DOWNLOAD PDF THEORY OF FINS IN HEAT TRANSFER

Chapter 1 : Types Of Fins | Heat transfer Equation For Fins

Fins are used in a large number of applications to increase the heat transfer from surfaces. Typically, the fin material has a high thermal conductivity. The fin is exposed to a flowing fluid, which cools or heats it, with the high thermal conductivity allowing increased heat being conducted from.

Heat Transfer by Natural Convection 1. To determine the overall heat transfer coefficient at the surface of a given vertical metal cylinder by the natural convection method. To determine the value of Nusselt number. Natural Convection Apparatus - a metal cylinder fitted vertically in a wooden rectangular duct which is open at the top and the bottom Fig 1. An electric heater is provided in the vertical cylinder, which heats the surface of the cylinder. Heat is lost from the cylinder to the surrounding air by natural convection, because the air in contact with the cylinder gets heated and becomes less dense, causing it to rise. This in turn creates a continuous flow of air upward in the duct. The temperature at the various locations on the surface of the vertical cylinder and in the incoming and outgoing air is monitored with thermocouples. The duct is made of wood because it is a poor conductor, so not much heat will transfer from the air to the duct. Thus the duct will enhance air flow without introducing another convective surface. Heat transfer theory seeks to predict the energy transfer that takes place between material bodies as a result of temperature difference. This energy transfer is defined as heat. The three modes by which heat can be transferred from one place to another are conduction, convection and radiation. It is well known that a hot plate of metal will cool faster when placed in front of a fan than when placed in still air. With the fan, we say that the heat is convected away, and we call the process convection heat transfer. Convection involves the transfer of heat by motion and mixing of a fluid. Forced convection happens when the fluid is kept in motion by an external means, such as a turbine or a fan. Some examples of forced convection are stirring a mixture of ice and water, blowing on the surface of coffee in a cup, orienting a car radiator to face airflow, etc. Convection is called natural convection when motion and mixing of fluid is caused by density variation resulting from temperature differences within the fluid. The density of fluid near the hot surface is less than that of the colder fluid away from the heated surface, and gravity creates a buoyant force which lifts the heated fluid upward. In the case of convection, the heat flow is proportional only to the surface area A of the object, 2 Where h is the convective heat transfer coefficient units Wm-2 K-1 which depends on the shape and orientation of the object. Convection is an enhanced form of conduction, since the movement of the fluid helps carry heat transferred by conduction, so one would expect some relation between h and k. If the temperature of the cylinder is not much above that of the surrounding air, the moving fluid can be approximated as a stationary layer having some characteristic thickness L. Note that N is a dimensionless quantity. In our case, which does involve turbulent flow, we are interested in temperature variation along the length of a metal cylinder, so we will take the characteristic length L to be the length of the cylinder. Natural convection heat transfer is extensively used in the following areas of engineering: Cooling of commercial high voltage electrical power transformers. Heating of houses by electrical baseboard heaters. Heat loss from steam pipe lines in power plants and heat gain in refrigerant pipe lines in air conditioning applications. Cooling of reactor cores in nuclear power plants, though often the coolant is driven by pumps, resulting in more efficient heat transfer by forced convection. Cooling of electronic devices chips, transistors by finned heat sinks, though a fan is often present to augment the natural convection with forced convection.

Chapter 2 : Heat Exchangers

Fins improve heat transfer in two ways. One way is by creating turbulent flow through fin geometry, which reduces the thermal resistance (the inverse of the heat transfer coefficient) through the nearly stagnant film that forms when a fluid flows parallel to a solid surface.

