A heat exchanger is a device used to transfer heat between two or more fluids.Classification of Heat Exchangers by Flow Configuration There are four basic flow configurations: Counter Flow Cocurrent Flow Crossflow Hybrids such as Cross Counterflow and Multi Pass Flow Figure 1 illustrates an idealized counterflow exchanger in which the two fluids flow parallel to each other but in opposite directions.In general shell and tube exchangers are made of metal but for specialist applications (e.g., involving strong acids of pharmaceuticals) other materials such as graphite, plastic and glass may be used.Other types of tubular exchanger include: Furnaces--the process fluid passes through the furnace in straight or helically wound tubes and the heating is either by burners or electric heaters.Devices involving energy sources such as nuclear fuel pins or fired heaters are not normally regarded as heat exchangers although many of the principles involved in their design are the same.A Recuperative Heat Exchanger has separate flow paths for each fluid and fluids flow simultaneously through the exchanger exchanging heat across the wall separating the flow paths.Regenerative heat exchangers In a regenerative heat exchanger, the flow path normally consists of a matrix, which is heated when the hot fluid passes through it (this is known as the "hot blow"). This heat is then released to the cold fluid when this flows through the matrix (the "cold blow").This type of flow arrangement allows the largest change in temperature of both fluids and is therefore most efficient (where efficiency is the amount of actual heat transferred compared with the theoretical maximum amount of heat that can be transferred).Tubular heat exchangers can be subdivided into a number of categories, of which the shell and tube exchanger is the most common.A Shell and Tube Exchanger consists of a number of tubes mounted inside a cylindrical shell.The shell and tube exchanger consists of four major parts: Front end-this is where the fluid enters the tubeside of the exchanger.Rear end-this is where the tubeside fluid leaves the exchanger or where it is returned to the front header in exchangers with multiple tubeside passes.Tube bundle-this comprises of the tubes, tube sheets, baffles and tie rods etc.Electrically heated-in this case the fluid normally flows over the outside of electrically heated tubes, (see Joule Heating).In cocurrent flow heat exchangers, the streams flow parallel to each other and in the same direction as shown in Figure 2, This is less efficient than countercurrent flow but does provide more uniform wall temperatures.Examples of these are combined crossflow/counterflow heat exchangers and multi pass flow heat exchangers.Regenerators are mainly used in gas/gas heat recovery applications in power stations and other energy intensive industries.Recuperative heat exchangers There are many types of recuperative exchangers, which can broadly be grouped into indirect contact, direct contact and specials.Indirect contact heat exchangers keep the fluids exchanging heat separate by the use of tubes or plates etc..The popularity of shell and tube exchangers has resulted in a standard being developed for their designation and use.It is also normal for the tubes to be straight but in some cryogenic applications helical or Hampson coils are used.Air Cooled Heat Exchangers consist of bundle of tubes, a fan system and supporting structure.The first considers the flow configuration within the heat exchanger, while the second is based on the classification of equipment type primarily by construction.Crossflow heat exchangers are intermediate in efficiency between countercurrent flow and parallel flow exchangers.Classification of Heat Exchangers by Construction In this section heat exchangers are classified mainly by their construction, Garland (1990), (see Figure 5).The first level of classification is to divide heat exchanger types into recuperative or regenerative.However, because regenerative heat exchangers tend to be used for specialist applications recuperative heat exchangers are more common.Tubular heat exchangers are very popular due to the flexibility the designer has to allow for a wide range of pressures and temperatures.This is the Tubular Exchanger Manufactures Association (TEMA) Standard.This exchanger consists of a one or more tubes contained within a larger pipe.The book by E.A.D. Saunders [Saunders (1988)] provides a good overview of tubular exchangers.The tubes are normally mounted in some form of duct and the plates act as supports and provide extra surface area in the form of fins.Air is either sucked up through the tubes by a fan mounted above the bundle (induced draught) or blown through the tubes by a fan mounted under the bundle (forced draught).A Regenerative Heat Exchanger has a single flow path, which the hot and cold fluids alternately pass through.Both types of regenerator are transient in operation and unless great care is taken in their design there is normally cross contamination of the hot and cold streams.However, the use of regenerators is likely to increase in the future as attempts are made to improve energy efficiency and recover more low grade heat.Direct contact exchangers do not separate the fluids exchanging heat and in fact rely on the fluids being in close contact.Heat Exchanger Types This section briefly describes some of the more common types of heat exchanger and is arranged according to the classification given in Figure 5.Two fluids can exchange heat, one fluid flows over the outside of the tubes while the second fluid flows through the tubes.Shell--this contains the tube bundle.In its most complex form there is little difference between a multi tube double pipe and a shell and tube exchanger.However, double pipe exchangers tend to be modular in construction and so several units can be bolted together to achieve the required duty.Tubes in plate--these are mainly found in heat recovery and air conditioning applications.The tubes can have various type of fins in order to provide additional surface area on the air side.They tend to be used in locations where there are problems in obtaining an adequate supply of cooling water.The fluids can be single or two phase and, depending on the exchanger type, may be separated or in direct contact.In industrial heat exchangers, hybrids of the above flow types are often found.Regenerative Heat Exchangers are sometimes known as Capacitive Heat Exchangers.A good overview of regenerators is provided by Walker (1982).The two main types of regenerator are Static and Dynamic.Indirect heat exchangers In this type, the steams are separated by a wall, usually metal.Examples of these are tubular exchangers, see Figure 6, and plate exchangers, see Figure 7.A simple form of the shell and tube exchanger is the Double Pipe Exchanger.In order to discuss heat exchangers it is necessary to provide some form of categorization.In these units, the streams flow at right angles to each other as shown in Figure 3.Heat exchanger classifications.Heat exchanger classifications.Figure 8 illustrates a typical unit that may be found in a petrochemical plant.There are two approaches that are normally taken.Countercurrent flow.Countercurrent flow.Cocurrent flow.Cocurrent flow.Crossflow.Crossflow.The fluids can be single or two phase and can flow in a parallel or a cross/counter flow arrangement.to hold the bundle together.Both are considered here.Figure 1.Figure 2.Figure 3.(See for example Figure 4.) Cross/counter flow.Figure 4.Cross/counter flow.Figure 5.