Thermal conductivity

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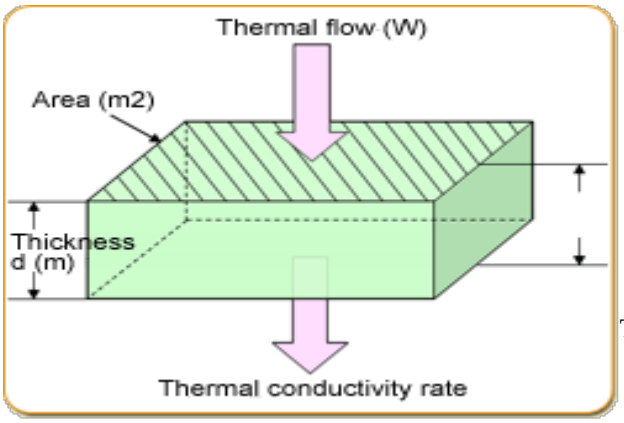
Introduction to Thermal conductivity

The property of a substance that describes how easily heat is transmitted through it is called thermal conductivity. Thermal conduction is generated by the movement of electrons and the transfer of lattice vibrations. Metals with low electrical resistance and crystals in which lattice vibrations are transferred easily (for example, crystals with atoms or ions of similar masses at lattice points and covalent crystals with strong bonds) display high thermal conductivity.

What is thermal conductivity?



Thermal conductivity is the property of a material that indicates its ability to conduct heat and is denoted by the letter 'k'.

When two objects of differenttemperatures are put in contact with one another, there is an exchange of thermal energy. This exchange, known as heat conduction, causes the warmer object to cool and the cooler object to warm.

The thermal energy of an object is a measure of the speed of the object's particles. When two objects of different temperatures are put in contact with one another, the faster moving particles collide with the slower moving particles, and energy is exchanged. The faster moving particles give up some energy and therefore slow down and the slower moving particles gain some energy and therefore speed up. This process, known as heat conduction, continues until equilibrium is reached, which occurs when all the particles of both objects are moving at roughly the same speed. This equilibrium speed (or equilibrium temperature) must be somewhere in between the two objects' original temperatures. Therefore, the warmer object will be cooler and the cooler object will be warmer.

Thermal conductivity is defined as the quantity of heat (Q) transmitted through a unit thickness (L) in a direction normal to a surface of unit area (A) due to a unit temperature gradient (?T) under steady state conditions, when heat transfer depends only on the temperature gradient. In equation form, this becomes the following:

Thermal Conductivity = heat × distance / (area × temperature gradient)

$k = Q \times L / (A \times ?T)$

The S.I. unit of K is obtained as watt /m K. In the cgs system, the unit of K is cal/s cm °C.

Coefficient of thermal conductivity

A material's coefficient of thermal conductivity is defined as the rate of flow of heat, in the steady state, through a slab of the material, which has a unit area of cross-section and unit thickness, and whose opposite faces are maintained at unit temperature difference.

Approximate values of thermal conductivity for some common materials are presented in the table below.

Material	Thermal Conductivity W/m,oK	Thermal Conductivity (cal/sec)/(cm2,oC/cm)
Air at 0 C	0.024	0.000057
Aluminum	205.0	0.50
Brass	109.0	-
Concrete	0.8	0.002
Copper	385.0	0.99
Glass, ordinary	0.8	0.0025
Gold	310	-
Ice	1.6	0.005
Iron	-	0.163
Lead	34.7	0.083
Polyethylene HD	0.5	-
Polystyrene expanded	0.03	-
Silver	406.0	1.01
Styrofoam	0.01	-
Steel	50.2	-
Water at 20 C	-	0.0014
Wood	0.12-0.04	0.0001

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Reference links:

- http://physics.about.com/od/glossary/g/heat.htm
- http://www.wisegeek.com/what-is-conduction.htm
- http://www.thefreedictionary.com/temperature+gradient

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