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Wilson Plot

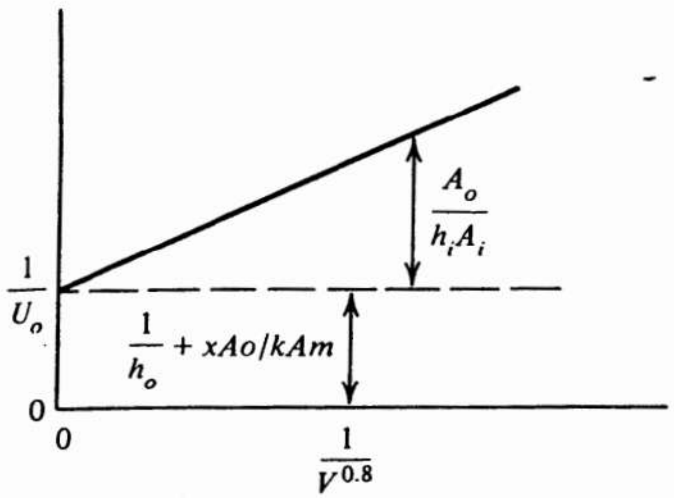


Figure 12-16 A Wilson plot to determine the individual heat-transfer coefficients of a condenser.

12-13 Wilson plots Constructing a Wilson plot is a technique of processing heat-transfer data to determine the individual heat-transfer coefficients in a heat exchanger. The concept was introduced by Wilson[13] and is often applied to condensers and evaporators to determine the condensing or evaporating heat-transfer coefficient along with the air- or water-side coefficient.

If it is a water-cooled condenser that is being analyzed, for example, a series of heat-transfer tests is run and the U value determined for various flow rates of cooling water. If the condenser tubes are clean, Eq. (12-8) applies and h_o is the condensing-side coefficient and h_i the water-side coefficient.

$$\frac{1}{U_o} = \frac{1}{h_o} + \frac{xA_o}{kA_m} + \frac{A_o}{h_i A_i} \qquad (12\text{-}27)$$

The properties of the cooling water are primarily a function of temperature, and if the temperature range throughout the tests is not large, the properties may be assumed constant. Equation (12-9) can then be simplified to

$$h_i = (\text{const})\,(V^{0.8}) \qquad (12\text{-}28)$$

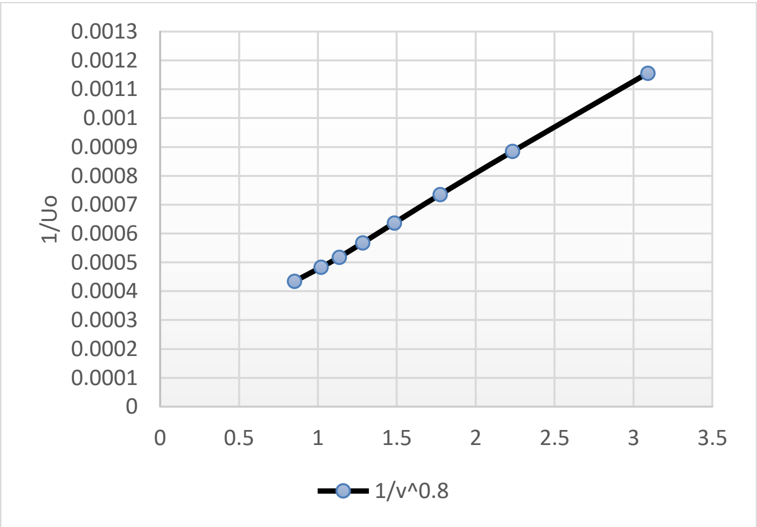
12-13 The following values were measured[17] on an ammonia condenser:

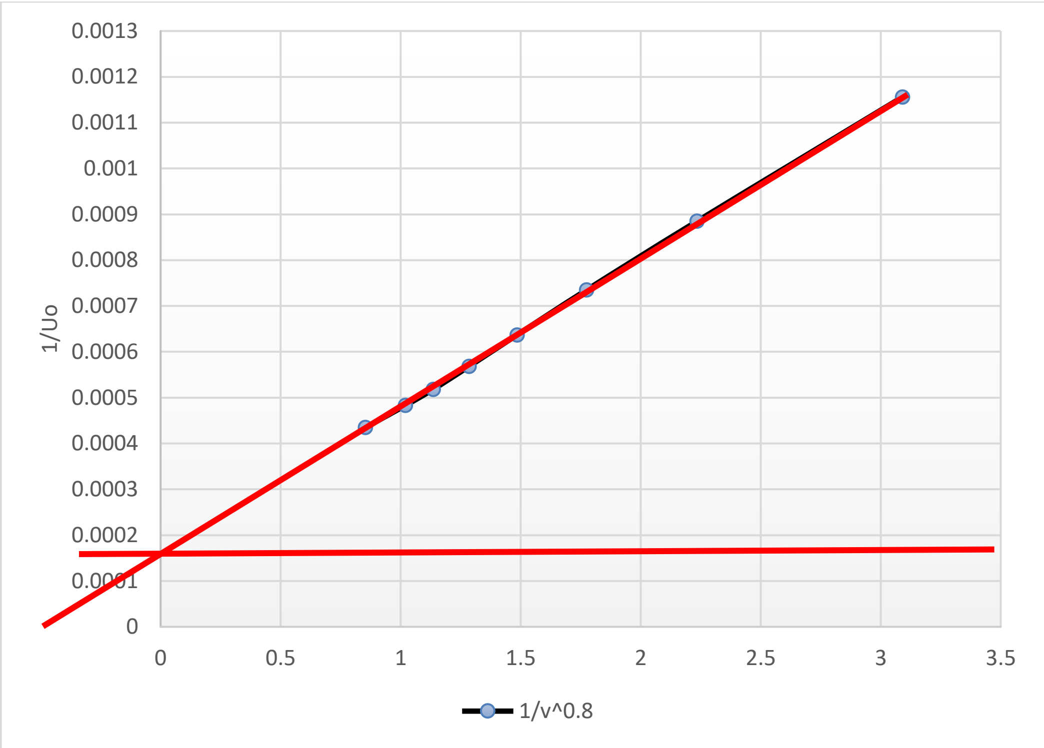
U_o, W/m^2 · K	2300	2070	1930	1760	1570	1360	1130	865
V, m/s	1.22	0.975	0.853	0.731	0.610	0.488	0.366	0.244

Water flowed inside the tubes, and the tubes were 51 mm OD and 46 mm ID and had a conductivity of 60 W/m · K. Using a Wilson plot, determine the condensing coefficient. *Ans.* 8600 W/m^2 · K

Solution

Uo	V	1/Uo	1/v^0.8
2300	1.22	0.000435	0.852928
2070	0.975	0.000483	1.020461
1930	0.853	0.000518	1.13564
1760	0.731	0.000568	1.28489
1570	0.61	0.000637	1.485033
1360	0.488	0.000735	1.775269
1130	0.366	0.000885	2.234679
865	0.244	0.001156	3.090923





$$C_1 = 0.000153033$$

But:

$$C_1 = \frac{1}{h_o} + \frac{xA_o}{kA_m}$$

$$\frac{A_o}{A_m} = \frac{51}{(51+46)/2} = 1.05155$$

x = (1/2)(51 - 46) = 2.5 mm = 0.0025 m

k = 60 W/m.K

$$0.000153033 = \frac{1}{h_o} + \frac{(0.0025)(1.05155)}{60}$$

h_o = 9,156 W/m^2.K - - - Ans.