

<i>Situation</i>	$\bar{h}$, W/m ² K
<i>Natural convection in gases</i>	
• 0.3 m vertical wall in air, $\Delta T = 30^\circ\text{C}$	4.33
<i>Natural convection in liquids</i>	
• 40 mm O.D. horizontal pipe in water, $\Delta T = 30^\circ\text{C}$	570
• 0.25 mm diameter wire in methanol, $\Delta T = 50^\circ\text{C}$	4,000
<i>Forced convection of gases</i>	
• Air at 30 m/s over a 1 m flat plate, $\Delta T = 70^\circ\text{C}$	80
<i>Forced convection of liquids</i>	
• Water at 2 m/s over a 60 mm plate, $\Delta T = 15^\circ\text{C}$	590
• Aniline-alcohol mixture at 3 m/s in a 25 mm I.D. tube, $\Delta T = 80^\circ\text{C}$	2,600
• Liquid sodium at 5 m/s in a 13 mm I.D. tube at 370°C	75,000
<i>Boiling water</i>	
• During film boiling at 1 atm	300
• In a tea kettle	4,000
• At a peak pool-boiling heat flux, 1 atm	40,000
• At a peak flow-boiling heat flux, 1 atm	100,000
• At approximate maximum convective-boiling heat flux, under optimal conditions	10^6
<i>Condensation</i>	
• In a typical horizontal cold-water-tube steam condenser	15,000
• Same, but condensing benzene	1,700
• Dropwise condensation of water at 1 atm	160,000

Table 2.1 Some typical interfacial conductances (air gaps not evacuated)

<i>Situation</i>	h_c (W/m ² K)
Iron/aluminum (70 atm pressure)	45,000
Copper/copper (moderate pressure and normal finishes)	10,000 – 25,000
Aluminum/aluminum (moderate pressure and normal finishes)	2,200 – 12,000
Graphite/metals (moderate pressure and normal finishes)	3,000 – 6,000
Ceramic/metals (moderate pressure and normal finishes)	1,500 – 8,500
Ceramic/ceramic (moderate pressure and normal finishes)	500 – 3,000
Stainless steel/stainless steel (moderate pressure and normal finishes)	300 – 3,700
Rough aluminum/aluminum (low pressure and evacuated interstices)	~ 150

Lienhard IV John, Lienhard V John, A heat transfer Tesbeck, Phlogiston Press, Massachusetts, U.S.A., 2001

Table 2.2 Typical values or ranges of U

<i>Heat Exchange Configuration</i>	<i>U (W/m²K)</i>
Walls and roofs dwellings with a 24 km/h exterior wind velocity:	
• Insulated roofs	0.3–2
• Finished masonry walls	0.5–6
• Frame walls	0.8–5
• Uninsulated roofs	1.2–4
Single-pane windows	~ 6 [†]
Air to heavy tars and oils	As low as 45
Air to low-viscosity liquids	As high as 600
Air to various gases	60–550
Steam or water to oil	60–340
Liquids in coils immersed in liquids	110–2,000
Feedwater heaters	110–8,500
Air condensers	350–780
Steam-jacketed, agitated vessels	500–1,900
Shell-and-tube ammonia condensers	800–1,400
Steam condensers with 25°C water	1,500–5,000
Heat pipes	
• Cryogenic	< 1,000
• Water	3,000
• Liquid metal	50,000
Condensing steam to high-pressure boiling water	Ø(7,000)

[†] Main heat loss is by infiltration.

Table 2.3 Some typical fouling resistances

<i>Fluid and Situation</i>	<i>Fouling Resistance R_f (m²K/W)</i>
Distilled water	0.0001
Seawater	0.0001 – 0.0004
Treated boiler feedwater	0.0001 – 0.0002
Clean river or lake water	0.0002 – 0.0006
About the worst waters used in heat exchangers	< 0.0020
No. 6 fuel oil	0.0001
Transformer or lubricating oil	0.0002
Most industrial liquids	0.0002
Most refinery liquids	0.0002 – 0.0009
Steam, non-oil-bearing	0.0001
Steam, oil-bearing (e.g., turbine exhaust)	0.0003
Most stable gases	0.0002 – 0.0004
Flue gases	0.0010 – 0.0020
Refrigerant vapors (oil-bearing)	0.0040