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Estimating Fouling Layer Thickness from Heat Transfer Resistance Reported by DATS

For some fouling investigations valuable insight into the phenomena may be gained by calculating an estimated thickness for the fouling layer. This value is easily calculated from the DATS type 1, 2 or 3 fouling monitor with the following precautions:

1) The thermal conductivity of the fouling material must be known! Therefore you must identify the (dominant) deposited material.
2) This calculation assumes a solid, homogenous deposit of the fouling material.
3) This calculation assumes the surface of the deposit is sufficiently smooth to not disturb the convective boundary layer beyond that of a normal tube (primary source of error in calculation).
4) You must use the differential or change in heat transfer resistance reported by the DATS for this calculation. If you properly "zero" the DATS at the beginning of the time period, then the absolute value reported by the DATS is the appropriate value for calculation. If not, you must subtract any initial value from the reported DATS heat transfer resistance (HTR).
5) This can be a rate based calculation (time required to deposit specific thickness) if you divide the value by the time interval over which the DATS showed the increase in heat transfer resistance.
6) Insure you use consistent units for your calculation!

Theory (simplified 1 dimensional heat transfer):

The DATS reports the heat transfer resistance from the equation		Q = UA(Th-Tl)
Heat transfer due to thermal conductivity is calculated from		Q = kA(Th-Tl)/(thickness)
Setting these equations equal and solving for thickness yields		thickness = kA(Th-Tl)/UA(Th-Tl)
Deleting like terms	thickness = k / A = k * HTR	since HTR = 1 / U

Typical Example: Calcium Carbonate scale deposit, estimated thermal conductivty: k = 2 Watts/M deg C
DATS HTR rise of .00020 M^2 deg C/Watt over 2 weeks
Therefore: Thickness = 2 * .00020 = .00040 meters or .4 mm thickness
This yields a deposition rate of: .4mm/(2 weeks * 7 days/week) = .028 mm/day

To estimate the mass of material deposited on the tube wall you need the density of the fouling material. The mass is just the surface area times the thickness times the density.

Typical Example: Calcium Carbonate scale deposit above, density = p = 2500 kg/M^3
Assume a unit area 1 meter x 1 meter
Therefore: Mass = 1 meter^2 * .0004 meters * 2500 kg/M^3 = 1 kg or 1000 grams/m^2

Table of Values (these are estimates based material at or near 30 degrees C. Actual experimental data [scrapings] are preferred).

	Thermal conductivity	density
Calcium carbonate (limestone / marble)	1.26 to 2.94 w/m deg C	2500 to 2700 kg/m^3
Biofilms (same as stagnant water)	.60 to .65 w/m deg C	997 to 988 kg/m^3Sili
Silica scale	~.78 w/m deg C	2200 to 2700 kg/m^3
Carbon Steel	36 to 54 w/m deg C	7750 to 7830 kg/m^3
Iron Oxide (rust Fe2O3)		