For example, the free convection transfer from a 3 in. O.D. horizontal cylinder for a temperature difference of 40 F = 25.0 × 0.73 × 1.52 = 27.7 Btu per square foot per hour.

Problems in either forced convection or natural convection may be solved by the simple first-power equation if the convection coefficient is expressed as a unit conductance:

$$q_c = h\,A\,(t_1 - t_2) \qquad (2b)$$

where

q_c = heat transmission by convection, Btu per hour.
A = surface area, square feet.
$t_1 - t_2$ = temperature difference between the surface and the fluid degrees Fahrenheit.
h = unit conductance, from Table 5, Btu per square foot per hour per degree Fahrenheit temperature difference.

TABLE 3. FREE CONVECTION FACTORS FOR VARIOUS SHAPES

SHAPES	FACTOR
Horizontal cylinders 24 in. in diam. or over	0.73
Long vertical cylinders 24 in. in diam. or over	0.88
Vertical plates 24 in. in height or over	1.00
Horizontal plates warmer than air facing upward	1.28
Horizontal plates warmer than air facing downward	0.64
Horizontal plates cooler than air facing upward	0.64
Horizontal plates cooler than air facing downward	1.28

TABLE 4. FREE CONVECTION FACTORS FOR VARIOUS DIAMETER PIPES OR VARIOUS HEIGHT PLATES

Actual O.D., or height, in.	1	2	3	4	5	6	7	8
Factor	1.88	1.64	1.52	1.43	1.37	1.32	1.28	1.25
Actual O.D., or height, in.	9	10	12	14	16	18	20	22
Factor	1.22	1.19	1.15	1.11	1.09	1.06	1.04	1.02

NOMENCLATURE AND DIMENSIONS FOR TABLE 5

c_p = fluid unit heat capacity at constant pressure, Btu per pound per degree Fahrenheit.
D = cylinder diameter, feet.
$G = 3600\,V_s\rho$ = fluid mass velocity, pounds per hour per square foot of flow cross-section.
ρ = density, pounds per cubic foot.
h_c = unit conductance for thermal convection, Btu per hour per square foot per degree Fahrenheit.
k = unit thermal conductivity of the fluid, Btu per hour per square foot per degree Fahrenheit for one foot thickness.
R_H = hydraulic radius of the flow cross-section = flow cross-section area per wetted perimeter, feet.
s = fin spacing, feet.
t = average fluid film temperature; degree Fahrenheit.
$t_1 - t_2$ = temperature difference surface to main fluid, degree Fahrenheit.
V_s = fluid velocity, feet per second.
μ = fluid viscosity, pounds per hour per foot = viscosity in centipoises × 2.42.

TABLE 5. APPROXIMATE UNIT CONDUCTANCES FOR THERMAL CONVECTION FOR SEVERAL FLOW SYSTEMS[a]

Expressed in Convenient Empirical Form

CASE	SYSTEM	UNIT CONDUCTANCE EQUATION[b]
	FORCED CONVECTION	
1.	Longitudinal flow in cylinders, turbulent region. Fluid being heated.[c]	$\frac{h_c D}{k} = 0.0225\left(\frac{DG}{\mu}\right)^{0.8}\left(\frac{c_p\mu}{k}\right)^{0.4}$ For $\left(\frac{DG}{\mu}\right) > 3000$
2.	For longitudinal air flow in cylinders case 1 reduces toe.	$h_c = 0.0036\,G^{0.8}/D^{0.2}$ For $\left(\frac{DG}{\mu}\right) > 3000$
3.	For longitudinal water flow in cylinders case 1 reduces toe.	$h_c = 0.00486\,(1 + 0.01t)\,\frac{G^{0.8}}{D^{0.2}}$ For $\left(\frac{DG}{\mu}\right) > 3000$
4.	Air flow normal to a single right circular cylinder.	$h_c = 0.45\left(\frac{k}{D}\right) + 0.178\,G^{0.56}\left(\frac{k}{D}\right)^{0.44}$
5.	Air flow over staggered pipe banks.	$h_c = 0.061\left(\frac{k}{D}\right)^{0.31} G^{0.69}$
6.	Air flow over single spheres.	$h_c = 0.040\,\frac{G^{0.52}}{D^{0.48}}$ $0 < t < 250$ F
7.	Air flow over plane surfaces.	$h_c = 1 + 0.22\,V_s$ For $V_s < 16$ fps or $h_c = 0.53\,V_s^{0.8}$ 16 fps $< V_s <$ 100 fps
8.	Air flow normal to finned cylinders.	$h_c = 6.2\left(\frac{G}{3600}\right)^{0.6}\frac{s^{0.32}}{D^{0.52}}$ $0 < t < 250$ F
	FREE CONVECTION[d]	
9.	Single horizontal right circular cylinder in air.	$h_c = 0.23\left(\frac{t_1 - t_2}{D}\right)^{0.25}$
10.	Vertical surfaces in air.	$h_c = 0.3\,(t_1 - t_2)^{0.25}$
11.	Top surface of horizontal plates to air.	$h_c = 0.4\,(t_1 - t_2)^{0.25}$
12.	Bottom surface of horizontal plates to air.	$h_c = 0.2\,(t_1 - t_2)^{0.25}$

[a] Heat Transmission, by W. H. McAdams.

[b] Fluid properties should be evaluated at the arithmetic mean fluid temperature, $t_f = (t_{surface} + t_{fluid})$ divided by 2.

[c] These expressions are applicable to longitudinal flow in other than right circular cylinders provided the hydraulic radius is employed as the conduit dimension parameter. For non-circular cross-sections $D = 4\,R_H$.

[d] For low rates of heat transfer by free convection the exponent decreases towards zero, and for higher rates increases towards 0.33. The following equations employing an exponent equal to 0.25 are applicable in the intermediate range.