



ME 476

Solar Energy

UNIT FOUR

SOLAR COLLECTORS

Evacuated Tube Collectors (ETC)

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2

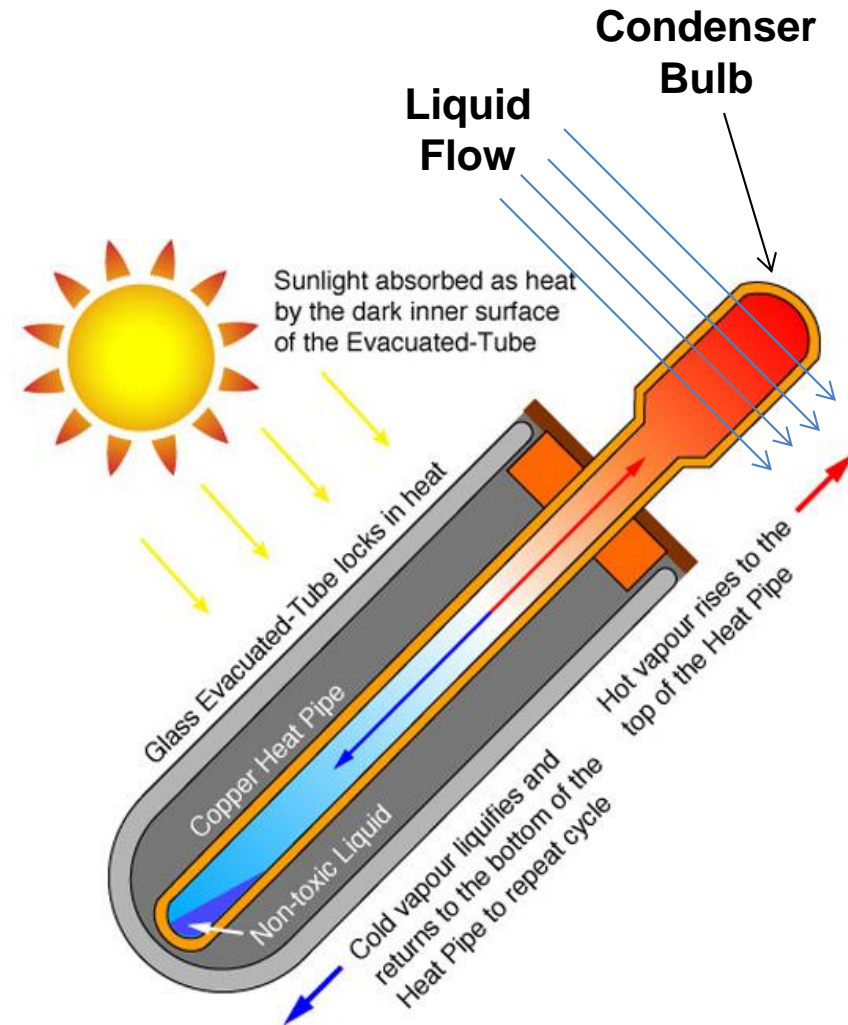
- ETCs are usually made of individual evacuated tubes that are commonly connected to the same header.
- The most common type of ETC is the **heat pipe** system.



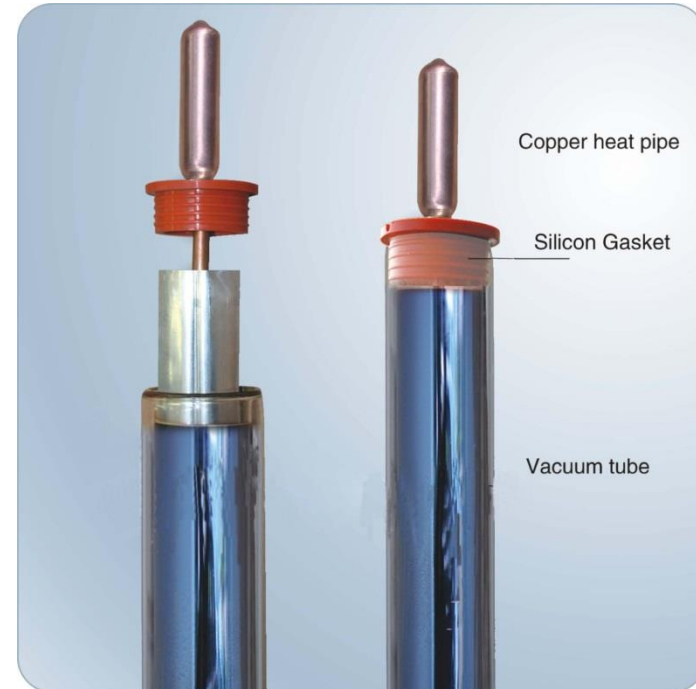
Evacuated Tube Collectors (ETC)

3

- As tube and plate absorb the solar irradiation, the fluid inside the tube (called **heat pipe**) vaporizes and rises to the top.
- The vapor reaches the condenser bulb as a saturated vapor.
- Water (or ethylene glycol, or other fluids) flow around the bulb and absorb the heat.
- The internal fluid condenses back to the liquid state and falls down to the bottom of the pipe.
- The cycle is restarted.



