

Fouling Factor

AHRI 550/590-2011 Section C6.3

The fouling of heat exchanger tubes is caused by dirt and material build-up on the tube surface introduced by water flowing through the heat exchangers. This build-up decreases the heat transfer efficiency between system cooling or heating water and refrigerant. For flooded evaporators, falling film evaporators and water-cooled condensers, fouling is found on the inside of the heat exchanger tubes. For direct expansion evaporators, fouling is found on the outside of the heat exchanger tubes. During performance testing, the tube surfaces are considered clean with a fouling factor of zero (0.000) h · ft² · °F/Btu. Therefore the water temperature difference, TD_a, is calculated for each heat exchanger to account for the difference between the specified design tube fouling and the clean tubes and is then added to the rated condenser entering water temperature and subtracted from the rated evaporator leaving water temperature to simulate the additional fouling factor.

FOULING FACTOR EQUATIONS and SAMPLE CALCulationS

Specified Fouling Factor, ff _{sp}	ff _{sp} = 0.00025 h · ft ² · °F/Btu
Condenser Load, q	q = 2,880,000 Btu/h
Specified Condenser Leaving Water Temperature, t _{wl}	t _{wl} = 95 °F
Specified Condenser Entering Water Temperature, t _{we}	t _{we} = 85 °F
Inside Tube Surface Area, A _i	A _i = 550 ft ²
Specified Refrigerant Saturated Condensing Temperature, t _s	t _s = 101 °F

$$S_{sp} = \text{small temperature difference} = t_s - t_{wl} = 101 - 95 = 6 \text{ °F}$$

$$R = \text{water temperature range} = t_{wl} - t_{we} = 95 - 85 = 10 \text{ °F}$$

$$\text{LMTD} = \text{log mean temperature difference} = \frac{R}{\ln(1 + R/S_{sp})} = \frac{10}{\ln(1 + 10/6)} = 10.2 \quad \text{(equation C8)}$$

$$\text{ILMTD} = \text{Incremental LMTD} = ff_{sp} (q / A_i) = 0.00025 (2,880,000 / 550) = 1.31 \quad \text{(equation C10)}$$

$$Z = \frac{R}{\text{LMTD} - \text{ILMTD}} = \frac{10}{10.2 - 1.31} = 1.125 \quad \text{(equation C12)}$$

$$\text{TD}_a = \text{temperature adjustment} = S_{sp} - \frac{R}{e^Z - 1} = 6.0 - \frac{10}{e^{1.125} - 1} = 6.0 - 4.8 = 1.2 \text{ °F} \quad \text{(equation C11b)}$$

The entering condenser water temperature for testing is then raised 1.2 °F to simulate the Fouling Factor allowance of 0.00025 h · ft² · °F/Btu.

The entering condenser water temperature for testing will be:

$$t_{we} + \text{TD}_a = 85 \text{ °F} + 1.2 \text{ °F} = 86.2 \text{ °F}$$