AL- Mustaqpal University

Science College

Dep. Medical Biotechnology

Second Stage

Lec 6

Interpretation of Heat Analysis
And
Interpretation of Heat transfer Between Objects

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Interpretation of Heat Analysis

Thermal analysis (TA) is a group of physical techniques in which the chemical or physical properties of a substance, a mixture of substances or a reaction mixture are measured as a function of temperature or time, while the substances are subjected to a controlled temperature programmed heating or cooling rate.

In other words Thermal analysis is a branch of materials science in which the properties of materials are studied as they change with temperature. Several common methods are used – they are distinguished from each other by the characteristic to be measured :

- Dielectric thermal analysis (DET).
- Differential thermal analysis (DTA).
- Differential Quantitative Scanning (DSC).
- Dilatometry (DIL).
- Thermal Optical Analysis (TOA).
- Derivative imaging: (It is a complex method of thermal analysis).
- Thermal analysis is often used as a term for studying heat transfer through the structure of composites.

This method is applied to:

- Analysis of pharmaceutical substances.
- Polymer analysis (a large area in which thermal analysis finds strong applications; eg, TGA is used to measure the fiber content of composites by heating a sample to remove the gummy substance by applying heat and then determining the remaining mass).
- Metal analysis (a sample of liquid metal is removed from the furnace and poured into a sample cup with a thermocouple embedded in it. The temperature is then monitored, and a phase diagram is observed to stop).

- Food analysis (most foods are exposed to temperature changes during production, transportation, storage, and consumption changes in temperature cause changes in the physical and chemical properties of the food components that affect the general characteristics of the final product, for example, taste, appearance, and texture).

The program may involve heating or cooling at a fixed rate of temperature change, or holding the temperature constant at different time spam. The graphical results obtained are called the thermogram.

These methods are usually applied to solids, liquids and gels to characterize the materials for quality control.

- **The advantages** of TA over other analytical techniques can be summarized as follows:

(1) The samples can be studied over a wide temperature range using various temperature programs.

(2) Almost any physical from of sample (solid, liquid or gel) can be accommodated using a variety of sample vessels.

(3) A small amount of sample (0.1 μg – 10 mg) is required.

(4) The atmosphere of the sample can be standardized.

(5) The time required to complete an experiment ranges from several minutes to hours.

Thermal analysis techniques

The general components of TA apparatus are; a physical property sensor, a controlled temperature programmed furnace and a recording device (x-y recorder or a microcomputer). According to the measurement property, the best method for thermal analysis is : **Thermogravimetric Analysis (TGA)**

Thermogravimetric analysis is the study of the changes in weight of a sample as a function of temperature. The technique is useful strictly for transformations involving the absorption or evolution of gases from a specimen. Suitable samples for TGA are solids that undergo one of the two general of reactions :

Reactant(s) → Product(s) + Gas (a mass loss)

Gas + Reactant(s) → Product(s) (a mass gain)

A plot of the changes of the mass versus temperature, is called TGA thermogram.

It permits studying of the thermal stabilities, rate of reactions, reaction processes, and sample composition.

Measurements of changes in sample mass with the temperature are made using thermobalance. The balance should be in a suitably enclosed system .