Climate models[edit] Climate models study the radiant heat transfer by using quantitative methods to simulate the interactions of the atmosphere, oceans, land surface, and ice. Heat equation[edit] The heat equation is an important partial differential equation that describes the distribution of heat or variation in temperature in a given region over time. In some cases, exact solutions of the equation are available; [22] in other cases the equation must be solved numerically using computational methods. System analysis by the lumped capacitance model is a common approximation in transient conduction that may be used whenever heat conduction within an object is much faster than heat conduction across the boundary of the object. This is a method of approximation that reduces one aspect of the transient conduction systemâ€”that within the objectâ€”to an equivalent steady state system. That is, the method assumes that the temperature within the object is completely uniform, although its value may be changing in time. For small Biot numbers, the approximation of spatially uniform temperature within the object can be used: Heat-transfer principles may be used to preserve, increase, or decrease temperature in a wide variety of circumstances. Insulation, radiance and resistance[edit] Thermal insulators are materials specifically designed to reduce the flow of heat by limiting conduction, convection, or both. Thermal resistance is a heat property and the measurement by which an object or material resists to heat flow heat per time unit or thermal resistance to temperature difference. Radiance or spectral radiance are measures of the quantity of radiation that passes through or is emitted. Radiant barriers are materials that reflect radiation, and therefore reduce the flow of heat from radiation sources. Good insulators are not necessarily good radiant barriers, and vice versa. Metal, for instance, is an excellent reflector and a poor insulator. The effectiveness of a radiant barrier is indicated by its reflectivity, which is the fraction of radiation reflected. A material with a high reflectivity at a given wavelength has a low emissivity at that same wavelength , and vice versa. An ideal radiant barrier would have a reflectivity of 1, and would therefore reflect percent of incoming radiation. Vacuum flasks , or Dewars, are silvered to approach this ideal. In the vacuum of space, satellites use multi-layer insulation , which consists of many layers of aluminized shiny Mylar to greatly reduce radiation heat transfer and control satellite temperature. A heat engine is a system that performs the conversion of a flow of thermal energy heat to mechanical energy to perform mechanical work. A thermoelectric cooler is a solid state electronic device that pumps transfers heat from one side of the device to the other when electric current is passed through it. It is based on the Peltier effect. A thermal diode or thermal rectifier is a device that causes heat to flow preferentially in one direction. Heat exchangers[edit] A heat exchanger is used for more efficient heat transfer or to dissipate heat. Heat exchangers are widely used in refrigeration , air conditioning , space heating , power generation , and chemical processing. In parallel flow, both fluids move in the same direction while transferring heat; in counter flow, the fluids move in opposite directions; and in cross flow, the fluids move at right angles to each other. Common constructions for heat exchanger include shell and tube, double pipe , extruded finned pipe, spiral fin pipe, u-tube, and stacked plate. Examples of heat sinks are the heat exchangers used in refrigeration and air conditioning systems or the radiator in a car. A heat pipe is another heat-transfer device that combines thermal conductivity and phase transition to efficiently transfer heat between two solid interfaces. Architecture[edit] Efficient energy use is the goal to reduce the amount of energy required in heating or cooling. In architecture, condensation and air currents can cause cosmetic or structural damage. An energy audit can help to assess the implementation of recommended corrective procedures. For instance, insulation improvements, air sealing of structural leaks or the addition of energy-efficient windows and doors. Thermal transmittance is the rate of transfer of heat through a structure divided by the difference in temperature across the structure. Well-insulated parts of a building have a low thermal transmittance, whereas poorly-insulated parts of a building have a high thermal transmittance. Thermostat is a device to monitor and control temperature.

Anthropogenic heat An example application in climate engineering includes the creation of Biochar through the pyrolysis process. Thus, storing greenhouse gases in carbon reduces the radiative forcing capacity in the atmosphere, causing more long-wave infrared radiation out to Space. Climate engineering consists of carbon dioxide removal and solar radiation management. Since the amount of carbon dioxide determines the radiative balance of Earth atmosphere, carbon dioxide removal techniques can be applied to reduce the radiative forcing. Solar radiation management is the attempt to absorb less solar radiation to offset the effects of greenhouse gases. The ability of the atmosphere to capture and recycle energy emitted by the Earth surface is the defining characteristic of the greenhouse effect. The greenhouse effect is a process by which thermal radiation from a planetary surface is absorbed by atmospheric greenhouse gases, and is re-radiated in all directions. Since part of this re-radiation is back towards the surface and the lower atmosphere, it results in an elevation of the average surface temperature above what it would be in the absence of the gases. Heat transfer in the human body[edit] See also: Wet-bulb temperature The principles of heat transfer in engineering systems can be applied to the human body in order to determine how the body transfers heat. Heat is produced in the body by the continuous metabolism of nutrients which provides energy for the systems of the body. Therefore, excess heat must be dissipated from the body to keep it from overheating. When a person engages in elevated levels of physical activity, the body requires additional fuel which increases the metabolic rate and the rate of heat production. The body must then use additional methods to remove the additional heat produced in order to keep the internal temperature at a healthy level. Heat transfer by convection is driven by the movement of fluids over the surface of the body. This convective fluid can be either a liquid or a gas. For heat transfer from the outer surface of the body, the convection mechanism is dependent on the surface area of the body, the velocity of the air, and the temperature gradient between the surface of the skin and the ambient air. Heat transfer occurs more readily when the temperature of the surroundings is significantly less than the normal body temperature. Clothing can be considered an insulator which provides thermal resistance to heat flow over the covered portion of the body. This smaller temperature gradient between the surface temperature and the ambient temperature will cause a lower rate of heat transfer than if the skin were not covered. In order to ensure that one portion of the body is not significantly hotter than another portion, heat must be distributed evenly through the bodily tissues. Blood flowing through blood vessels acts as a convective fluid and helps to prevent any buildup of excess heat inside the tissues of the body. This flow of blood through the vessels can be modeled as pipe flow in an engineering system. The heat carried by the blood is determined by the temperature of the surrounding tissue, the diameter of the blood vessel, the thickness of the fluid , velocity of the flow, and the heat transfer coefficient of the blood. The velocity, blood vessel diameter, and the fluid thickness can all be related with the Reynolds Number , a dimensionless number used in fluid mechanics to characterize the flow of fluids. Latent heat loss, also known as evaporative heat loss, accounts for a large fraction of heat loss from the body. When the core temperature of the body increases, the body triggers sweat glands in the skin to bring additional moisture to the surface of the skin. The liquid is then transformed into vapor which removes heat from the surface of the body. The body continuously loses water by evaporation but the most significant amount of heat loss occurs during periods of increased physical activity.

