Salahaddin University - Erbil

College of Agricultural Sciences Engineering

Food Technology Department

Third year

F.P.E. (Practical)

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3 Hours

Mrs. Darwin Mohammed

**Lecture 4 \ Energy Balances**

**Energy:**

Energy is the force used for movement along distance.[[1]](#footnote-1) It is a scalar quantity. Energy cannot be observed directly, but it can be measured using indirect methods.[[2]](#footnote-2)

**Kinds of Energy:**

Energy can be divided into various types according to their source or function as the following:

1. Mechanical energy.
2. Thermal energy.
3. Nuclear energy.
4. Chemical energy.
5. Electromagnetic energy.
6. Sonic energy.
7. Gravitational energy.
8. Kinetic energy.
9. Potential energy.
10. Ionization energy.

**On which law energy balance is based? Write the equation of energy balance.**

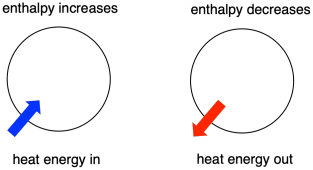
* The energy balance around a system is based on the first law of thermodynamics. The law of conservation of energy: “Energy can be transformed from one form to another, it can neither be created nor destroyed”.[[3]](#footnote-3) For instance, fractions of mechanical energy may seem to be lost while transferring due to transforming them into thermal energy and/or electrical energy.

Accumulation = Energy in – Energy out[[4]](#footnote-4)

If the system in steady state, the accumulation amount is ***zero***.

**Heat content (Enthalpy)**

Enthalpy (**H**) in a thermodynamic system is the sum of the internal energy and the product of its pressure and volume.[[5]](#footnote-5)



Enthalpy is directly proportional with the environment temperature. It increases with surrounding heat and decreases in a colder temperature.[[6]](#footnote-6)

Enthalpy can be calculated by the following equation:

H = Cp (T – Tref)[[7]](#footnote-7)

**Specific Heat of Solids and Liquids**

Specific heat (**Cp**) is the amount of heat that accompanies a unit change in temperature for a unit mass. Most Solids and liquids have a constant specific heat in a wide range of temperature unlike gases in which it varies noticeably with the change in temperature.[[8]](#footnote-8) The enthalpy change (**q**) with a material with mass (**m**) is:

q = m dT [[9]](#footnote-9)

And when average specific heat is given, the enthalpy change is calculated as below:

q = m Cavg ( T2 – T1 ) [[10]](#footnote-10)

When fat is present in the solid or liquid material, the specific heat above freezing can be estimated from the mass fraction fat (**F**), mass fraction solid nonfat (**SNF**), and mass fraction moisture (**M**), as the following equation:

C′avg = 0.4 F + 0.2 SNF + M … in ( ) [[11]](#footnote-11)

Cavg = 1674.72 F + 837.36 SNF + 4186.8 M … in ([[12]](#footnote-12)

**Q – Is it suitable to use specific heats for whole mixture below freezing? Why?**

A- Below freezing, it is not suitable to use specific heats for the whole mixture because the amount of frozen and unfrozen water varies at different temperatures.

**Example:**

Calculate the specific heat of beef roast containing 15% protein, 20% fat, and 65% water.

**Solution**

C′avg = 0.15(0.2) + 0.2(0.4) + 0.65(1)

= 0.76

Cavg = 0.15(837.36) + 0.2(1674.72) + 0.65(4186.8)

= 3182

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**Problem:**

Calculate the specific heat of orange juice concentrate having a solids content of 45%.

1. Azzuni, A. and Breyer, C., 2018. Definitions and dimensions of energy security: a literature review. *Wiley Interdisciplinary Reviews: Energy and Environment*, *7*(1), p268. [↑](#footnote-ref-1)
2. Baldwin, A.L. and Hammerschlag, R., 2014. *Biofield-based therapies: a systematic review of physiological effects on practitioners during healing*. Explore, 10(3), pp.150-161. [↑](#footnote-ref-2)
3. Hadfield, L.C. and Wieman, C.E., 2010. Student interpretations of equations related to the first law of thermodynamics. Journal of Chemical Education, 87(7), pp.750-755. [↑](#footnote-ref-3)
4. Podgorny, A.I., 1989. *On the possibility of the solar flare energy accumulation in the vicinity of a singular line. Solar physics*, 123(2), pp.285-308. [↑](#footnote-ref-4)
5. McNaught, A.D., 1997. *Compendium of chemical terminology* (Vol. 1669). Oxford: Blackwell Science. [↑](#footnote-ref-5)
6. Ibid [↑](#footnote-ref-6)
7. Menon, S.K., Boettcher, P.A. and Blanquart, G., 2013. Enthalpy based approach to capture heat transfer effects in premixed combustion. Combustion and flame, 160(7), pp.1242-1253. [↑](#footnote-ref-7)
8. Toledo, R.T., Singh, R.K., Kong, F., 2007. *Fundamentals of food process engineering* (Vol. 297). New York: Springer. [↑](#footnote-ref-8)
9. Ibid [↑](#footnote-ref-9)
10. Ibid [↑](#footnote-ref-10)
11. Ibid [↑](#footnote-ref-11)
12. Ibid [↑](#footnote-ref-12)