

Heat Exchangers: Theory and Selection

Heat exchangers are devices that transfer heat between two fluids. They can transfer heat between a liquid and a gas (i.e., a liquid-to-air heat exchanger) or two gases (i.e., an air-to-air heat exchanger), or they can perform as liquid-to-liquid heat exchangers. These devices are used in many applications, such as air conditioning, gas turbines, automobiles and electronics cooling. For example, the radiator in a car is a water-to-air heat exchanger that cools the heated water returning from the engine.

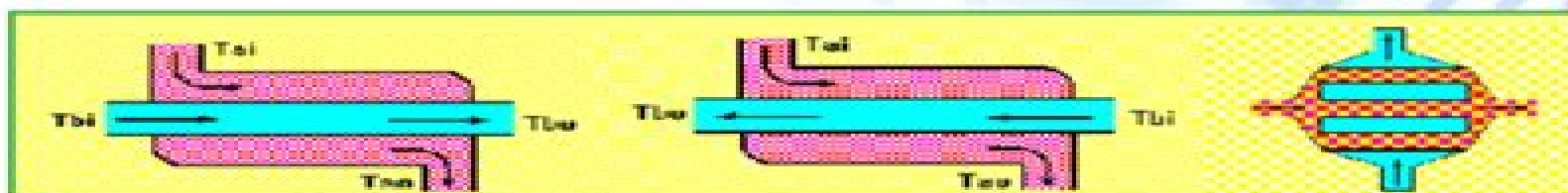


Figure 1. Parallel flow in a heat exchanger.

Figure 2. Counter flow in a heat exchanger.

Figure 3. Cross flow heat exchanger.

The many types of heat exchangers can be characterized by flow arrangement and construction. Some common examples are parallel flow heat exchangers, in which both fluids move in the same direction (Figure 1); counter flow heat exchangers, with fluids moving in the opposite directions (Figure 2); and cross flow heat exchangers, where one fluid moves perpendicular to the other (Figure 3).

The cross flow exchanger can be arranged so that one fluid is confined to a tube and the other fluid mixed, or both fluids can be confined to tubes and unmixed. The tubes can have any geometry such as flat or round.

Shell and tube exchangers with different numbers of shells are industrial type exchangers (Figure 4). Compact heat exchangers have very large surface areas, typically on their gas side. Since the gas side has a much smaller heat transfer coefficient compared to the liquid side, increasing the surface area reduces the total resistance on the gas side. In this type of heat exchanger, the tubes have fins on the outside, or parallel plates are attached to maximize the air side surface area.

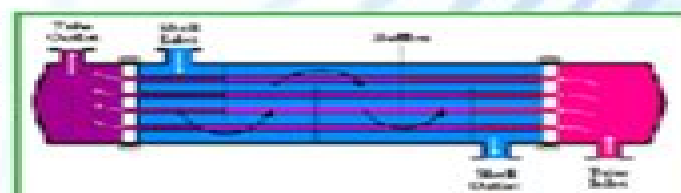


Figure 4. Shell and tube heat exchanger.

The most fundamental variable in heat exchanger design is the definition of the overall effective heat transfer coefficient, U [1]. The formula is:

$$\frac{1}{UA} = \frac{1}{(hA)_c} + R_c + \frac{1}{(hA)_h} + R_h$$

Where:

U = overall effective heat transfer coefficient

A = area of the hot or cold side of the fluids,

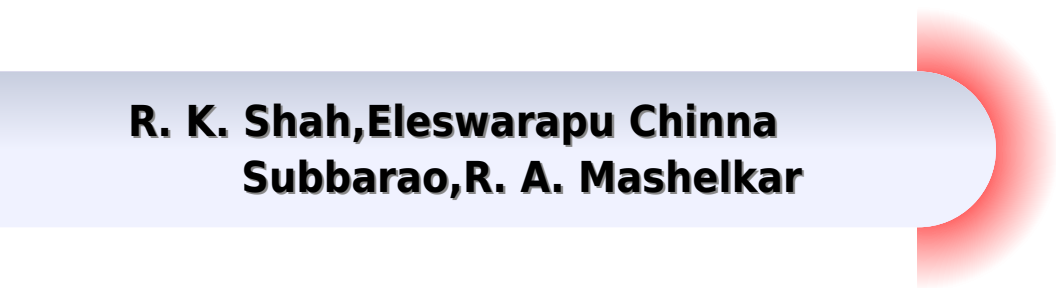
h = heat transfer coefficient for either the cold or the hot side

R_c = conduction resistance of the material separating the hot and cold fluids.

