PREDICTION OF TUBE SIDE HEAT TRANSFER COEFFICIENT FOR WATER BY NOMOGRAPH

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In view of its favourable thermal properties and economic availability, water is being used as a versatile heat exchange medium in industrial practice. For calculation of tube side heat transfer coefficient, equations of Dittus-Boeltier and Colburn (jH- factor) are quite often used. For moderate pressures and temperatures, the Dittus-Boeltier equation has been simplified and given as under by McAdams[1]

$$h_i = 150\,(1 + 0.011\,t_b)\,\frac{V^{0.8}}{D^{0.2}} \qquad (1)$$

Where, h_i = inside film coefficient for heat transfer, $\frac{B\,t\,u}{hr.\,ft^2\,°F}$

t_b = bulk (i.e. average) temperature of water, °F

V = linear velocity of water in the tube, fps

D = tube diameter, inch

Equation - 1 when rewritten in a convenient SI unit becomes,

$$h_i = 1450\,(1 + 0.014\,t)\,\frac{V^{0.8}}{D^{0.2}} \qquad (2)$$

Where, h_i = inside film coefficient for heat transfer, $\frac{W}{m.^2\,K}$

t = bulk temperature of water. °C

V = linear velocity of water, m/Sec.

D = tube diameter, m.

In order to make the use of equation — (2) more convenient and meaningful for design calculations, a nomograph (figure -1) has been prepared.

Range of applicability of the nomograph :

The range of applicability of the nomograph is presented below (table - 1).

Table - 1

Range of applicability of the nomograph

Variable	Unit	Range of applicability
t	°C	2.0 - 98.0
V	m/Sec.	0.8 - 20.0
D	m	0.007 - 0.140

The ranges of variables cover the working range for industrial heat transfer involving water.

ACCURACY OF THE NOMOGRAPH

The values of tube side heat transfer coefficient for water obtained from figure -1 have been found to agree well with

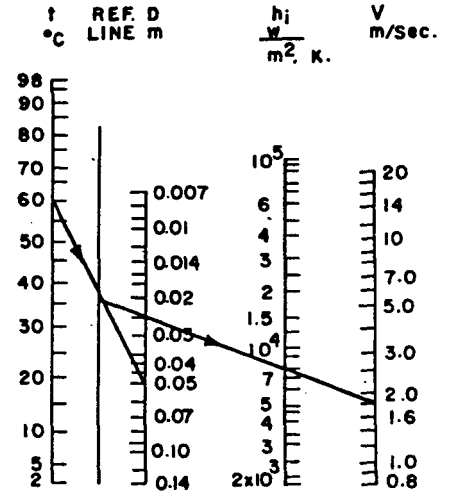

FIG. 1 PREDICTION OF TUBE SIDE HEAT TRANSFER COEFFICIENT FOR WATER BY NOMOGRAPH.

their respective values calculated with the help of equation - 2, which is evident from an example given below.

Example : For the following case, calculate the tube side heat transfer coefficient and compare the value with that obtained from nomograph :

Water velocity (v) - 1.8 m/Sec.

Tube diameter (D) - 0.025 m

Bulk temperature of water (t) - 60°C

Solution :

From equation - 2,

$$h_i = 1450\,(1 + 0.014 \times 60)\,\frac{(1.8)^{0.8}}{(0.025)^{0.2}}$$

$$= 8929\ \frac{W}{m^2 K}$$

h_i from nomograph (figure - 1)

$$= 8000\ \frac{W}{m^2 K}$$

% deviation of nomograph value from calculated one,

$$= \frac{8929 - 8000}{8929} = 10.4$$

REFERENCE :

1. W.H.McAdams, "Heat Transmission" McGraw Hill Book Co. Inc., Third Edition, p - 228.