



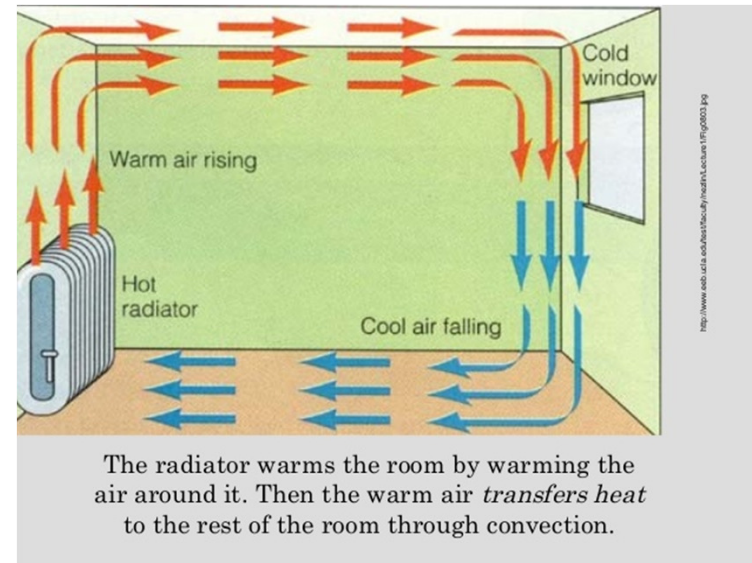
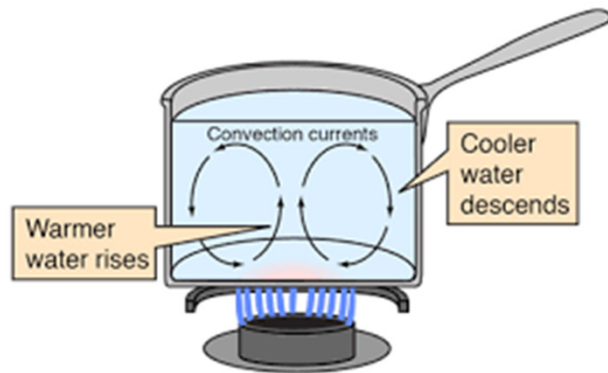
FDE 208 HEAT TRANSFER AND THERMAL PROCESSES

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HEAT TRANSFER BY CONVECTION

- The transfer of heat by bulk transport and mixing of macroscopic elements of warmer portions with cooler portions of a gas or liquid.
- Often refers to the energy exchange between a solid surface and a fluid



CONVECTIVE HEAT TRANSFER

NEWTON'S LAW OF COOLING

- $\dot{Q} = hA\Delta T$


Q: rate of heat transfer (W) or (J/s)

h: convective heat transfer coefficient (W/m²K)

A: area perpendicular to heat flow (m²)

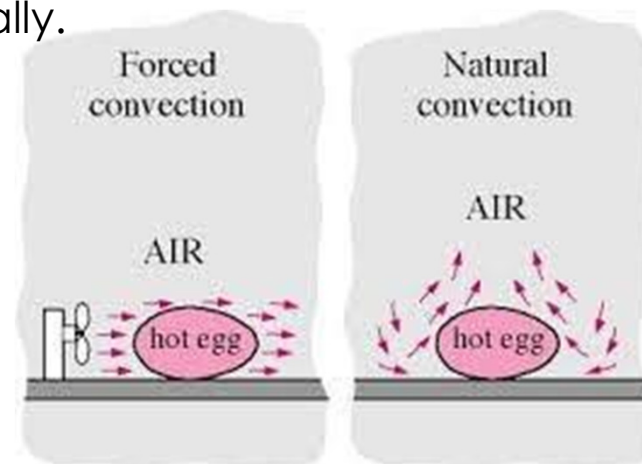
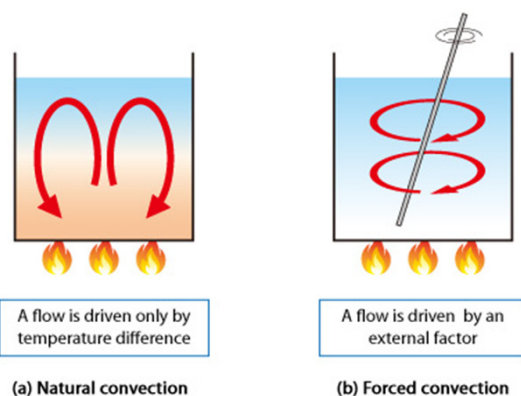
ΔT : temperature difference (K)

