ME 476
Solar Energy

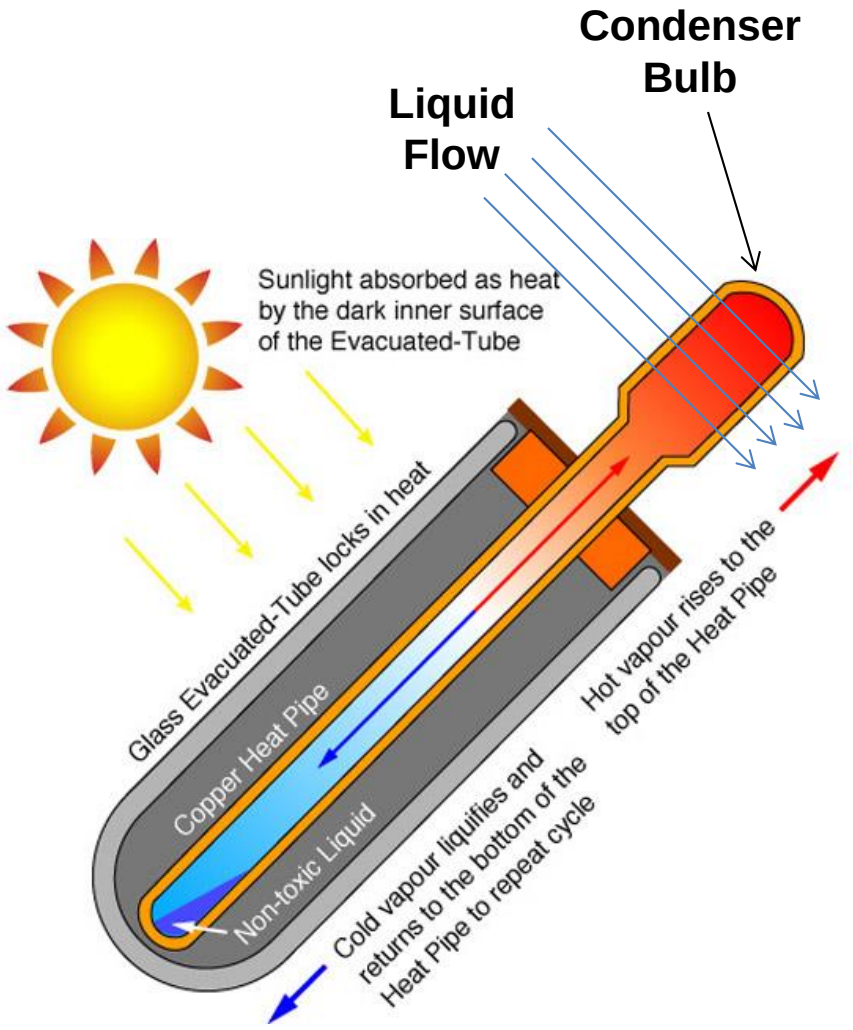
UNIT FOUR
SOLAR COLLECTORS
Evacuated Tube Collectors (ETC)

Evacuated Tube Collectors (ETC)

- 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)

- 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.



Evacuated Tube Collectors (ETC)

- 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.

Evacuated Tube Collectors (ETC)

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.**

Evacuated Tube Collectors (ETC)

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.

Evacuated Tube Collectors (ETC)

DISADVANTAGES

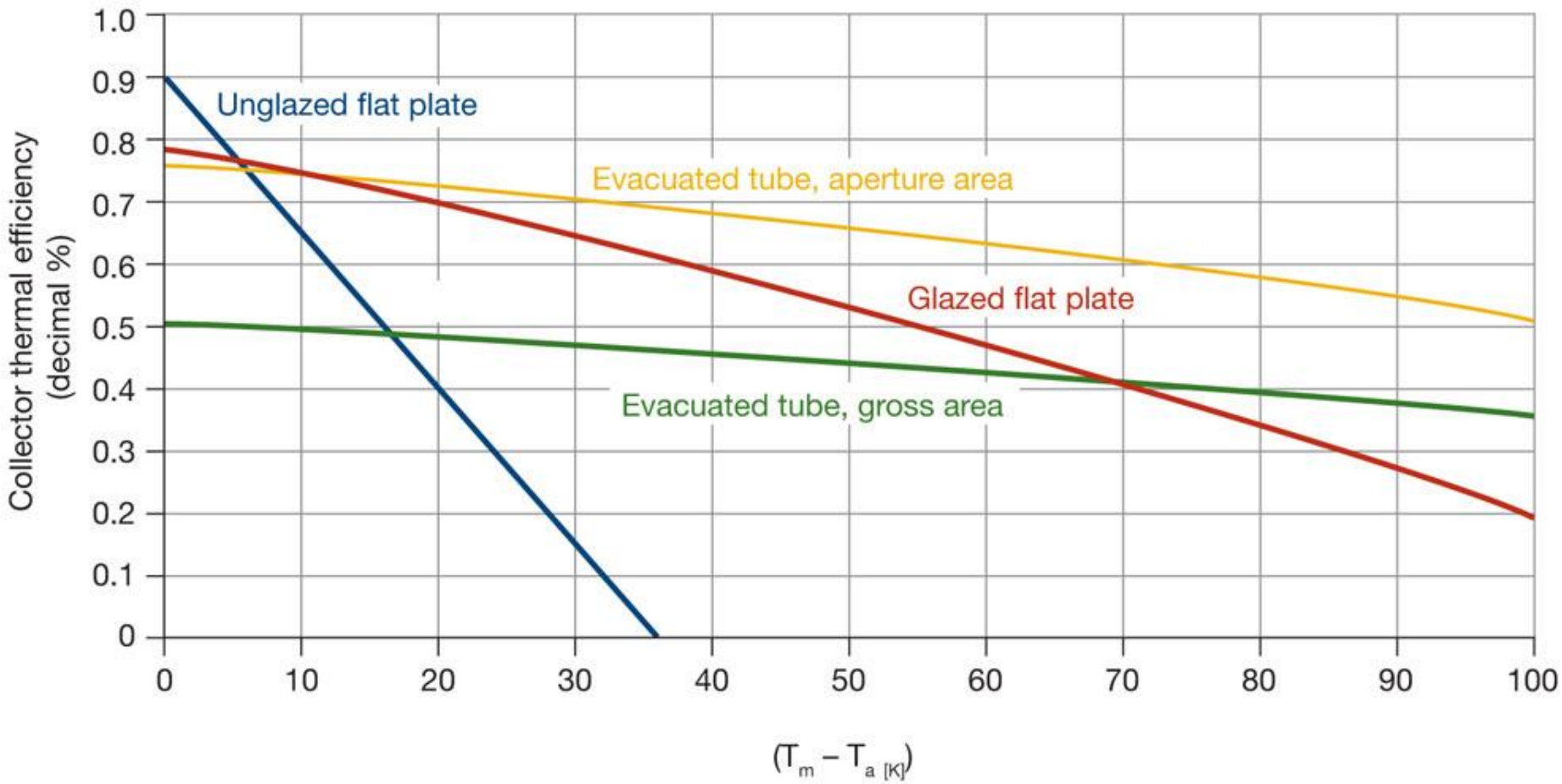
- Cost of ETCs is high.
- Glass breakage can lead to fast deterioration of the properties of the selective coating.
  - **Efficiency can drop quickly.**

Evacuated Tube Collectors (ETC)

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.