ΔT HEAT EXCHANGERS
Phone: (519)471-2800
Fax: (519)471-8494
E-mail: sales@deltathx.com
1674 Hyde Park Rd., Suite 206, London, ON, Canada N6H 5L7

Industrial Heat Exchangers

www.deltathx.com

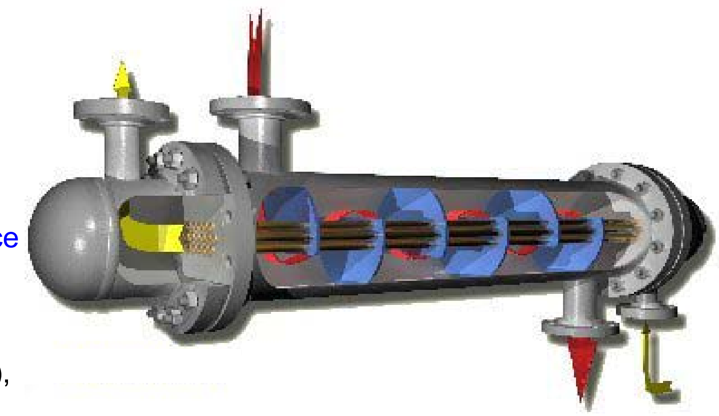
U Factor for Heat Exchangers

The defining equation describing the heat transfer in a heat exchanger is;

$$Q = UA\,\Delta T_m$$

where,

Q = rate of heat transfer
U = mean overall heat transfer coefficient
A = heat transfer surface area
ΔT_m = logarithmic mean temperature difference



The logarithmic mean temperature difference (LMTD), is given by;

$$\Delta T_m = \text{LMTD} = \frac{\Delta t_1 - \Delta t_2}{\ln(\Delta t_1 / \Delta t_2)}$$

$$\Delta t_1 = (T_{\text{hot fluid in}} - T_{\text{cold fluid out}})$$
$$\Delta t_2 = (T_{\text{hot fluid out}} - T_{\text{cold fluid in}})$$

This equation is often used to confirm the accuracy of a heat exchanger design, however a more practical application of this equation is to get a rough estimate of the size of a required exchanger early on in the design process. The surface area A of heat exchangers required for a given service is determined from;

$$A = \frac{Q}{U\,\Delta T_m}$$

For a given heat transfer service with known mass flow rates and inlet and outlet temperatures the determination of Q is straightforward and ΔT_m can be easily calculated if a flow arrangement is selected (e.g. logarithmic mean temperature difference for pure countercurrent or cocurrent flow). This is different for the overall heat transfer coefficient U. The determination of U is often tedious and needs data not yet available in preliminary stages of the design. Therefore, typical values of U are useful for quickly estimating the required surface area. The literature has many tabulations of such typical coefficients for commercial heat transfer services. On the following page, is a table with values for different applications and heat exchanger types.

The ranges given in the table are an indication for the order of magnitude. Lower values are for unfavourable conditions such as lower flow velocities, higher viscosities, and additional fouling resistances. Higher values are for more favourable conditions. Coefficients of actual equipment may be smaller or larger than the values listed. Note that the values should not be used as a replacement of rigorous methods for the final design of heat exchangers, although they may serve as a useful check on the results obtained by these methods.

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Typical Overall Heat Transfer Coefficients in Heat Exchangers			
Type	**Application and Conditions**	***U*** W/(m^2 K)[1)]	***U*** Btu/(ft^2 °F h)[1)]
Tubular, heating or cooling	Gases at atmospheric pressure inside and outside tubes	5 - 35	1 - 6
	Gases at high pressure inside and outside tubes	150 - 500	25 - 90
	Liquid outside (inside) and gas at atmospheric pressure inside (outside) tubes	15 - 70	3 - 15
	Gas at high pressure inside and liquid outside tubes	200 - 400	35 - 70
	Liquids inside and outside tubes	150 - 1200	25 - 200
	Steam outside and liquid inside tubes	300 - 1200	50 - 200
Tubular, condensation	Steam outside and cooling water inside tubes	1500 - 4000	250 - 700
	Organic vapors or ammonia outside and cooling water inside tubes	300 - 1200	50 - 200
Tubular, evaporation	steam outside and high-viscous liquid inside tubes, natural circulation	300 - 900	50 - 150
	steam outside and low-viscous liquid inside tubes, natural circulation	600 - 1700	100 - 300
	steam outside and liquid inside tubes, forced circulation	900 - 3000	150 - 500
Air-cooled heat exchangers[2)]	Cooling of water	600 - 750	100 - 130
	Cooling of liquid light hydrocarbons	400 - 550	70 - 95
	Cooling of tar	30 - 60	5 - 10
	Cooling of air or flue gas	60 - 180	10 - 30
	Cooling of hydrocarbon gas	200 - 450	35 - 80
	Condensation of low pressure steam	700 - 850	125 - 150
	Condensation of organic vapors	350 - 500	65 - 90
Plate heat exchanger	liquid to liquid	1000 - 4000	150 - 700
Spiral heat exchanger	liquid to liquid	700 - 2500	125 - 500
	condensing vapor to liquid	900 - 3500	150 - 700

Notes:
1) 1 Btu/(ft^2 °F h) = 5.6785 W/(m^2 K)
2) Coefficients are based on outside bare tube surface