Salahaddin University - Erbil

College of Agricultural Sciences Engineering

Food Technology Department

Third year

F.P.E. (Practical)

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3 Hours

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**Lecture 2 \ Heat Transfer in Food Processing**

1. **Heat transfer:**

Heat transfer means the movement of thermal energy from one side or medium to another. It occurs repeatedly in food industry while cooking, baking drying, … etc. Hence, it is necessary to understand heat transfer so as to understand a significant side of food processing. Thermal energy can be transferred in three ways: conduction, convection, and radiation.



 The temperature difference between the source of heat and the receiver is the active factor of heat transfer. Then, increasing the temperature difference strengthens the active factor; then the heat transfer increases. During this operation the heat passes through a medium in which a resistance appears against the heat transfer. Therefore, the resistance becomes the second effective factor in heat transfer operation. Eventually, the equation becomes:

Rate of heat transfer= temperature difference/medium resistance[[1]](#footnote-1)

Generally, the equation of transferred heat is:

 Q = m \* c \* ∆T Joule

**Problem:** A pan has a mass of 3.5 and a specific heat of 0.8, the initial temperature is 278 and the goal is to heat it 320 more degrees. Determine the transferred heat.

Q: Transferred Heat

m: Mass

c: Specific Heat

∆T: Temperature Difference

1. . Conductive heat transferring:

It is the method in which the thermal energy is transferred by direct contact, it is used widely overall the world in food industry especially in baking.[[2]](#footnote-2)

 It is easy to find the temperature difference by subtracting the receiver’s temperature from the source’s temperature:

∆T = T1 – T2

Transferred heat by conduction can be calculated by the equation[[3]](#footnote-3):

Q = $(\frac{ҡA\left(Thot - Tcold\right)}{ⅾ})$ Watt

ҡ: thermal conductivity

A: area of the surface

Thot: hot temperature

Tcold: cold temperature

*d*: the thickness of the material

**Problem:** A chef uses a rectangle pan (w: 30cm, l: 40cm) to make an omelet, the stove is 450o kelvin, and temperature of the pan and the contents is 275o kelvin. The pan’s thickness is 5mm. The room’s temperature is 27o C. Determine the heat transfer. (thermal conductivity= 200 $\frac{W}{m.k}$)

1. Convective heat transferring:

 It is the method in which the thermal energy is transferred from the source to the receiver without direct contact through a fluid medium. This method is used in boiling food.

 Transferred heat via convection can be calculated by the following equation:[[4]](#footnote-4)

Q = HC A (Thot−Tcold) Watt

HC: Heat transfer coefficient

**Problem:** 1529.6 KJ of thermal energy was transferred in a process of frying French fries by an aluminum frying pan. The pan before heating was 290o kelvin, it was placed on a stove until it reached 450o kelvin. Determine the heat transfer coefficient of the pan when you know that the area of the pan is 400cm2.

1. Radiative heat transfer:

It is the method in which the thermal energy is transferred by electromagnetic waves. It is used while in electrically baked food.

 Transferred heat by radiation can be calculated as following:[[5]](#footnote-5)

Q= σ (Thot−Tcold) A Watt

σ : Stefan Boltzmann Constant: 5.67e-8 W.m-2.K-4

1. nzifst.org.nz. (n.d.). *Unit Operations in Food Processing* - R. L. Earle. [online] Available at: https://nzifst.org.nz/resources/unitoperations/httrtheory1.html [↑](#footnote-ref-1)
2. ibid [↑](#footnote-ref-2)
3. Toppr-guides. (2019). *Heat Transfer Formula: Definition, Concepts and Examples*. [online] Available at: https://www.toppr.com/guides/physics-formulas/heat-transfer-formula/. [↑](#footnote-ref-3)
4. Ibid [↑](#footnote-ref-4)
5. Ibid [↑](#footnote-ref-5)