R_h = fouling factor

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**R. K. Shah, Eleswarapu Chinna
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understanding of the underlying physical aspects of heat transfer and fluid flow as well as improve their ability to analyze and interpret computed results

Controlled Environment Engineering Ilhami Yildiz, 2025-12-15 This integrated book introduces broad engineering concepts and relevant physiological principles and environmental parameters and demonstrates in a step by step approach how controlled environment engineering knowledge can be put in use in designing plant animal and aquatic bioenvironmental systems It covers integrated energy and waste management approaches and clean energy technologies including real world case studies and complete design examples with state of the art technologies and updated material globally Provides exclusive material on plant animal and aquatic systems engineering and relevant waste management systems in a single book Introduces broad engineering concepts relevant physiological principles and environmental parameters Incorporates a design and integrated energy and waste management approach Demonstrates how controlled environment engineering knowledge can be put in use in designing plant animal and aquatic production facilities Includes calculations and controlled environment design examples including homework problems This book is aimed at researchers and graduate students in agricultural aquacultural and biosystems engineering control systems aquaculture and agriculture

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Mechanical Design of Heat Exchangers Krishna P. Singh, Alan I. Soler, 2013-04-17 A tubular heat exchanger exemplifies many aspects of the challenge in designing a pressure vessel High or very low operating pressures and temperatures combined with sharp temperature gradients and large differences in the stiffnesses of adjoining parts are amongst the legion of conditions that behoove the attention of the heat exchanger designer Pitfalls in mechanical design may lead to a variety of operational problems such as tube to tubesheet joint failure flanged joint leakage weld cracks tube buckling and flow induced vibration Internal failures such as pass partition bowing or weld rip out pass partition gasket rib blow out and impingement actuated tube end erosion are no less menacing Designing to avoid such operational perils requires a thorough grounding in several disciplines of mechanics and a broad understanding of the inter relationship between the thermal and mechanical performance of heat exchangers Yet while there are a number of excellent books on heat exchanger thermal design comparable effort in mechanical design has been non existent This apparent void has been filled by an assortment of national codes and industry standards notably the ASME Boiler and Pressure Vessel Code and the Standards of Tubular Exchanger Manufacturers Association These documents in conjunction with scattered publications form the motley compendia of the heat exchanger designer s reference source The subject matter clearly beckons a methodical and comprehensive treatment This book is directed towards meeting this need

Heat Exchangers Kuppam Thulukkanam, 2024-02-29 Heat Exchangers Classification Selection and Thermal Design Third Edition discusses heat

exchangers and their various applications such as refrigeration air conditioning automobiles gas turbines process industries refineries and thermal power plants With a focus on thermal design methods including rating and sizing the book covers thermohydraulic fundamentals and thermal effectiveness charts for various flow configurations and shell and tube heat exchangers It provides construction details geometrical features and correlations and thermo hydraulic details for tube fin plate fin air cooled shell and tube microchannel and plate heat exchangers and thermal design methods like rating and sizing The book explores additive manufacturing of heat exchangers printed circuit heat exchangers and heat transfer augmentation methods The book also describes recuperators and regenerators of gas turbine cycles waste heat recovery devices and phase change phenomena including boiling condensation and steam generation The book serves as a useful reference for researchers graduate students and engineers in the field of heat exchanger design including heat exchanger manufacturers

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Cryocoolers Graham Walker,2012-12-06 The rapidly expanding use of very low temperatures in research and high technology during the last several decades and the concurrent high degree of activity in cryogenic engineering have mutually supported each other each improvement in refrigeration technique making possible wider opportunities for research and each new scientific discovery creating a need for a refrigerator with special features In this book Professor Walker has provided us with an excellent exposition of the achievements of this period the fundamental principles involved and a critical examination of the many different cryogenic systems which have led to a new era of low level refrigeration I feel fortunate to have had a part in the developments discussed in this book During the early 1930s I constructed several rotary engines using leather vanes Their performance was not good but I was able to liquefy air I had been impressed by the usefulness of leather cups in tire pumps and in Claude type engines for air liquefaction I was trying to find a way to avoid that part of the friction generated by a leather cup as a result of the radial force of the working gas on the cylindrical part of the cup During the 1950s I built two efficient helium liquefiers in which essentially leather pistons were used

Dynamics and Control in Nuclear Power Stations British Nuclear Energy Society,1992 This volume covers a wider view of the aspects of control of nuclear power stations by taking into consideration the plant as a whole and the protection systems employed therein Authors with world wide experience consider all the aspects of dynamics and control in the context of both fast and thermal power stations The topics discussed include both the methods of development and applications within analysis of plant behaviour validation of mathematical models plant testing design and implementation of controls

Heat Transfer Equipment Design R. K. Shah,Eleswarapu Chinna Subbarao,R. A. Mashelkar,1988-07-01

Heat Exchangers Abdelhanine Benallou,2024-06-05 The last few decades have seen huge developments in the use of concentrated solar power plants communications technologies mobile telephony and 5G networks the nuclear sector with its small modular reactors and concentrated solar power stations These developments have called for a new generation of heat exchangers As well as presenting conventional heat exchangers

shell and tube and plate heat exchangers their design techniques and calculation algorithms Heat Exchangers introduces new generation compact heat exchangers including printed circuit heat exchangers plate fin heat exchangers spiral heat exchangers cross flow tube fin heat exchangers phase change micro exchangers spray coolers heat pipe heat exchangers and evaporation chambers This new generation of heat exchangers is currently undergoing a boom with applications in on board equipment in aircraft locomotives space shuttles and mobile phones where the volume of the equipment is one of the most important design parameters *Applied Mechanics Reviews* ,1987 **Developments in Heat Exchanger Technology** ,1980

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