46.42 A refrigeration system using R-22 operates between $80°F$ condensing and $0°F$ evaporation. The refrigerant exits the evaporator as a dry, saturated vapor. What is the specific work done by the compressor assuming isentropic compression?

A. $9\frac{Btu}{lb}$

B. $11\frac{Btu}{lb}$

C. $15\frac{Btu}{lb}$

D. $18\frac{Btu}{lb}$

Draw the refrigeration cycle on the Pressure-Enthalpy diagram for Refrigerant 22, labelling all 4 States. The compression process is from State 1 to State 2. The specific work done by the compressor is the difference between the enthalpy at State 2 and the enthalpy at State 1. Specific work is distinct from 'Work' in that its units are $\frac{Btu}{lb}$ (as opposed to $\frac{Btu}{hr}$) and it does not require the mass flow rate.

$$Work = \dot{W}_{comp} = \dot{m}\Delta h = \dot{m}\left(h_2 - h_1\right)$$

$$Specific Work = w = h_2 - h_1$$

Start by analyzing State 1 which is a dry, saturated vapor with a known Temperature. Use the Refrigerant 22 table to obtain the enthalpy at State 1.

$$T_1 = 0°F$$

$$h_1 = h_f = 104.6\frac{Btu}{lb}$$

Use the Pressure Versus Enthalpy Curves for Refrigerant 22 to locate State 1. Since the compression process is isentropic, draw a line of constant entropy up and to the right.

The condensing temperature is $80°F$, which is implied to refer to the segment of the condensing process line which lies inside the vapor dome. The condensing process is constant *pressure* throughout the entire process, however it is only constant *temperature* inside the vapor dome. Extend a horizontal line to the right from the $80°F$ line.

Graphically locate State 2 as the intersection of the extended $80°F$ line and the constant entropy line previously drawn from State 1. Read the enthalpy at State 2 along the top horizontal axis. Some uncertainty and imprecision is to be expected due to graphical nature of this approach.

$$h_2 \approx 120\frac{Btu}{lb}$$

Calculate the specific work.

$$w = 120\frac{Btu}{lb} - 104.6\frac{Btu}{lb} = 15.4$$

Answer C

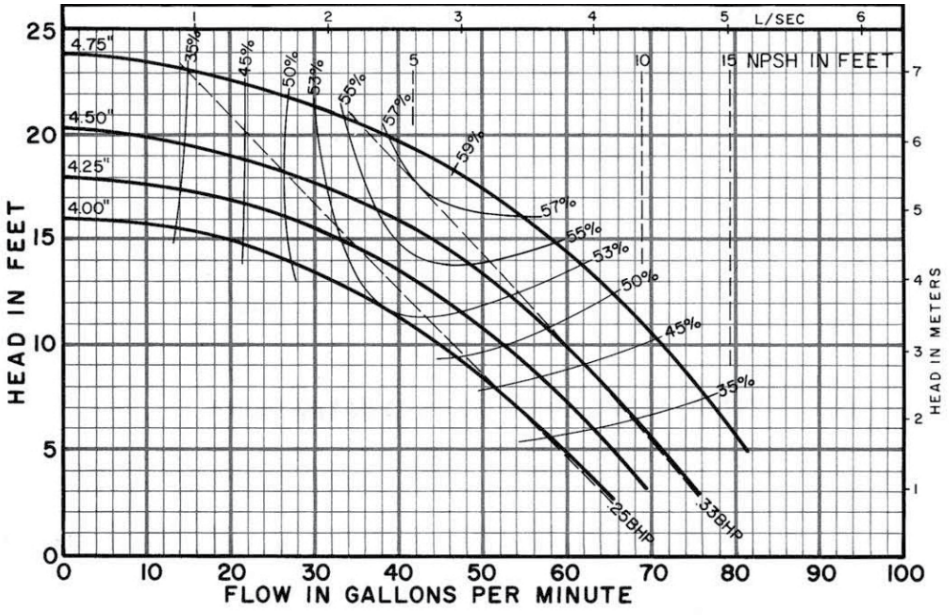
46.43 **The operating pressure in a hydronic system is $15ft$ of head and the required flow is $120gpm$. The system has been designed with 3 pumps operating in parallel. Referring to the pump curves below, what is the minimum impeller size sufficient for the system?**

A. $4.00in$

B. $4.25in$

C. $4.50in$

D. $4.75in$



Refer to Pump Performance Curves.

Since the 3 pumps are in parallel, the head added is the same across each pump.

$$\Delta h = 15ft$$

The volume flow rate will be split equally across all 3 pumps.

$$Q = \frac{120gpm}{3} = 40gpm$$

Find the operating point on the chart for $40gpm, 15ft$ and choose the next size up, which is the $4.5in$ impeller.

Answer C