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			271,400 Btu

Heating Load First Hour

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

Heating Load Second Hour

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

[a]Binder oxidizes and liberates heat, which is neglected in this calculation.
[b]Average 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.

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).

$$Y\ (S_{825} - S_{422}) + X\ (S_{825} - S_{70}) = 12930 \qquad (4)$$

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

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,

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

Heat in air exhausted from oven at 422 F per pound fuel burned = 0.333 × 123.9 × $(S_{422} - S_{70})$ = 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 ÷ 12,605 = 173 lb = 25.6 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 $(S_{675} - S_{70})$ = 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 ÷ 11,125 = 96.5 lb oil = 14.3 gal.

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