

HEATING VENTILATING AIR CONDITIONING GUIDE 1938

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. 4)		= 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.....				

HEATING LOAD FIRST HOUR

	HEATED TO		Btu
Sand.....	212 F	$\frac{142}{330} \times 120,120$	= 51,688
Binder ^a	212 F	$\frac{142}{330} \times 7,920$	= 3,408
Water.....	212 F		= 17,040
Evaporation.....	66.7%	$0.667 \times 116,520$	= 77,680
Superheat.....	66.7%	$0.667 \times 9,800$	= 6,530
Total Per Ton.....			156,346
For 6 ton.....		$6 \times 156,346$	= 938,076
Steel plates.....	390 F	$320 \times 30,000 \times 0.12$	= 1,152,000
Radiation ^b	422 F Avg.	$352 \times 856 \times 0.30$	= 90,394
Total.....			2,180,470

HEATING LOAD SECOND HOUR

Sand.....	400 F	$\frac{188}{330} \times 120,120$	= 68,432
Binder ^a	400 F	$\frac{188}{330} \times 7,920$	= 4,512
Water.....			
Evaporation.....	33.3%	$0.333 \times 116,520$	= 38,840
Superheat.....	33.3%	$0.333 \times 9,800$	= 3,270
Total Per Ton.....			115,054
For 6 ton.....		$6 \times 115,054$	= 690,324
Steel plates.....	460	$70 \times 30,000 \times 0.12$	= 252,000
Radiation ^b	575	$505 \times 856 \times 0.30$	= 129,684
Total.....			1,072,008

^aBinder oxidizes and liberates heat, which is neglected in this calculation.

^bAverage value of coefficient is less than 0.3 because oven is not up to 575 F. This is neglected. 422 F is arrived at by taking area under curve as compared to area under 575 F ordinate.

CHAPTER 35. DRYING SYSTEMS

Heat in 1 lb fuel oil	=	18,830 Btu
Heater Loss (10 per cent)	= 1883	
Duct Loss (5 per cent)	= 942	2,825 Btu
		16,005 Btu available to heat oven.

Heat content of gases in 1 lb fuel oil at 825 F is 205 Btu (Fig. 8)

15 lb × 205	=	3,075 Btu sensible heat in products of perfect combustion.
		12,930 Btu to heat air X and Y (Fig. 11).

$$Y (S_{825} - S_{422}) + X (S_{825} - S_{70}) = 12930$$

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

(4)

where

S = heat content of air at temperature noted taken from Fig. 8

(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 4,

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

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

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

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

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

$$\text{Btu available for heating material} = 16,005 - 3,400 = 12,605 \text{ Btu per pound fuel.}$$

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

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.

$$\text{Heat in air exhausted} = 41.3 (S_{575} - S_{70}) = 41.3 (127 - 8.6) = 4880 \text{ Btu per pound fuel.}$$

$$\text{Heat available for heating material} = 16,005 - 4880 = 11,125 \text{ Btu.}$$

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

$$\text{Total oil used per load} = 25.6 + 14.3 = 39.9 \text{ gal.}$$

ESTIMATING METHODS

Values based on practical experience are available for rough estimating of drying problems. The temperature will drop approximately 8.5 F per grain of water evaporated per cubic foot of air (measured at 70 F) or approximately 0.62 F per pound of air at any temperature. Air will drop 55 F per cubic foot for each Btu extracted. Generally air will absorb from 2 grains to 5 grains per cubic foot of air in one passage through an air drier, depending on the temperature and the degree of contact with the material. The amount of steam required to evaporate a pound of water will vary from 1.5 lb to a more usual figure of from 2.5 to 3 lb of steam per pound of water evaporated.