through the tower counter to the direction of water flow at the rate of 30,000 lb of dry air per hour.

The cross-section of the tower is to be 8 ft x 8 ft and the packing is to be of the type producing a rate coefficient as indicated in curve No. 2 of Fig. 6. For this type of packing the average cross-sectional area for air flow will be 36 sq ft.

Solution:

Initial air enthalpy = 25.1 Btu per pound of dry air.

Final air enthalpy:

$$(h_1 - h_2) = \frac{Lc}{G}(t_1 - t_2)$$

$$(h_1 - 25.1) = \frac{36{,}000 \times 1}{30{,}000}(110 - 80)$$

$$h_1 = 61.1 \text{ Btu per pound dry air.}$$

A numerical integration (Table 4) is employed to determine the Number of Transfer Units (NTU) required. Temperature increments of 2 F are used between successive determinations of the quantity $\frac{1}{h'' - h_a}$. The energy balance indicates that the enthalpy increments corresponding to these temperature increments are:

$$\Delta h = \frac{Lc}{G}\,\Delta t = \frac{36{,}000}{30{,}000} \times 2 = 2.4 \text{ Btu per pound of dry air.}$$

The result of the integration is that the Number of Transfer Units required (NTU) = 1.72.

Unit gas mass velocity, $\frac{G}{S} = \frac{30{,}000}{36} = 830$ lb per (hour) (square foot average cross-sectional air flow area).

From Curve 2, Fig. 6, Ka = 138 Btu.

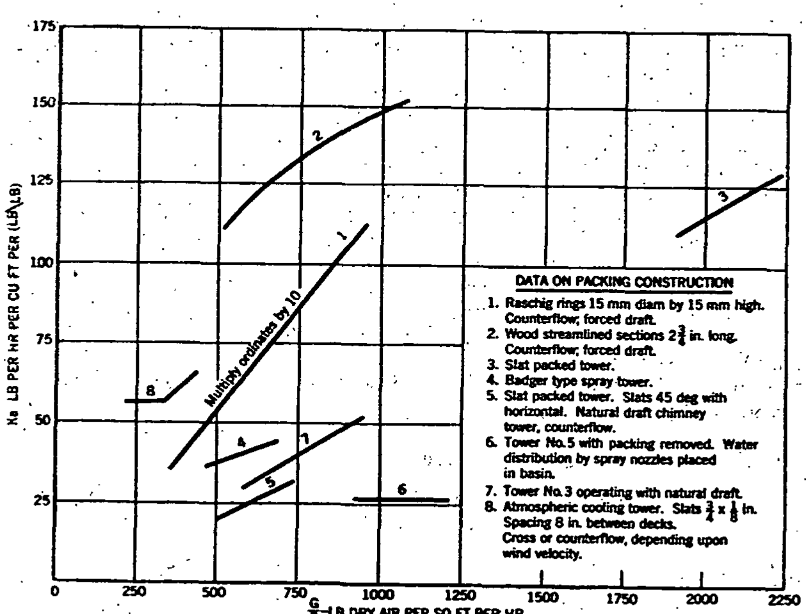

Fig. 6. Unit Conductances for Various Types of Packing Construction

The tower volume required is:

$$V = \frac{G}{Ka}(NTU) = \frac{30{,}000}{138} \times 1.72 = 217 \times 1.72 = 374 \text{ cu ft.}$$

Height of the packed section is:

$$\frac{374}{8 \times 8} = 5.9 \text{ ft.}$$

The graphical solution for the Number of Transfer Units required for the desired performance is plotted in Fig. 7. $\frac{1}{h'' - h_a}$ is plotted as a function of h, and the area under the curve from the initial enthalpy of the air, 25.1 Btu per pound, to the final enthalpy of the air, 61.1 Btu per pound is 1.72, the Number of Transfer Units required. The effect of the rapid decrease in potential due to the cooling of the water is indicated by comparison of area A_1, A_2, and A_3 of Fig. 7. Each represents the Number of Transfer Units required to achieve a water temperature reduction of about 10 F.

$A_1 = 0.471\ NTU$ (110 to 100 F)
$A_2 = 0.595\ NTU$ (100 to 90 F)
$A_3 = 0.657\ NTU$ (90 to 80 F)

The use of the logarithmic mean driving potential is illustrated by applying Equation 7 to Example 1:

$$NTU = \frac{(Ka)\ V}{G} = \frac{h_1 - h_2}{\Delta h_{lm}}$$

$$\Delta h_{lm} = \frac{(h''_1 - h_1) - (h''_2 - h_2)}{\log_e \dfrac{h''_1 - h_1}{h''_2 - h_2}} = \frac{30.7 - 18.4}{\log_e \dfrac{30.7}{18.4}} = 24$$

$$NTU = \frac{61.1 - 25.1}{24} = 1.5$$

The Number of Transfer Units required as determined by use of the logarithmic mean driving potential equals 1.5 which compares favorably with the correct magnitude, 1.72.

Table 4. Numerical Integration for the Number of Transfer Units

Water Temperature Interval F Deg.	Mean Water Temperature F Deg	Mean Air Enthalpy, h_a Btu per Lb Dry Air	Saturated Air Enthalpy, h'' Btu per Lb Dry Air	Enthalpy Potential $h'' - h_a$	$\frac{\Delta h}{h'' - h_a}$
80–82	81	26.3	44.6	18.3	0.131
82–84	83	28.7	46.9	18.2	0.132
84–86	85	31.1	49.2	18.1	0.133
86–88	87	33.5	51.7	18.2	0.132
88–90	89	35.9	54.4	18.5	0.130
90–92	91	38.3	57.1	18.8	0.128
92–94	93	40.7	60.0	19.3	0.124
94–96	95	43.1	63.0	19.9	0.121
96–98	97	45.5	66.2	20.7	0.116
98–100	99	47.9	69.6	21.7	0.111
100–102	101	50.3	73.2	22.9	0.105
102–104	103	52.7	77.0	24.3	0.099
104–106	105	55.1	80.9	25.8	0.093
106–108	107	57.5	85.1	27.6	0.087
108–110	109	59.9	89.5	29.6	0.081
					1.723