Heat transfer Between Objects

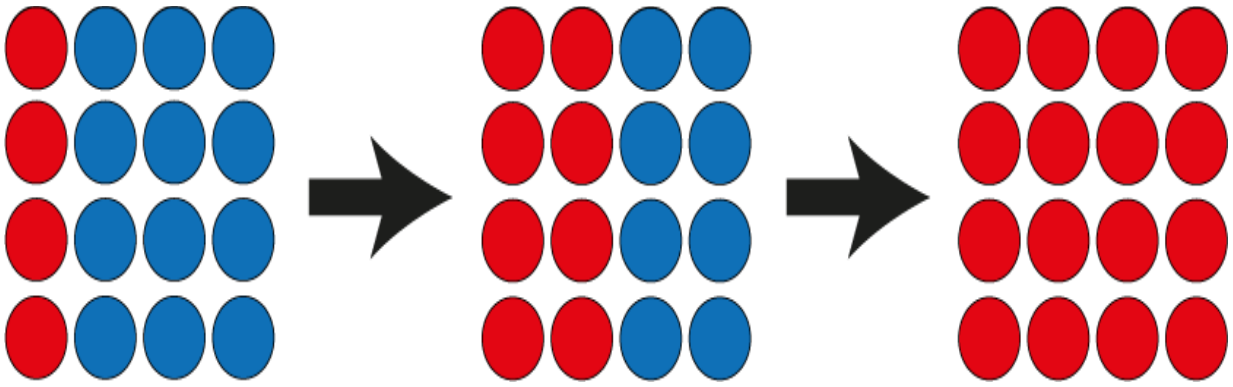
Heat transfer is the exchange of thermal energy between physical objects.
Heat will naturally flow from a hotter to a colder object.

Heat transfer occurs between states of matter whenever a temperature difference exists and heat transfer occurs only in the direction of decreasing temperature, meaning from a hot object to a cold object.

The transfer of heat can occur in three ways:

1- **Conduction. (It occurs between solid objects).**
2- **Convection. (It occurs between liquid as well as gaseous media).**
3- **Radiation.(It can occur in a vacuum).**

Conduction is the main method of heat transfer within solid objects or between solid objects in contact with each other.



• Molecules in the hotter part of the object vibrate faster than the molecules in the cooler parts. The faster moving molecules transfer part of the energy to their slower moving neighbours – so transferring heat through the object

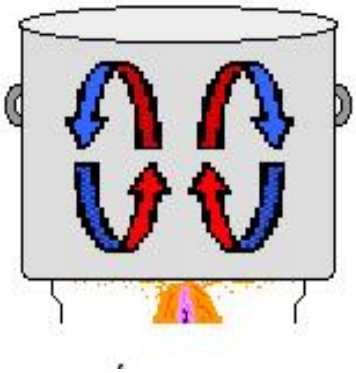
• A 'steady state' is achieved when the heat entering the object at one side is balanced by that being emitted from the other side. Throughout the period of time, the object's heat remains constant.

• Metals are highly conductive whereas gases are not.

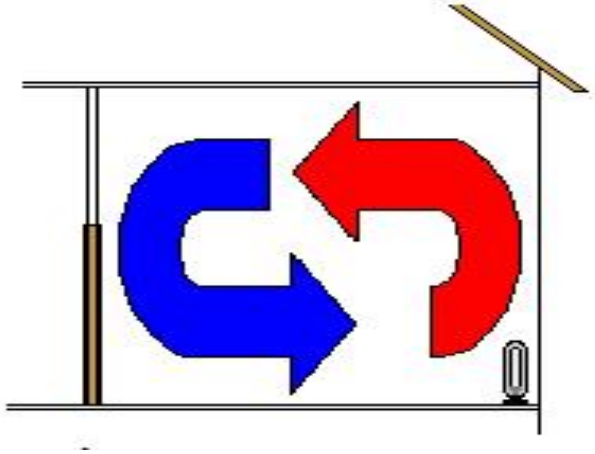
Convection

• Liquids and gases are fluids.

Convection is the movement of heat via currents as heated molecules move from hot places to cooler places.



