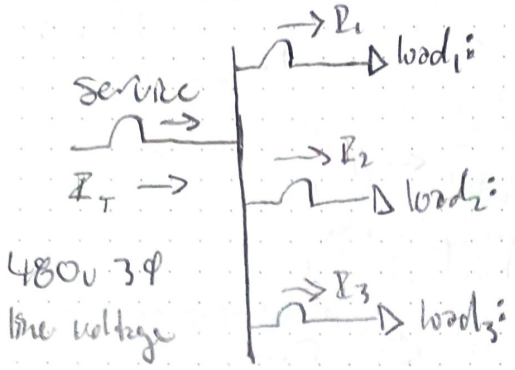

load 1: 5 tonne HP heat pump (3)
COP = 2.1
PF = 0.9 lag

load 2: 10 HP lathe
η = 87%
PF = 0.8 lag

load 3: 8 kBTU/hr autoclave
η = 100%
PF = 1.0

1 kW / 3.4 kBTU/hr

$\bar{S}_3 = \left(8\ \text{kBTU/hr} \Big/ 3.4\ \text{kBTU/hr}\right) + j0$

$= 2.4\text{kVA} \angle 0°$

$= \sqrt{3}\, \bar{V} \bar{I}_3^*$ (line current, line voltage)

$\bar{I}_3 = \dfrac{2.4\text{kVA} \angle 0°}{\sqrt{3} \cdot 480\text{v} \angle 0°}$ ← ref phase angle

$= 2.9\text{A} \angle 0°$

load 1: $P_1 \rightarrow$ [HP] $\rightarrow$ 5 tonnes thermal

3.5 kW/tonne → 17.5 kW thermal

$P_{out} = COP\ P_{In}$
$P_{thermal} = COP\ P_{electrical}$
} $P_{electrical} < P_{thermal}$

$17.5\text{ kW} = (2.1)\, P_1$

$P_1 = 8.3\text{ kW}$

$PF_1 = \dfrac{P_1}{S_1} \rightarrow S_1 = \dfrac{P_1}{PF_1}$

$S_1 = 9.3\text{ kVA}$

$PF_1 = \cos\theta_1 \rightarrow \theta_1 = \cos^{-1}(PF_1)$

$= 26°$

$\bar{S}_1 = \sqrt{3}\, \bar{V}_{480} \bar{I}_1^* \rightarrow \bar{I}_1 = \dfrac{(9.3\text{kVA} \angle 26°)^*}{\sqrt{3}\ 480\text{v} \angle 0°}$

$= 11.2\text{ A}$

load 2 : P_{elec} (kW) → (M) → P_{mech} (HP) $P_{elec} > P_{mech}$ [kW]

$$P_{elec} \cdot \eta = P_{mech} \quad \text{since} \quad \eta = \frac{P_{out}}{P_{in}}$$

$$P_{mech\,kW} = (0.746\ kW/HP)\, P_{mech\,HP}$$

$$P_{mech\,kW} = (0.746\ kW/HP) \cdot 10\ HP = 7.5\ kW$$

$$P_{elec} = \frac{P_{mech\,kW}}{\eta} = \frac{7.5\,kW}{0.87} = 8.6\ kW$$

$$P_{elec} = P_2 = 8.6\,kW$$

$$S_2 = \frac{8.6\,kW}{0.8} = 10.8\ kVA$$

$$\theta_2 = \cos^{-1}(0.8) = 37°$$

$$S_2 = \sqrt{3}\, V_{480}\, I_2$$

$$I_2 = \frac{10.8\,kVA}{\sqrt{3}\ 480\,V} = 13\ A$$

$$\bar{S}_T = \bar{S}_1 + \bar{S}_2 + \bar{S}_3$$

$$= 9.3\,kVA \angle 26° + 10.8\,kVA \angle 37° + 24\,kVA \angle 0°$$

$$I_T = \frac{S_T}{\sqrt{3}\ 480\,V}$$