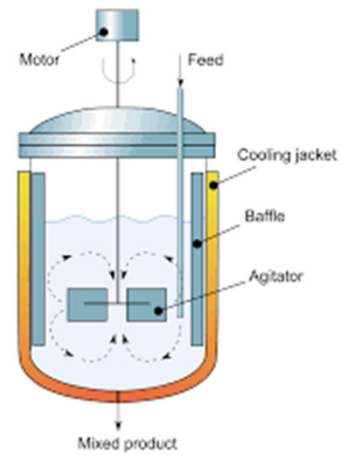
- h (convective heat transfer coefficient) is an experimentally determined parameter whose value depends on all the variables affecting convection
 - Surface geometry, fluid motion, fluid transport properties, velocity
 - Empirical correlations are available to predict convective heat transfer coefficient.

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- Convective heat transfer occurs in three different ways:
 - NATURAL CONVECTION
 - FORCED CONVECTION
 - PHASE CHANGE

NATURAL (FREE) CONVECTION VS. FORCED CONVECTION

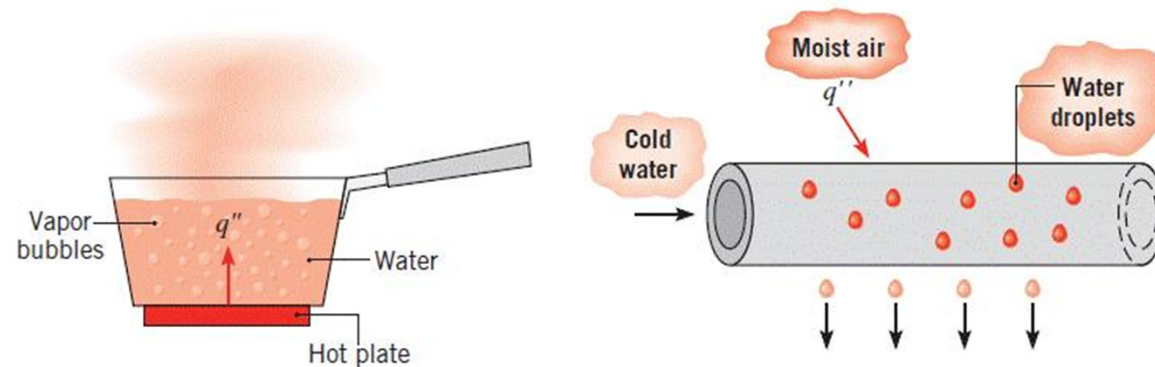
- Natural convection occurs when a warmer or cooler fluid next to the solid surface causes a circulation because of a density difference.
 - Fluid circulation is natural.
- If the fluid is forced to flow past a solid surface by a pump, fan or other mechanicals means, then it is named as Forced Convection.
 - Fluid circulation takes place mechanically.





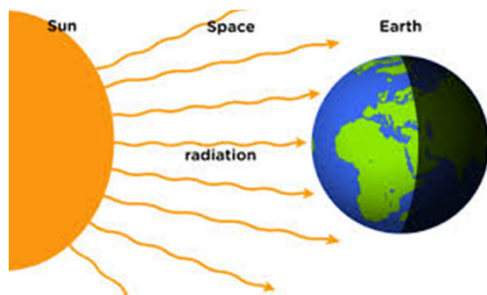
CONVECTIVE HEAT TRANSFER BY PHASE CHANGE

- Heat transfer process that involves phase change of fluids (boiling, condensation) are also considered to be convection.
 - induced fluid motion such as the rise of vapour bubbles during boiling or fall of liquid droplets during condensation.



HEAT TRANSFER BY RADIATION

- Radiation is the transfer of energy through space by means of electromagnetic waves.
 - Different from conduction and convection (no medium is required)
 - Radiation can occur under vacuum.
 - Transport of heat to the earth from the sun is by radiation.
 - All surfaces at a temperature above absolute zero (0 K) emit radiation energy.



- People feel colder in winters as compared to summers although the room temperature is the same. Why?



HEAT TRANSFER BY RADIATION

- Stefan-Boltzmann Law:

- $\dot{Q} = \varepsilon\sigma A(T_1^4 - T_2^4)$

Q: rate of heat transfer (W) or (J/s)

ε : emissivity

σ : Stefan-Boltzmann constant which is $5.67 \times 10^{-8} \text{ W/m}^2\text{K}^4$

A: area (m^2)