- ETCs are evacuated to reduce natural convection losses.
- The tube and absorber plate are usually painted with selective coating with:
 - **High absorptance (to maximize heat gain)**
 - **Low emittance (to minimize heat loss)**
- The tube and absorber plate are usually made of copper to maximize thermal conductivity.
- ETCs are very well sealed to maintain the vacuum.
- Most common working fluids are alcohols.



ADVANTAGES

- No condensation can happen in the ETC since there are no leaks.
- This is an advantage over flat plate collectors (which are not very tightly sealed and can have moisture entering the collector and damaging internal components).
- Since the working fluid changes phase (at relatively constant pressure), it will always evaporate at a pre-defined saturation temperature.
 - **No possibility for overheating.**

ADVANTAGES (continued)

- The working fluid also has low freezing temperature.
 - **No possibility for freezing in winter (like water in flat plate collectors)**
- Operating temperatures can be as high as 150 °C.
- Because of all of the above, the efficiency of ETCs is high.
- If one tube malfunctions, only that tube needs to be replaced.

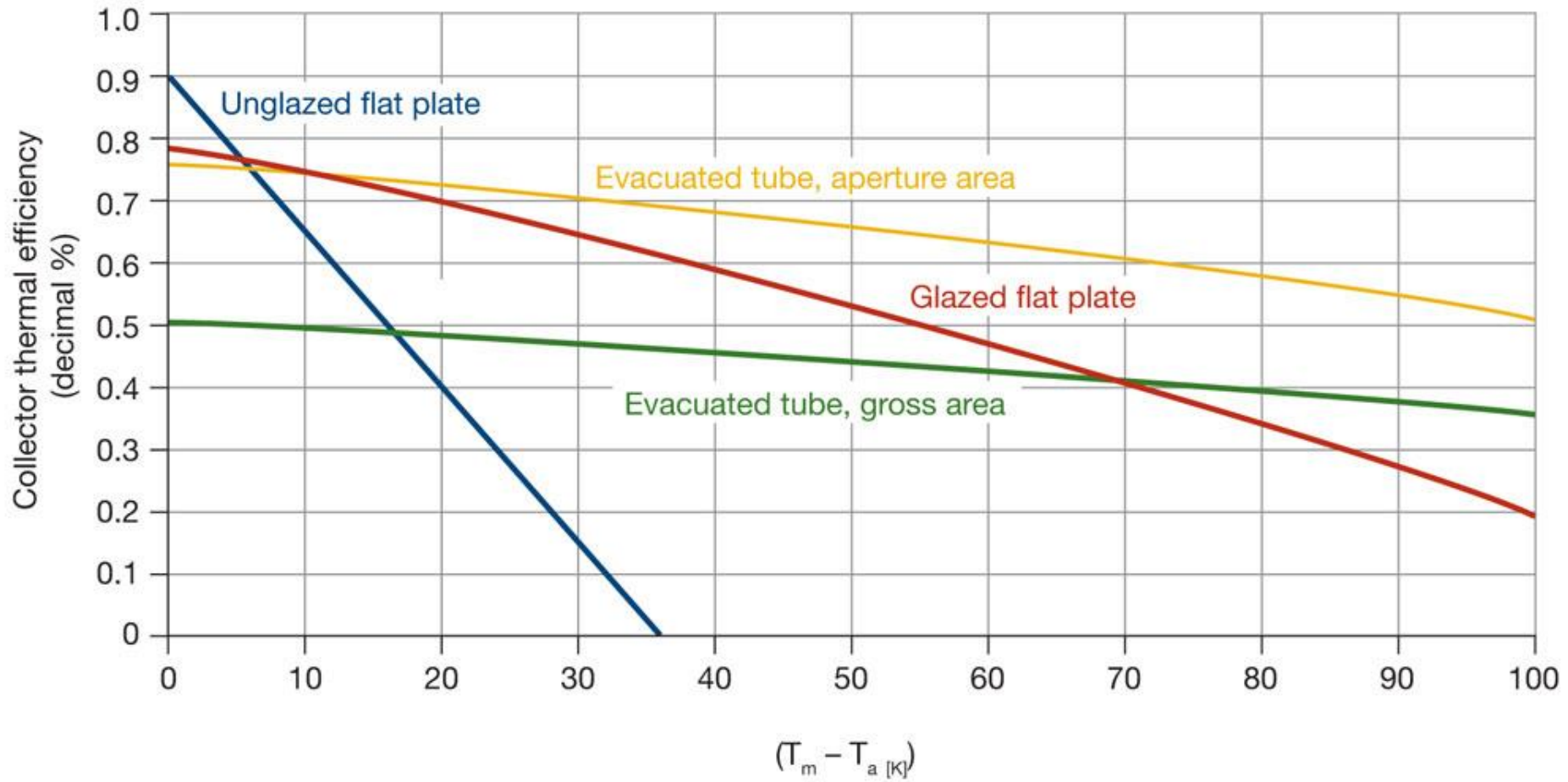
DISADVANTAGES

- Cost of ETCs is high.
- Glass breakage can lead to fast deterioration of the properties of the selective coating.
 - **Efficiency can drop quickly.**

Typical ETC Specifications

Parameter	Value
Glass tube diameter	65 mm
Glass thickness	1.6 mm
Collector length	1965 mm
Absorber plate material	Copper
Coating	Selective
Absorber area	0.1 m ²

Efficiency of Evacuated Tube Collectors



Inlet fluid parameter, °K; T_m equals mean collector fluid temperature; T_a equals ambient temperature.