Chapter 3 : Fins for Cooling Success - Lytron Inc

In the study of heat transfer, fins are surfaces that extend from an object to increase the rate of heat transfer to or from the environment by increasing convection. The amount of conduction, convection, or radiation of an object determines the amount of heat it transfers.

For most heat exchanger and cold plate applications, the overall heat transfer coefficient consists mainly of a combination of conduction and convection terms, where the conduction term tends to be much smaller than the convection term s. This is important because component designers usually have little control over the materials of construction, which affects conduction, and the coolant to be used. They do, however, wield considerable control over fin geometry and fin density, which affects convection. Fin geometry and density Fins improve heat transfer in two ways. One way is by creating turbulent flow through fin geometry, which reduces the thermal resistance the inverse of the heat transfer coefficient through the nearly stagnant film that forms when a fluid flows parallel to a solid surface. A second way is by increasing the fin density, which increases the heat transfer area that comes in contact with the fluid. Fin geometries and densities that create turbulent flow and improve performance also increase pressure drop, which is a critical requirement in most high performance applications. The optimum fin geometry and fin density combination is then a compromise of performance, pressure drop, weight, and size. Typically, fin thicknesses vary from 0. In most high performance applications, fins are made of copper or aluminum. Aluminum fins are preferred in aircraft electronic liquid cooling applications due to their lighter weight. Copper fins are mostly used in applications where weight is not an important factor but compatibility with other cooling loop materials is. There are many different fin geometries used in heat transfer applications. Some of the most commonly used are louvered, lanced offset, straight, and wavy fins. Maximizing performance by minimizing thermal resistance The task of optimizing performance and minimizing thermal resistance can be best demonstrated by a theoretical example. Figure 2 illustrates the heat flow path through the heat exchanger using an electrical analogy. Electrical analogy of heat flow diagram In this example, heat flows by convection between temperatures TH and T1, then by conduction between temperatures T1 and T2, and finally by convection between T2 and TC. The total thermal resistance is then equal to the sum of the three thermal resistances in series. By comparison, a cold plate typically has only one coolant flowing through it. As a result, heat flows by conduction from the heat-dissipating electronic device mounted on the cold plate through the thermal interface material and cold plate materials. Heat then flows by convection from the internal surface of the fluid path material to the coolant. As shown in the example above, if we want to maximize heat transfer we must minimize thermal resistance. To accomplish this, we must increase the corresponding heat transfer areas, the film coefficients, or both. Increasing the heat transfer area is relatively easy in concept, though sometimes constrained by application requirements such as weight, size, and pressure drop. An effective way to increase the heat transfer area is to increase the fin density fins per unit length. Increasing the film coefficient is more complicated, however, because the film coefficient is dependent upon the properties of the fluid being considered, the fluid velocity, and the fin geometry. Meeting the challenge When faced with demanding and sometimes conflicting application requirements, including performance, pressure drop, weight, and size, working with an experienced supplier that understands how to optimize the fin geometry and fin density of heat exchangers and cold plates is essential in order to maximize performance and meet the application requirements.

