

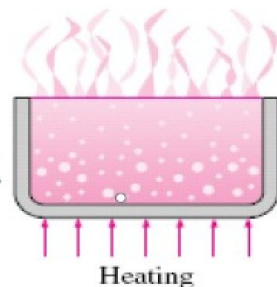
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PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGERS

Topic - Types of boiling, Pool boiling, flow boiling

Classification of boiling

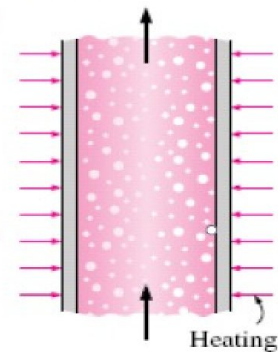
Pool Boiling

- Boiling is called **pool boiling** in the absence of bulk fluid flow.
- Any motion of the fluid is due to natural convection currents and the motion of the bubbles under the influence of buoyancy.



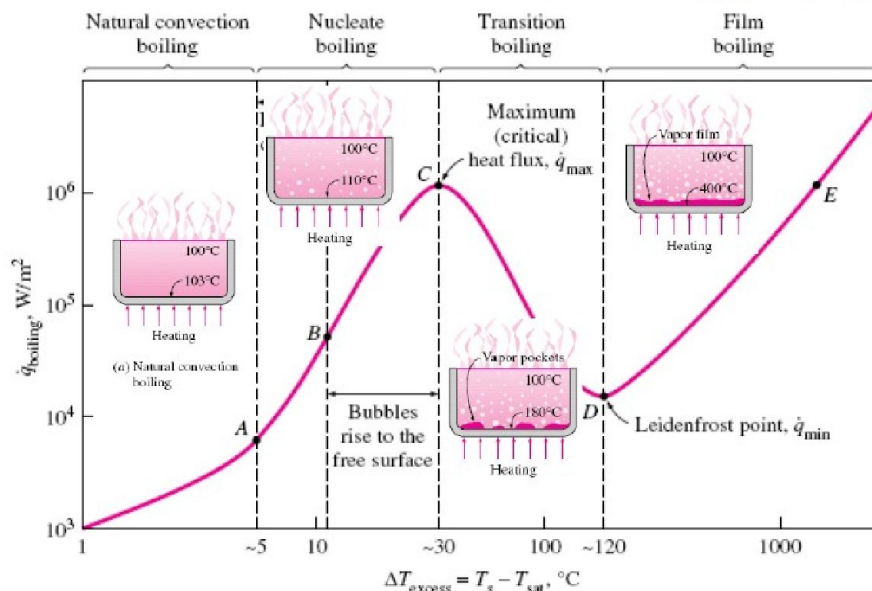
Flow Boiling

- Boiling is called **flow boiling** in the presence of bulk fluid flow.
- In flow boiling, the fluid is forced to move in a heated pipe or over a surface by external means such as a pump.



Pool Boiling

Boiling takes different forms, depending on the $DT_{excess} = T_s - T_{sat}$

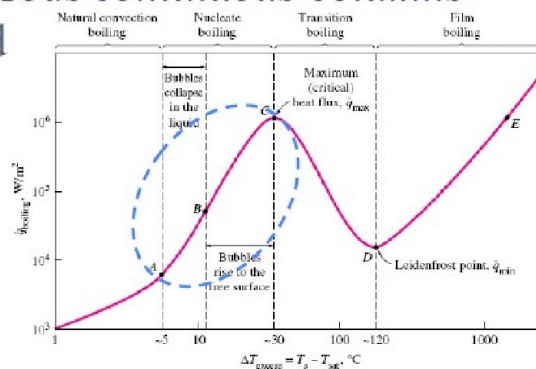
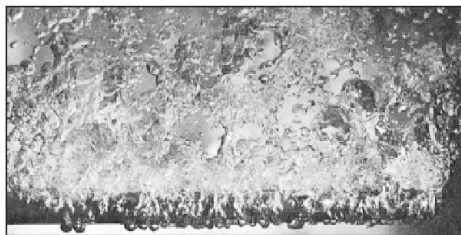


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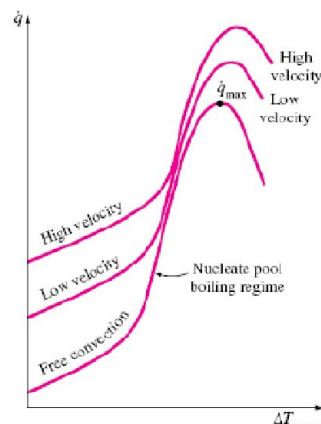
Nucleate Boiling

- The bubbles form at an **increasing rate** at an increasing number of nucleation sites as we move along the boiling curve **toward point C**.
- **Region A–B** — *isolated bubbles*.
- **Region B–C** — numerous *continuous columns of vapor* in the liquid



External Forced Convection Boiling (Flow Boiling)

- In **flow boiling**, the fluid is forced to move by an external source such as a pump as it undergoes a phase-change process.
- The boiling in this case exhibits the combined effects of convection and pool boiling.
- Flow boiling is classified as either *external* and *internal flow boiling*.
- *External flow* — the higher the velocity, the higher the nucleate boiling heat flux and the critical heat flux.



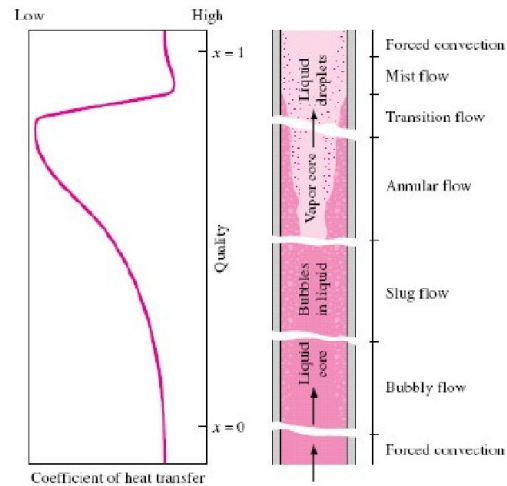
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Flow Boiling – Internal Flow

- The two-phase flow in a tube exhibits different flow boiling regimes, depending on the relative amounts of the liquid and the vapor phases.
- Typical flow regimes:
 - Liquid single-phase flow,
 - Bubbly flow,
 - Slug flow,
 - Annular flow,
 - Mist flow,
 - Vapor single-phase flow.

Axial position in the tube

References:

1. Kothandaraman C.P “Fundamentals of Heat and Mass Transfer” New Age International, New Delhi, 4th Edition 2012 (Unit I, II, III, IV, V).
2. Frank P. Incropera and David P. DeWitt, “Fundamentals of Heat and Mass Transfer”, John Wiley and Sons, New Jersey, 6th Edition 1998 (Unit I, II, III, IV, V)
3. MIT open courseware - <https://ocw.mit.edu/courses/mechanical-engineering>

Other web sources



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