STUDY ON HEAT

A red-hot iron rod cooling after being worked by a blacksmith.

Heat is a form of energy associated with the motion of atoms,molecules and other particles which comprise matter.

Creation

It can be created by chemical reactions (such as burning), nuclear reactions (such as fusion taking place inside the Sun),electromagnetic dissipation (as in electric stoves), or mechanicaldissipation (such as friction).

Transfer properties

Heat can be transferred between objects by radiation, conduction and convection. Heat can only be transferred between objects, or areas within an object, that have different temperatures.

Measurement

Temperature is used to indicate the level of elementary motion associated with heat.

During its 350 year development, the science of thermodynamics had established a physical quantity namedtemperature to quantify the level of "warmth", whereas heat (also improperly called heat change) was defined as a transient form of energy that quantifies the spontaneous transfer of thermal energy due to a temperature difference (or gradient.)

The SI unit for heat is the joule; an alternative unit still in use in the United States of America[[1]] and other countries is the British thermal unit.

Usage

By common knowledge, the term heat has been used in connection with the warmthe, or hotness, of surrounding objects. The concept that warm objects "contain heat" is not uncommon.

Domestic usage of heat energy for various purposes such as water heating, room heating etc. is very common.

In industries this heat energy, obtained from different sources, has been extensively used for various purposes such as for heating process materials and in specific, electric power generation.

Properties

The amount of heat exchanged by an object when its temperature varies by one degree is called heat capacity. Heat capacity is specific to each and every object. When referred to a quantity unit (such as mass ormoles), the heat exchanged per degree is termed specific heat, and depends primarily on the compositionand physical state (phase) of objects. Fuels generate predictable amounts of heat when burned; this heat is known as heating value and is expressed per unit of quantity. Upon transitioning from one phase to another, pure substances can exchange heat without their temperature suffering any change. The amount of heat exchanged during a phase change is known as latent heat and depends primarily on the substance and the initial and final phase.

Heat is a process quantity—as opposed to being a state quantity—and is to thermal energy as work is to mechanical energy. Heat flows between regions that are not in thermal equilibrium with each other; it spontaneously flows from areas of high temperature to areas of low temperature. All objects (matter) have a certain amount of internal energy, a state quantity that is related to the random motion of their atoms ormolecules. When two bodies of different temperature come into thermal contact, they will exchange internal energy until the temperature is equalized (that is, until they reach thermal equilibrium). The amount of energy transferred is the amount of heat exchanged. It is a common misconception to confuse heat with internal energy: heat is related to the change in internal energy and the work performed by the system. The term heat is used to describe the flow of energy, while the term internal energy is used to describe the energy itself. Understanding this difference is a necessary part of understanding the first law of thermodynamics.

Infrared radiation is often linked to heat, since objects at room temperature or above will emit radiation mostly concentrated in the mid-infrared band (see black body).

Notation

Total heat is traditionally abbreviated as Q, and is measured in joules in SI units.

Total heat, heat transfer rate, and heat flux are often abbreviated with different cases of the letter Q. They are often switched in different contexts.

Sign Convention: When a body releases heat into its surroundings, Q < 0 (-). When a body absorbs heat from its surroundings, Q > 0 (+).

Heat transfer rate, or heat flow per unit time, is labeled

$$\dot{Q} = \frac{dQ}{dt}$$

to indicate a change per unit time. In Unicode, this is Q̇, though it may not display correctly in all browsers. It is often shown as ˙Q, .Q, Q•, or as a Q with no dot, where it is not easy to produce a dotted Q. Some form of dotted Q, such as .Q, is preferable, since undotted Q is used for total heat. It is measured in watts.

Heat flux is defined as amount of heat per unit time per unit cross-sectional area, is abbreviated q, and is measured in watts per meter squared. It is also sometimes notated as Q” or q” or $\dot{Q}''$.

Changes of temperature

The amount of heat energy, ΔQ, required to change the temperature of a material from an initial temperature, T0, to a final temperature, Tf depends on the heat capacity of that material according to the relationship:

$$\Delta Q = \int_{T_0}^{T_f} C_p \, dT$$

The heat capacity is dependent on both the amount of material that is exchanging heat and its properties. The heat capacity can be broken up in several different ways. First of all, it can be represented as a product of mass and specific heat capacity (more commonly called specific heat):

$$C_p = mc_s$$

or the number of moles and the molar heat capacity:

$$C_p = nc_n$$

Both the molar and specific heat capacities only depend upon the physical properties of the substance being heated, not on any specific properties of the sample. The above definitions of heat capacity only work approximately for solids and liquids, but for gases they don't work at all most of the time. The molar heat capacity can be "patched up" if the changes of temperature occur at either a constant volume or constantpressure. Otherwise, it's generally easiest to use the first law of thermodynamics in combination with an equation relating the internal energy of the gas to its temperature.