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Chapter 4 : Fin (extended surface) - Wikipedia

This set of Heat Transfer Multiple Choice Questions & Answers (MCQs) focuses on "Fins". 1. A very long copper rod 20 mm in diameter extends horizontally from a plane heated wall maintained at degree Celsius.

Generalized Conduction and Previous: Typically, the fin material has a high thermal conductivity. The fin is exposed to a flowing fluid, which cools or heats it, with the high thermal conductivity allowing increased heat being conducted from the wall through the fin. The design of cooling fins is encountered in many situations and we thus examine heat transfer in a fin as a way of defining some criteria for design. The fin is of length. The other parameters of the problem are indicated. The fluid has velocity and temperature. We assume using the Reynolds analogy or other approach that the heat transfer coefficient for the fin is known and has the value. The end of the fin can have a different heat transfer coefficient, which we can call. The approach taken will be quasi-one-dimensional, in that the temperature in the fin will be assumed to be a function of only. This may seem a drastic simplification, and it needs some explanation. With a fin cross-section equal to and a perimeter , the characteristic dimension in the transverse direction is For a circular fin, for example,. The regime of interest will be taken to be that for which the Biot number is much less than unity, , which is a realistic approximation in practice. The physical content of this approximation can be seen from the following. Heat transfer per unit area out of the fin to the fluid is roughly of magnitude per unit area. The heat transfer per unit area within the fin in the transverse direction is again in the same approximate terms where is an internal temperature. These two quantities must be of the same magnitude. In other words, if , there is a much larger capability for heat transfer per unit area across the fin than there is between the fin and the fluid, and thus little variation in temperature inside the fin in the transverse direction. To emphasize the point, consider the limiting case of zero heat transfer to the fluid, i. Under these conditions, the temperature within the fin would be uniform and equal to the wall temperature. Element of fin showing heat transfer If there is little variation in temperature across the fin, an appropriate model is to say that the temperature within the fin is a function of only, , and use a quasi-one-dimensional approach. There is heat flow of magnitude at the left-hand side and heat flow out of magnitude at the right hand side. There is also heat transfer around the perimeter on the top, bottom, and sides of the fin. From a quasi-one-dimensional point of view, this is a situation similar to that with internal heat sources, but here, for a cooling fin, in each elemental slice of thickness there is essentially a heat sink of magnitude , where is the area for heat transfer to the fluid. It is a second order equation and needs two boundary conditions. The first of these is that the temperature at the end of the fin that joins the wall is equal to the wall temperature. Does this sound plausible? Why or why not? The second boundary condition is at the other end of the fin. We will assume that the heat transfer from this end is negligible The boundary condition at is The last step is to work in terms of non-dimensional variables to obtain a more compact description. In this we define as range from zero to one. We also define , where also ranges over zero to one. The boundary condition at is is that the temperature gradient is zero or Solving the two equations given by the boundary conditions for and in terms of the hyperbolic cosine or: In terms of the actual heat transfer parameters it is written as Several features of the solution should be noted. First, one does not need fins which have a length such that is much greater than 3. Second, the assumption about no heat transfer at the end begins to be inappropriate as gets smaller than 3, so for very short fins the simple expression above would not be a good estimate. We will see below how large the error is. The temperature distribution, tip temperature, and heat flux in a straight one-dimensional fin with the tip insulated. Lienhard, A Heat Transfer Textbook, Prentice-Hall publishers] Muddy Points Why did you change the variable and write the derivative as in the equation for heat transfer in the fin?

Chapter 5 : Heat Transfer From a Fin

The fin efficiency,, is defined as a ratio of the actual heat transferred from the wall with the fin attached to the heat transferred if the entire fin was the wall temperature. It can be shown that: () In this equation, L is the length of the fin in *meters.*

Chapter 6 : Heat Exchanger Theory and the Heat Exchanger Design Equation

A fin is a part of a machine or equipment that is having sole purpose to increase the surface area so that the heat transfer increase usually between air and a heat generating device like engine, CPU, heat exchanger etc.

Chapter 7 : Heat transfer - Wikipedia

The section contains questions and answers on concepts of fins, steady heat flow along a rod, performance of fin, design consideration for fins, thermometric well properties and heat dissipation from a long fin and a fin which is insulated at the tip.