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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Content

Chapter 1: General Introduction to the Different Modes of Heat Transfer

Introduction

The subject of transfer phenomena, also known as transport phenomena, three closely related topics: fluid dynamics, heat transfer, and mass transfer. Fluid dynamics involves the transport of *momentum*, heat transfer deals with the transport of *energy*, and mass transfer is concerned with the transport of *mass* of various chemical species.

These three transport phenomena should, at the introductory level, be studied together for the following reasons:

- They frequently occur simultaneously in industrial problems ;
- The basic equations that describe the three transport phenomena are closely related ;
- The mathematical tools needed for describing these phenomena are very similar ;
- The molecular mechanisms underlying the various transport phenomena are very closely related.

1. Transfer phenomena

The most well-known transfer phenomena are:

- **Heat transfer**: in which the transferred quantity is *heat* (*temperature* or *energy*), this transfer occurs between two zones with different temperatures, it always occurs from the higher temperature to the lower temperature. The temperature difference is called the *driving force of heat transfer* ;
- **Mass transfer**: in which the transferred quantity is the *matter* (*mass concentration*), this transfer occurs between two zones with different mass concentrations. It always occurs from the higher concentration to the lower concentration. The concentration difference is called the *driving force of mass transfer* ;
- **Momentum transfer**: in this process, the quantity transferred is *momentum* (*velocity*). It occurs between two entities with different velocities, always from the entity with the higher velocity to the one with the lower velocity. The difference in velocity is referred to as the *driving force of momentum transfer*.

2. Transfer modes

2.1. Conduction transfer

Conduction is a mode of heat transfer that does not require the movement of matter. Heat is transferred from one atom to another through simple atomic agitation. The efficiency of this transfer increases with a greater temperature difference (driving force) between two materials. However, it also depends on the thermal conductivity of the materials.

Heat transfer occurs through direct contact between two stationary solids at different temperatures.

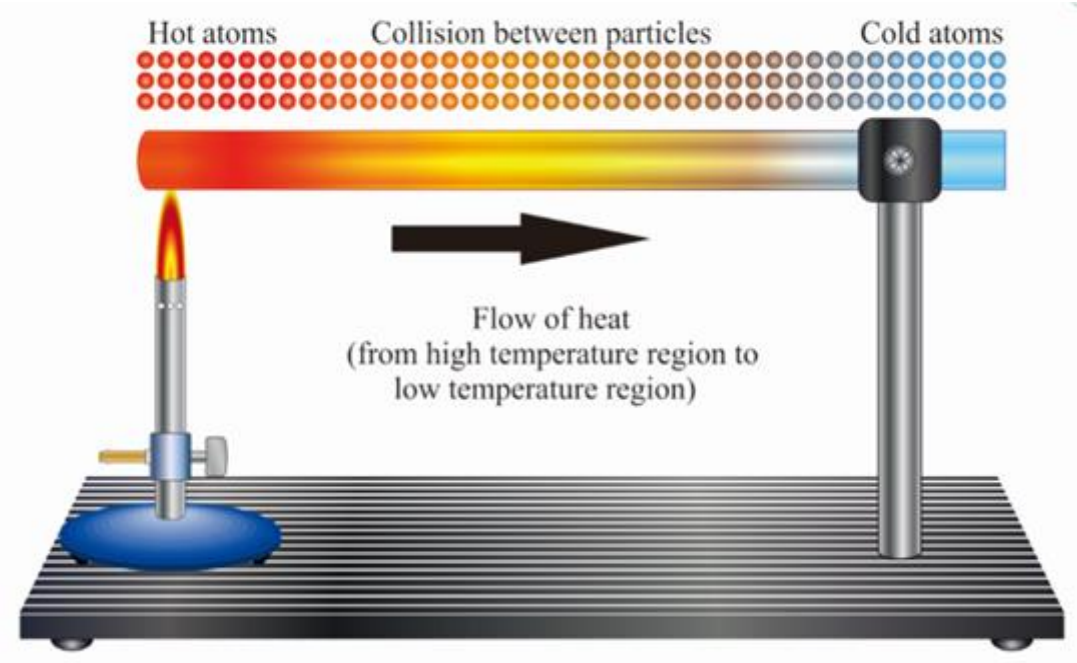

Figure 1 - Conduction heat transfer.

