

intermediate point on the wet-bulb temperature curve can be calculated similarly. The points for $w = 0.5$ are shown in Fig. 7.

Below the point, $w = 0.25$, the temperature of the stock begins to rise appreciably above the wet-bulb temperature. Its temperature at any given point in this range, for example at $w = 0.15$, may be computed as follows: At this point, $H = 0.0234$ (from Equation 4) and from Fig. 6, $t_w = 95$ F. Hence the wet-bulb depression, $t - t_w = 150 - 95 = 55$ F.

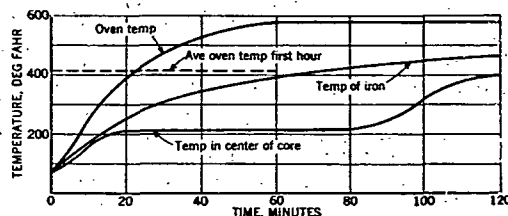


FIG. 8. CORE DRYING TIME TEMPERATURE RELATIONS

The assumption made regarding the relation between stock temperature and moisture content in this range may be formulated:

$$\frac{\Delta t}{t - t_w} = \frac{w}{0.25}$$

At the point $w = 0.15$, $\Delta t = 33$ F, $t = 117$ F. The temperature of the stock leaving the dryer, similarly computed, is 136 F.

Fig. 7 thus computed gives in graphical form the information as to the temperature humidity relationships in the dryer. The air requirements can be computed by Equation 4. Thus, per 100 lb of dry stock, it is necessary to supply 633 lb of dry air. Furthermore, since from Fig. 6 it is seen that the volume of 50 per cent saturated air at 70 F is 13.55 cu ft per pound, 8580 cu ft of room air must be supplied per 100 lb dry stock. Similarly, since the volume of 50 per cent saturated air at 150 F is 18.0 cu ft per pound, the volume of hot wet air discharged from the dryer is

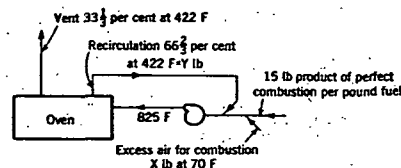


FIG. 9. CORE DRYING DIAGRAM OF COMBUSTION PRODUCTS AND AIR

11,400 cu ft per 100 lb of dry stock. Finally, the heat required for the dryer, as a whole or to any section of it, may be computed from Equation 5.

High Temperature Dryer

In the design of a high temperature dryer unit a method of approach to the necessary calculations involved is outlined as follows:

Example 2. Cores 4 and 5 in. thick are to be dried by heating to a temperature at 400 F. An intermittent type box oven is to be used, size 12 x 14 x 10 ft with 856 sq ft surface, having an average heat transfer of 0.3 Btu per (square foot) (degree) (hour).

Drying time as determined by test is 2 hr (Fig. 8). Cores weighing 6 tons, and 15-ton steel plates, trucks etc. are delivered to the dryer at 70 F. The oven is heated by an external heater; the products of combustion and 66 1/2 per cent recirculated air will be delivered to the oven at 825 F. The fuel oil used has 19,980 Btu gross and 18,830 Btu per pound net heating value, weighing 6.75 lb per gallon and having 15 lb product per pound fuel for perfect combustion. Cores consist of 91 per cent sand, 3 per cent oil binder, and 6 per cent water.

Solution. Heat required per ton of cores:

	Lb Material	× Temp. Rise	× Sp. Ht.	= Btu
Sand	0.91 × 2,000	× (400 - 70)	× 0.2	= 120,120
Binder	0.03 × 2,000	× (400 - 70)	× 0.4	= 7,920
Water heating	0.06 × 2,000	× (212 - 70)	× 1.0	= 17,040
Water evaporation	0.06 × 2,000	× 970 (Fig. 6)		= 116,520
Water superheating (approx. 50 per cent reaches 575 F)	= 0.5 × 0.06 × 2,000 × (575 - 212) × 0.45			= 9,800
Total Heat				271,400 Btu

Heat in 1 lb fuel oil	=	18,830 Btu
Heater Loss (10 per cent)	= 1883	
Duct Loss (5 per cent)	= 942	2,825 Btu

Btu available to heat oven = 16,005 Btu

Heat content of gases in 1 lb fuel oil at 825 F is 205 Btu

Sensible heat in products of perfect combustion = (15 lb + 205) = 3,075 Btu

Btu to heat air X and Y (Fig. 9) = 12,930 Btu

$$Y(S_{212} - S_{212}) + X(S_{212} - S_{70}) = 12,930 \quad (6)$$

$$Y = 2(X + 15) \text{ for } 66.7 \text{ per cent recirculation}$$

where

S = heat content of air at temperature noted taken from Fig. 6.

(Recirculation and exhaust contain water vapor, products of combustion, and a greater portion of air. Heat capacities of all vary so little that they have all been assumed to be air).

$$S_{212} - S_{212} = 190 - 91 = 99$$

$$S_{212} - S_{70} = 190 - 8.6 = 181.4$$

Substituting values of Y , H , etc. in Equation 6,

$$(2X + 30) 99 + 181.4 X = 12,930$$

$$X = 26.3 \text{ lb excess air.}$$

$$Y = 82.6 \text{ lb recirculating air.}$$

Total = 26.3 + 82.6 + 15 = 123.9 lb air and products of combustion circulated per pound fuel burned.

Heat in air exhausted from oven at 422 F per pound fuel burned = $0.333 \times 123.9 \times (S_{422} - S_{70}) = 41.3 (91 - 8.6) = 3,400$ Btu.

Btu available for heating material = 16,005 - 3,400 = 12,605 Btu per pound fuel.

Fuel used in first hour = $2,180,470 \div 12,605 = 173 \text{ lb} = 25.6 \text{ gal.}$

During the second hour the heater capacity will be much greater than required. If an automatic oven temperature control operates on the oil supply, the delivery temperature of the air entering the oven and the quantity of oil burned will decrease, the air supply being constant.

Heat in air exhausted = $41.3 (S_{127} - S_{70}) = 41.3 (127 - 8.6) = 4,880$ Btu per pound fuel.

Heat available for heating material = 16,005 - 4,880 = 11,125 Btu.

Fuel used in second hour = $1,072,008 \div 11,125 = 96.5 \text{ lb oil} = 14.3 \text{ gal.}$

Total oil used per load = 25.6 + 14.3 = 39.9 gal.