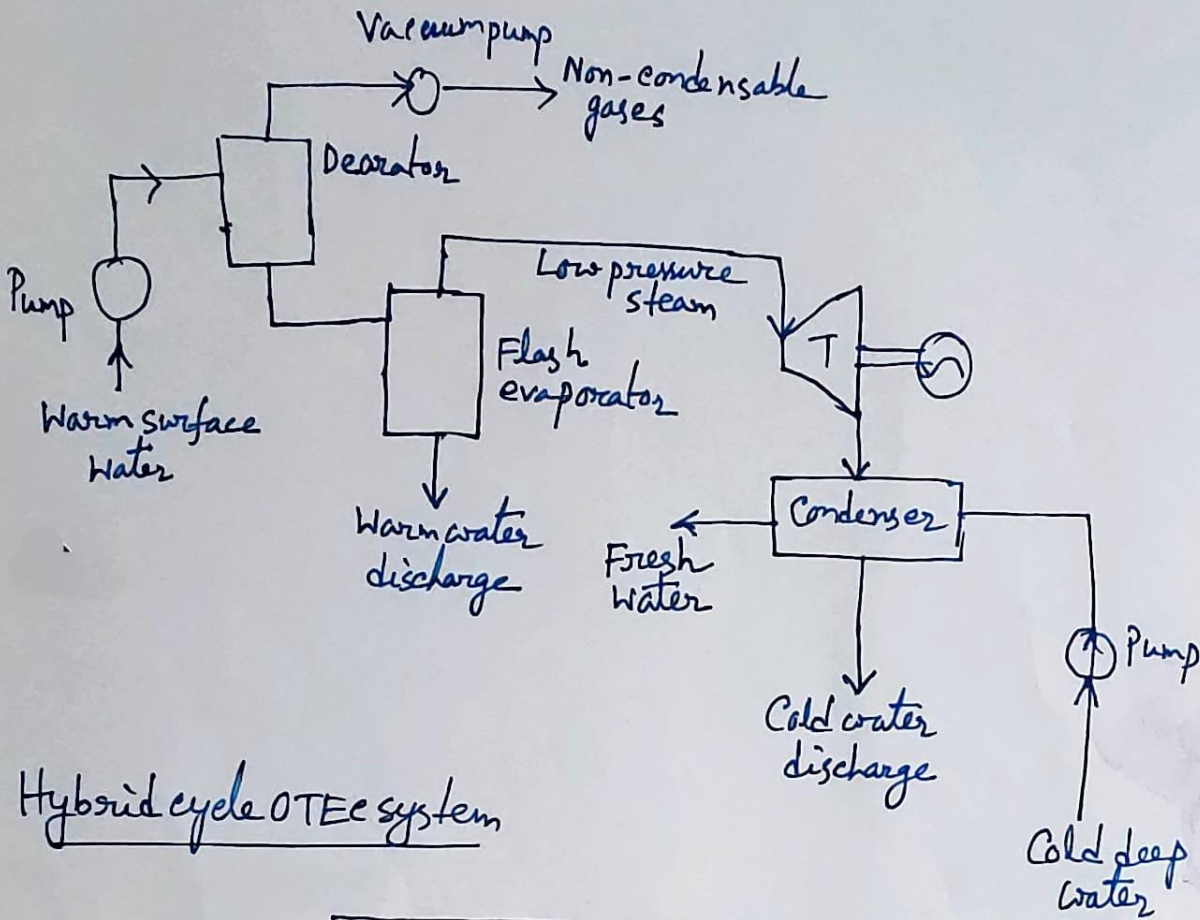
Typical mean temperature versus depth profiles of the open ocean at different latitudes

Closed-cycle OTEC system



Open cycle OTEC system

X. Tane (3)



Hybrid cycle OTEC system