2.2. Convective heat transfer

The exchange of heat between a surface and a moving fluid in contact with it, or the transfer of heat within a fluid through the collective movement of its molecules from one point to another. In the process of convection, heat always moves from hot regions to cold regions.

- Convection is the transfer of heat with the transfer of mass ;
- Common phenomenon (weather, domestic heating...).

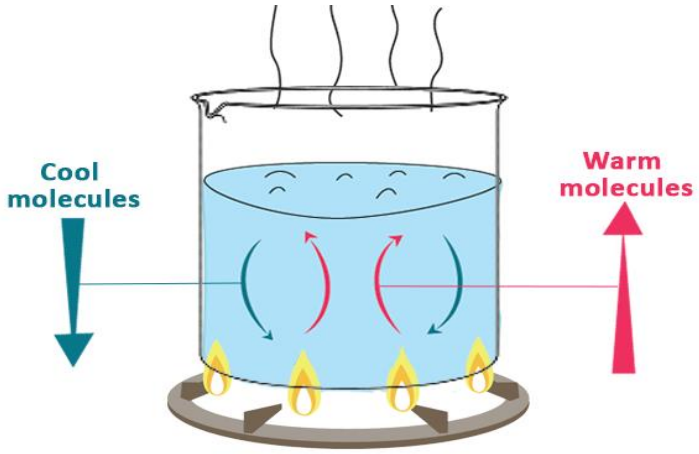

Figure 2 - Convection heat transfer.

Examples:

It is through convection that heat, transmitted to water inside a boiler, is transported to the different rooms of an apartment.

2.3. Radiation Transfer

Radiation is an original mode of transfer specific to thermal energy. A heated particle emits electromagnetic radiation in all directions. When this radiation strikes an object, the object can reflect a portion of it and absorb another portion as heat, which it will use to increase its temperature. This type of heat transfer is analogous to the propagation of light and does not require any material medium, unlike the first two modes of transfer. Gases, liquids, and solids are capable of emitting and absorbing thermal radiation.

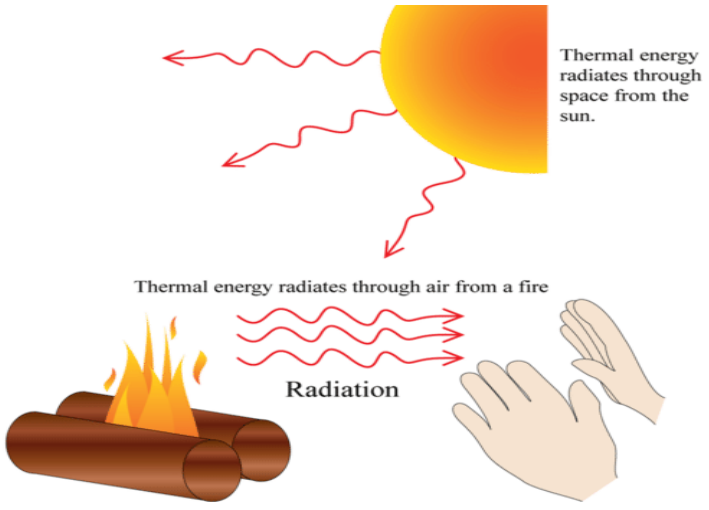

Figure 3 - Radiation heat transfer.

Examples:

The heat received by the Earth from the Sun is achieved through radiation.

The dishes are heated in a microwave oven through the heat carried by microwave radiation.