

## U in Heat Exchangers

The surface area  $A$  of heat exchangers required for a given service is determined from

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

where

$Q$  = rate of heat transfer

$U$  = mean overall heat transfer coefficient

$\Delta T_m$  = mean temperature difference

For a given heat transfer service with known mass flow rates and inlet and outlet temperatures the determination of  $Q$  is straightforward and  $\Delta T_m$  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. Following is a table with values for different applications and heat exchanger types. More values can be found in the sources given below.

The ranges given in the table are an indication for the order of magnitude. Lower values are for unfavorable conditions such as lower flow velocities, higher viscosities, and additional fouling resistances. Higher values are for more favorable 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.

Typical Overall Heat Transfer Coefficients in Heat Exchangers

Type	Application and Conditions	$U$ W/(m <sup>2</sup> K) <sup>1)</sup>	$U$ Btu/(ft <sup>2</sup> °F h) <sup>1)</sup>
<b>Tubular, heating or cooling</b>	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
<b>Tubular, condensation</b>	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
<b>Tubular, evaporation</b>	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
<b>Air-cooled heat exchangers<sup>2)</sup></b>	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
<b>Plate heat exchanger</b>	liquid to liquid	1000 - 4000	150 - 700
<b>Spiral heat exchanger</b>	liquid to liquid	700 - 2500	125 - 500
	condensing vapor to liquid	900 - 3500	150 - 700

Notes:

1) 1 Btu/(ft<sup>2</sup> °F h) = 5.6785 W/(m<sup>2</sup> K)

2) Coefficients are based on outside bare tube surface

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**Presented at The Chemical Engineers' Resource Page, [www.cheresources.com](http://www.cheresources.com)**

**Sources**

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