Changes of phase

A boiling pot of water, at sea level[[2]] and normal atmospheric pressure, will always be at 100 °C no matter how much heat is added. The extra heat changes the phase of the water from liquid into water vapor. The heat added to change the phase of a substance in this way is said to be "hidden," and thus it is called latent heat (from a Latin[[3]] word for hidden). Latent heat is heat per unit mass necessary to change the state of a given substance. Thus:

$$L = \frac{Q}{\Delta m}$$

and

$$Q = \int_{M_0}^{M} L\, dm$$

that is to say that turning 1 pound of water into one pound of steam at 100 °C and at normal atmospheric pressure would look like 1000 BTU = (1000 BTU/lb)(1 lb). Note that as pressure increases, the L rises slightly.

where M_o is the amount of mass initially in the new phase, and M is the amount of mass that ends up in the new phase.

L generally doesn't depend on the amount of mass that changes phase, so the equation can normally be written:

$$Q = L\Delta m$$

Sometimes L can be time-dependent if pressure and volume are time-varying, so that the integral can be handled:

$$Q = \int L\frac{dm}{dt}dt$$

someone check the above, please, to see if the latent heat really depends on where on the (P, V, T) curve the transition is taking place.

Heat transfer mechanisms

As mentioned previously, heat tends to move from a high temperature region to a low temperature region. This heat transfer may occur by the mechanisms conduction and radiation. In engineering, the term convective heat transfer is used to describe the combined effects of conduction and fluid flow and is regarded as a third mechanism of heat transfer.

Conduction

Conduction is the most common means of heat transfer in a solid. On a microscopic scale, conduction occurs as hot, rapidly moving or vibrating atoms and molecules interact with neighboring atoms and molecules, transferring some of their energy (heat) to these neighboring atoms.

In insulators the heat current is carried almost entirely by phonon vibrations.

The "electron fluid" of a conductive metallic solid conducts nearly all of the heat current through the solid. (Phonon currents are still there, but carry less than 1% of the energy.) Electrons also conduct electric currentthrough conductive solids, and the thermal and electrical conductivities of most metals have about the same ratio. A good electrical conductor, such as copper, usually also conducts heat well.

The Peltier-Seebeck effect[[4]] exhibits the propensity of electrons to conduct heat through an electrically conductive solid. Thermoelectricity is caused by the relationship between electrons, heat currents and electrical currents.

Convection

Convection is usually the dominant form of heat transfer in liquids and gases. This is a term used to characterize the combined effects of conduction and fluid flow. In convection, enthalpy transfer occurs by the movement of hot or cold portions of the fluid together with heat transfer by conduction. For example, when water is heated on a stove, hot water from the bottom of the pan rises, heating the water at the top of the pan. Two types of convection are commonly distinguished, free convection, in which gravity and buoyancy forces drive the fluid movement, and forced convection, where a fan, stirrer, or other means is used to move the fluid.Buoyant convection is due to the effects of gravity, and absent in microgravity environments.

Radiation

Radiation is the only form of heat transfer that can occur in the absence of any form of medium and as such is the only means of heat transfer through a vacuum. Thermal radiation is a direct result of the movements of atoms and molecules in a material. Since these atoms and molecules are composed of charged particles (protons[[5]] and electrons[[6]]), their movements result in the emission of electromagnetic radiation, which carries energy away from the surface. At the same time, the surface is constantly bombarded by radiation from the surroundings, resulting in the transfer of energy to the surface. Since the amount of emitted radiation increases with increasing temperature, a net transfer of energy from higher temperatures to lower temperatures results.

For room temperature objects (~300 K), the majority of photons emitted (and involved in radiative heat transfer) are in the infrared spectrum, but this is by no means the only frequency range involved in radiation. The frequencies emitted are partially related to black-body radiation. Hotter objects—a campfire is around 700 K, for instance—transfer heat in the visible spectrum or beyond. Whenever EM radiation is emitted and then absorbed, heat is transferred. This principle is used in microwave ovens, laser cutting, and RF hair removal.

Other Heat transfer mechanisms

Latent heat: Transfer of heat through a physical change in the medium such as water-to-ice or water-to-steam involves significant energy and is exploited in many ways: steam engine, refrigerator etc. (seelatent heat of fusion)

Heat pipe: Using latent heat and capilliary action to move heat, it can carry many times as much heat as a similar sized copper rod. Orignally invented for use in satellites, they are starting to have applications inpersonal computers.

Heat dissipation

In cold climates, houses with their heating systems form dissipative systems. In spite of efforts to insulate such houses, to reduce heat losses to their exteriors, considerable heat is lost, or dissipated, from them which would make their interiors uncomfortably cool or cold. The house is an open system in as much as it is incapable of preventing heat from escaping. Furthermore, the interior of the house must be maintained out of thermal equilibrium with its exterior for the sake of its inhabitants.

In such a house, a thermostat is a device capable of starting the heating system when the house's interior falls to a set temperature, and of stopping that same system when another set temperature has been achieved. Thus the thermostat controls the flow of energy into the house, that energy eventually being dissipated to the exterior.

Source : http://engineering.wikia.com/wiki/Heat