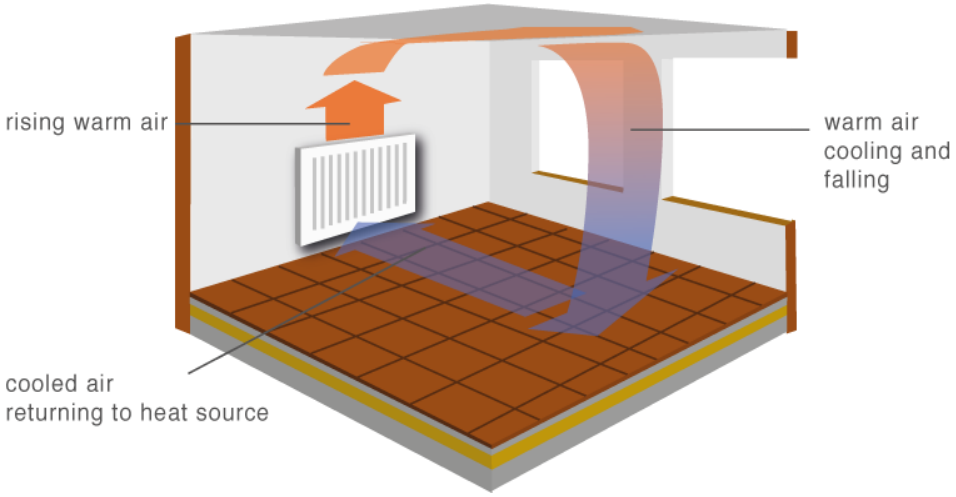
- When molecules are heated in a fluid, they vibrate faster.
- Higher temperature fluid molecules expand the space they occupy.
- The resulting heated space is less dense compared with the cooler spaces
- The heated, less dense fluid rises to replace the denser, cooler fluid, which in turn sinks into the warmer areas.



- The repeated rising and falling of warming and cooling liquid or gas sets up the convection current.

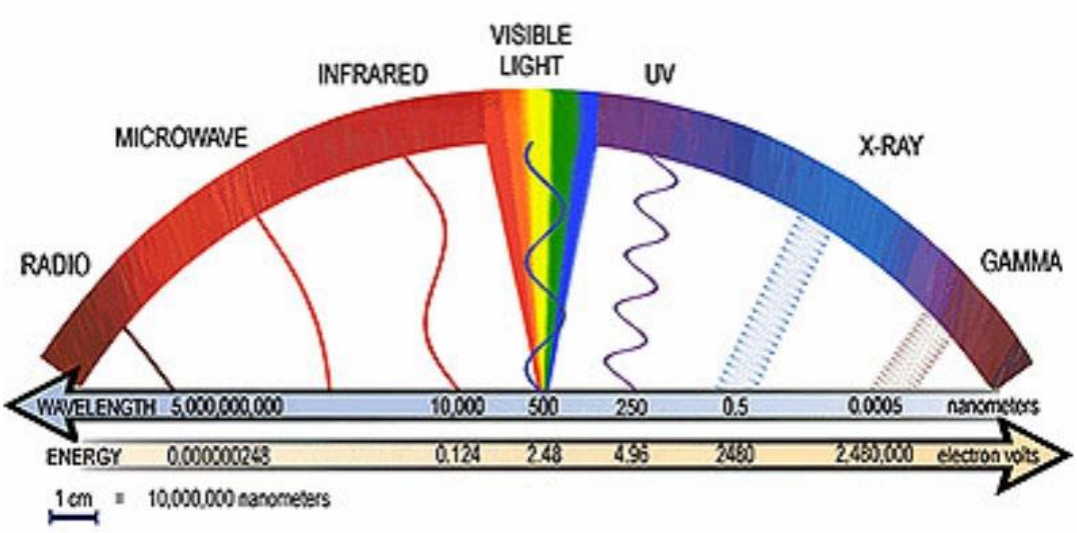
- Through warming up one side of a solid container of fluid, the convection currents

can transfer heat to the other sides; or heat between two solid objects sandwiching a fluid.



Radiation

- All objects absorb and emit thermal radiation (Also known as infrared electromagnetic radiation).
- Heat energy is transferred via waves, not particles.



• The Earth is heated through thermal radiation from the Sun.

• Thermal radiation is emitted as a result of the random movements of atoms and molecules in matter. Since these atoms and molecules are composed of charged particles (protons and electrons) their movement causes the emission of electromagnetic radiation, which carries energy away from the surface of the body.

• Thermal radiation is absorbed well by :

- Water, water vapour, glass, wood, brick, stone, concrete, asphalt, copper,

• Thermal radiation is reflected well by :

- Aluminium foil