People's Democratic Republic Of Algeria
MINISTRY OF HIGHER EDUCATION AND SCIENTIFIC RESEARCH
Abdelhafid Boussouf University Center - Mila
Institute of Science & Technology
Process Engineering Department

Heat Transfer

Course Notes

For students of: 3rd year of process engineering

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Academic Year: 2023 - 2024

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Chapter 3

Convection Heat Transfer

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II. Convection Heat Transfer

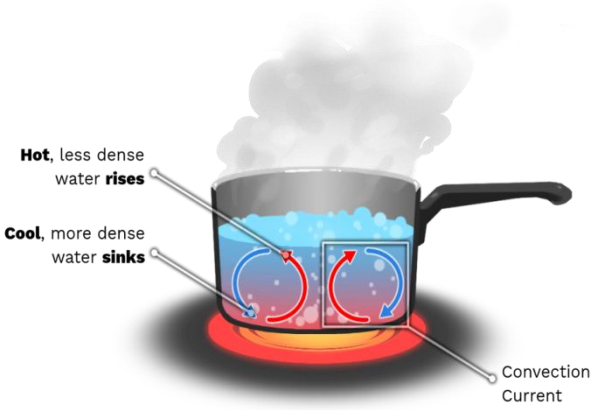
1. INTRODUCITON

Convection heat transfer takes place if a fluid **moves** over a solid surface or in the vicinity of it, given that there is a difference in temperature between the fluid and the solid surface. Convection is the process of heat transfer by the bulk movement of molecules within fluids such as gases and liquids. The initial heat transfer between the object and the fluid takes place through conduction, but the bulk heat transfer happens due to the motion of the fluid.

- Convection is the process of heat transfer in fluids by the actual motion of matter ;
- It happens in liquids and gases ;
- It may be natural or forced;
- It involves a bulk transfer of portions of the fluid.

2. PROCESS OF CONVECTION

When a fluid is heated from below, thermal expansion takes place. The lower layers of the fluid, which are hotter, become less dense. We know that colder fluid is denser. Due to buoyancy, the less dense, hotter part of the fluid rises up. And the colder, denser fluid replaces it. This process is repeated when this part also gets heated and rises up to be replaced by the colder upper layer. This is how the heat is transferred through convection.

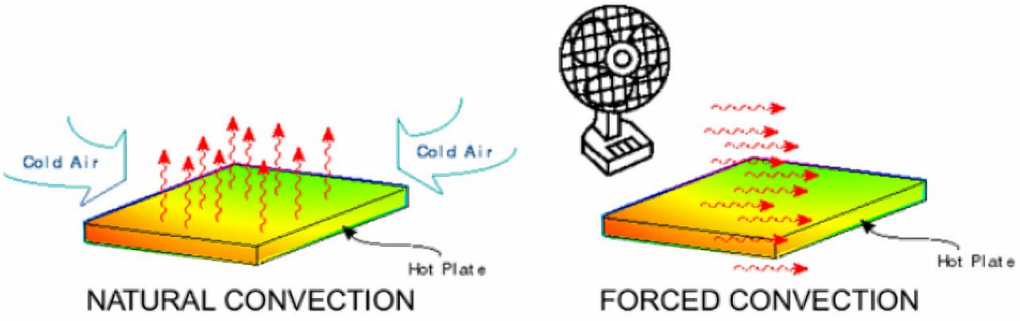


3. TYPES OF CONVECTION

There are two types of convection, and they are: Natural convection ; Forced convection.

a) Natural convection: when convection takes place due to **buoyant force** as there is a difference in densities caused by the difference in temperatures it is known as natural convection ;

b) Forced convection: when **external sources** such as fans and pumps are used for creating induced convection, it is known as forced convection.



4. NEWTON'S LAW OF COOLING

Is either free or forced also may be laminar or turbulent. The rate of convection heat transfer is observed to be proportional to the temperature difference and is conveniently expressed by newton's law of cooling as

$$q_{conv} = h.\,A.\,(T_s - T_\infty)$$

Where

h: is the convection heat transfer coefficient in (W/m².ºC) ;

A: is the surface area through which convection heat transfer takes place (m^2) ;

$\mathbf{T_s}$: is the surface area temperature (ºC) ;

$\mathbf{T_\infty}$: is the temperature of fluid sufficiently far from the surface (ºC).

- **Typical Values of the Convection Heat Transfer Coefficient**

Process	h (W/m².ºC)
Free Convection	
Gases	2-25
Liquids	50-1000
Forced Convection	
Gases	25-250
Liquids	100-20000
Convection with Phase Change	
Boiling or Condensation	2500-100000