**Problem 10.3**

**Known:** A cannot vapor refrigeration cycle operates between known reservoir temperatures.

**Find:** Determine operating pressures in the condenser and evaporator for (a) Refrigerant 134A, (b) propane, (c) water, (d) Refrigerant 22, and (e) ammonia as the working fluid. Calculate the coefficient of performance.

**Schematic & Given Data:**

![Thermodynamic cycle diagram]

**Engineering Model:** (1) Each component operates at steady state. (2) All processes are internally reversible. (3) The condenser and evaporator operate at the respective reservoir temperatures. (4) The compression and expansion are adiabatic.

**Analysis:** The operating pressures are the saturation pressures at the respective temperatures.

(a) Refrigerant 134A

\[
P_{\text{cond}} = P_{\text{sat}} @ 90^\circ F = 118.99 \text{ lb/in}^2 \quad P_{\text{cond}}
\]

\[
P_{\text{evap}} = P_{\text{sat}} @ 40^\circ F = 49.738 \text{ lb/in}^2 \quad P_{\text{evap}}
\]

(b) Propane

\[
P_{\text{cond}} = P_{\text{sat}} @ 90^\circ F = 165.2 \text{ lb/in}^2 \quad P_{\text{cond}}
\]

\[
P_{\text{evap}} = P_{\text{sat}} @ 40^\circ F = 78.6 \text{ lb/in}^2 \quad P_{\text{evap}}
\]

(c) Water

\[
P_{\text{cond}} = P_{\text{sat}} @ 90^\circ F = 0.698 \text{ lb/in}^2 \quad P_{\text{cond}}
\]

\[
P_{\text{evap}} = P_{\text{sat}} @ 40^\circ F = 0.1271 \text{ lb/in}^2 \quad P_{\text{evap}}
\]

(d) Refrigerant 22

\[
P_{\text{cond}} = P_{\text{sat}} @ 90^\circ F = 183.16 \text{ lb/in}^2 \quad P_{\text{cond}}
\]

\[
P_{\text{evap}} = P_{\text{sat}} @ 40^\circ F = 83.278 \text{ lb/in}^2 \quad P_{\text{evap}}
\]

(e) Ammonia

\[
P_{\text{cond}} = P_{\text{sat}} @ 90^\circ F = 180.73 \text{ lb/in}^2 \quad P_{\text{cond}}
\]

\[
P_{\text{evap}} = P_{\text{sat}} @ 40^\circ F = 73.359 \text{ lb/in}^2 \quad P_{\text{evap}}
\]

The coefficient of performance is

\[
\beta_{\text{max}} = \frac{T_C}{T_H - T_C} = \frac{500}{550 - 500} = 10 \quad \beta_{\text{max}}
\]

1. Refrigerant 134A has lower operating pressures than propane, Refrigerant 22, and ammonia in this cycle.
2. Water operates at very low pressures and cannot be used to achieve temperatures lower than 32°F.