PROBLEMS IN PRACTICE

1 ● Dichlorodifluoromethane (F_{12}) at a saturated temperature of 30 F but superheated 25 F to 55 F is compressed to a saturation temperature of 90 F with a compressor having an overall efficiency of 70 per cent. It leaves the condenser sub-cooled 5 F. What is the: *a.* Work per pound; *b.* Refrigerating effect; *c.* Pounds per minute per ton; *d.* Horsepower per ton; *e.* Heat rejected to condenser neglecting radiation; *f.* Equivalent discharge temperature?

a. $\frac{1.151}{0.151} \times 43.16 \times 144 \times 0.939 \times \frac{515}{490}\left[\left(\frac{114.3}{43.16}\right)^{\frac{0.151}{1.151}} - 1\right] \times \frac{1}{0.70} = 9000$ ft-lb.

(*By Pressure—Volume Method*).

Check: $(93.35 - 85.25) \times \frac{1}{0.7} = 11.6$ Btu per pound $= 9000$ ft-lb. (*By Heat Content Method*).

b. $95.25 - 27.48 = 57.77$ Btu per pound.

c. $\frac{200}{57.77} = 3.46$ lb per minute per ton.

d. $9000 \times \frac{3.46}{33{,}000} = 0.944$ hp per ton.

e. $200 + 0.944 \times 42.5 = 240$ Btu per minute per ton.

Check: Heat content leaving compressor $= 85.25 + 11.6 = 96.85$
$(96.85 - 27.48)\ 3.46 = 240$ Btu per minute per ton.

f. Heat Content $= 96.85$.
Pressure $= 114.3$ lb per square inch.
From Table 3, Temp. $= 146$ F.

2 ● If the velocity of vapor in the suction pipe is 50 fps and there are 10 velocity heads lost between evaporator and compressor, what is the saturation temperature at the evaporator?

$$h = \frac{V_2}{2g}$$

$$h = 10 \times \left(\frac{50}{2g}\right)^2 = 388 \text{ ft head.}$$

$$\text{Head per degree} = (47.28 - 43.16) \times \left(\frac{0.863 + 0.792}{2}\right) \times \frac{144}{5} = 98.4 \text{ ft.}$$

Check: Head per degree $= 9000 \times \frac{0.7}{(90 - 30)} = 105$ ft. (*Approx.*)

$$\text{Temperature} = 30 + \frac{388}{98.4} = 34 \text{ F.}$$

3 ● If the refrigerant is sub-cooled to 70 F, what is the effect on: *a.* Work per pound: *b.* Refrigerating effect; *c.* Horsepower per ton?

a. No effect on work per pound.

b. $(85.25 - 23.90) = 61.35$.
$61.35 - 57.77 = 3.58$ Btu increase.

$\frac{3.58}{57.77} = 6.2$ per cent increase.

c. $\frac{200}{61.35} = 3.27$ lb per minute per ton.

$9000 \times \frac{3.27}{33{,}000} = 0.891$ hp per ton.

$0.944 - 0.891 = 0.053$ hp decrease.

$\frac{0.053}{0.944} = 5.6$ per cent decrease.

4 ● What is the approximate change in capacity of the following types of systems per degree at 40 F: *a.* Reciprocating; *b.* Centrifugal; *c.* Ejector?

a. 2.5 per cent. *b.* 3.0 per cent. *c.* 7.5 per cent.

5 ● *a.* Which type of system will maintain the most uniform evaporator temperature with change of load?

b. Which system will maintain the most uniform load with change of evaporator temperature?

From Fig. 6.

a. Steam ejector.

b. Reciprocating and centrifugal.

6 ● *a.* What is the velocity of steam expanding from 100 lb per square inch gage, saturated to 0.0178 lb per square inch absolute, corresponding to 50 F if the nozzle has an efficiency of 90 per cent?

b. What is the velocity of the mixture of this steam with one-third the mass of entrained steam moving at 300 fps?

a. $V = \sqrt{778 \times 2g \times 0.9 \times (1189.0 - 810.3)}$

$V = 4130$ fps.

b. $V_{mix.} = \frac{3 \times 4130 + 1 \times 300}{4} = 3172$ fps.

7 ● If air entering an open adsorption system at 80 F and 50 per cent relative humidity is dehumidified and cooled to a temperature of 90 F and 12 per cent relative humidity, how much air is cooled per ton of refrigeration and what is the latent heat of the water which is adsorbed?

Entering Conditions	*Leaving Conditions*
66.6 F WB.	59.1 F WB.
30.85 Btu Total Heat	25.59 Btu Total Heat
76.0 Grains per Pound	24.5 Grains per Pound

$$\text{cfm} = \frac{200 \times 13.5}{(30.85 - 25.59)} = 513 \text{ cfm per ton.}$$

$$L = \frac{513 \times (760 - 24.5) \times 1044}{13.5 \times 7000} = 292.5 \text{ Btu.}$$

Check: $L = 200 + \left(\frac{513 \times 0.2415 \times 10}{13.5}\right) = 291.6$ Btu.

8 ● If air entering an open adsorption system at 80 F and 50 per cent relative humidity is cooled to 75 F and 12 per cent relative humidity, how much air is required per ton and what is the latent heat of the water which is absorbed?

Entering Conditions	*Leaving Conditions*
66.6 F WB	50.3 F WB
30.85 Btu Total Heat	20.35 Btu Total Heat
76.0 Grains per Pound	14.4 Grains per Pound