a wet-bulb temperature down to 20 per cent moisture, where $w = 0.25$, the corresponding humidity can be computed by the use of Equation 4 or by reading directly from the diagram, the value being 0.0392. Fig. 6 shows that the corresponding wet-bulb temperature is 105 F. Any 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. 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.

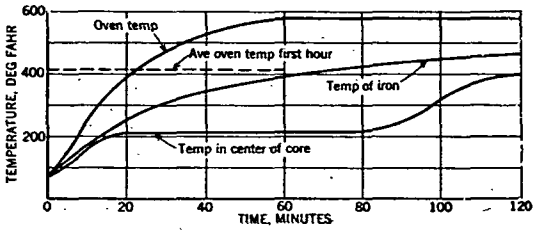


FIG. 8. CORE DRYING TIME TEMPERATURE RELATIONS

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 11,400 cu ft per 100 lb of dry stock. Finally, the heat necessary to supply to 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 per degree per 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

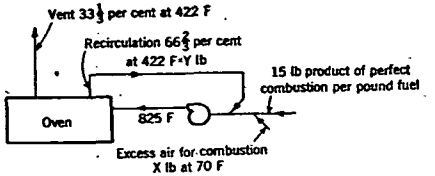


FIG. 9. CORE DRYING DIAGRAM OF COMBUSTION PRODUCTS AND AIR

external heater; the products of combustion and 66⅔ per cent recirculated air will be delivered to the oven at 825 F. Fuel oil of 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

$$Y\,(S_{825} - S_{422}) + X\,(S_{825} - S_{70}) = 12{,}930 \qquad (6)$$

$Y = 2\,(X + 15)$ for 66.7 per cent recirculation

where

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

(Recirculation and exhaust contains 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).

$S_{825} - S_{422} = 190 - 91 = 99$

$S_{825} - S_{70} = 190 - 8.6 = 181.4$

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

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

$X = 26.3$ lb excess air.

$Y = 82.6$ lb recirculating air.

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