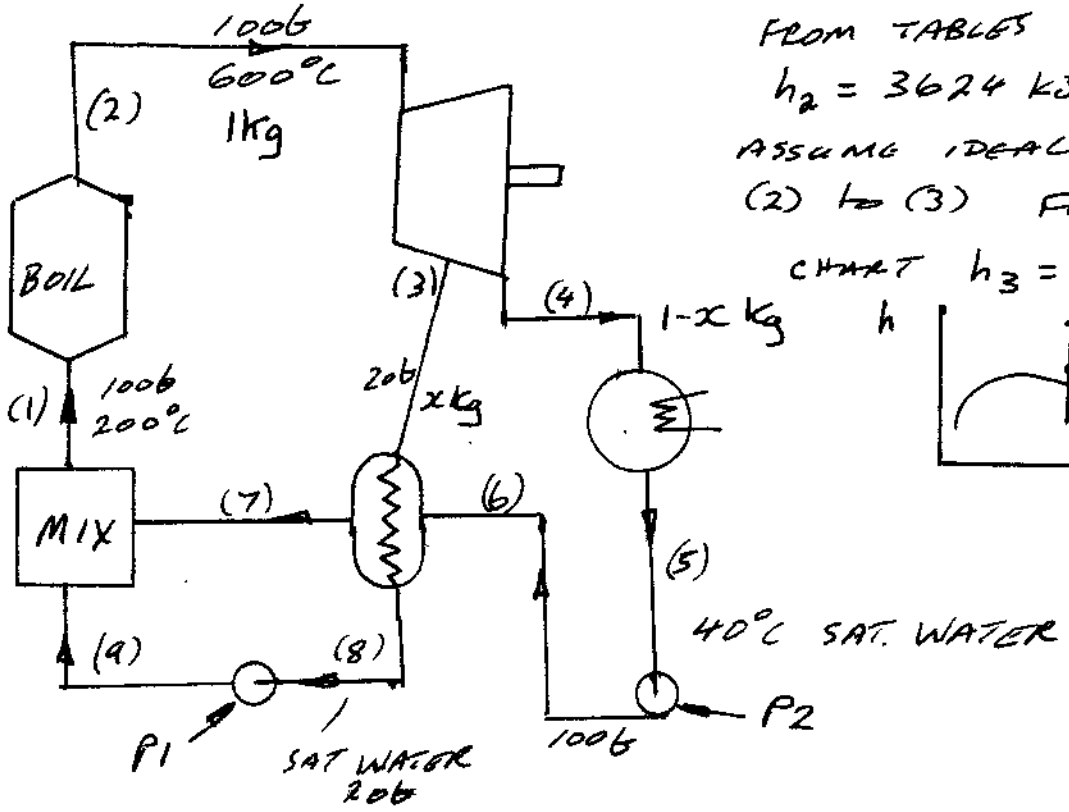
Q5 2001



FROM TABLES

$h_2 = 3624$ kJ/kg

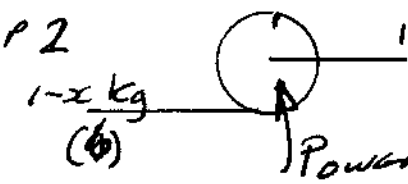
ASSUMG IDEAL EXPANSION (2) to (3) FROM CHART $h_3 = 3100$ kJ/kg

KNOWN POINT AT (1) WATER 100b 200°C

IDEALLY WE NEED WATER TABLES BUT AS THEY ARE NOT SUPPLIED $h_1 \simeq h_f$ @ 200°C

$h_1 \simeq 855$ kJ/kg

PUMP 2



SATURATED WATER $P_8 = P_s$ @ 40°C

$P_8 = 0.07375$ bar

$P_6 = 100$ bar

Power input $\simeq$ Vol $\times \Delta p$ Nominally $v = 0.001$ m³/kg

Power input $= 0.001 \times (100 - 0.07375) \times 10^5$

$= 10000$ J/kg or 10 kJ/kg

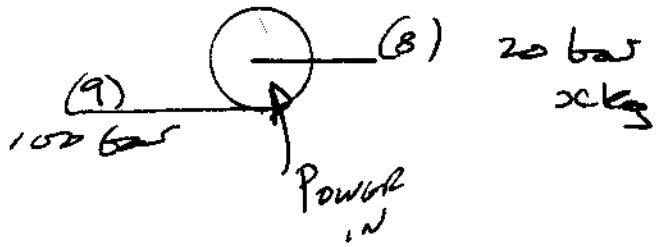
ENERGY BALANCE

$h_6 = h_5 + 10$ kJ/kg

$h_5 = h_f$ @ 40°C $= 167.5$ kJ/kg

$h_6 = 177.5$ kJ/kg

Pump 1



Power input = $v\,\Delta p = 0.001\,(100-20)\times10^5$

$= 8000\ 5\ \text{kg}$

$= 8\ \text{kJ/kg}$

Energy balance $h_9 = h_8 + 8$

$h_8 = h_f @ 20\ \text{bar} = 909\ \text{kJ/kg}$

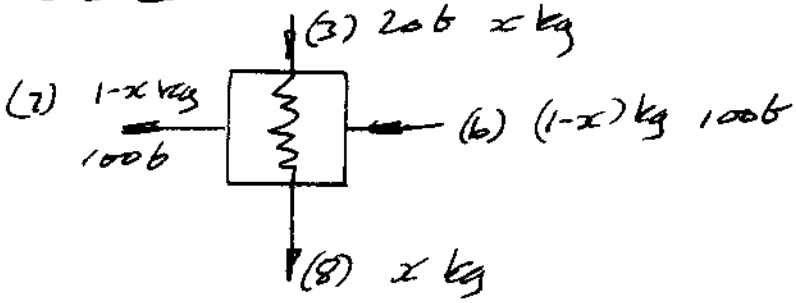
$h_9 = 909 + 8 = 917\ \text{kJ/kg}$

Feed heater

$h_3 = 3100\ \text{kJ/kg}$

$h_8 = h_f @ 20\ \text{b}$

$= 167.5\ \text{kJ/kg}$



Energy balance

$$(1-x)h_6 + x h_3 = (1-x)h_7 + x h_8$$

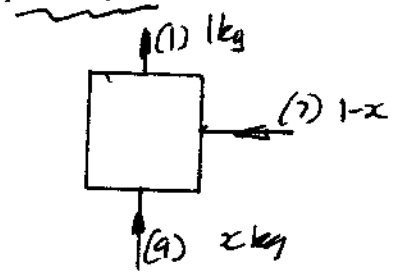
$$(1-x)\,177.5 + 3100x = (1-x)h_7 + x(167.5)$$

$$177.5 - 177.5x + 3100x = (1-x)h_7 + 167.5x$$

$$177.5 + 2755x = (1-x)h_7$$

$$h_7 = \frac{177.5 + 2755x}{(1-x)}$$

Mixer



$$1h_1 = (1-x)h_7 + x h_9$$

$$855 = (1-x)h_7 + x h_9$$

$$855 = (1-x)\left\{\frac{177.5 + 2755x}{(1-x)}\right\} + 917x$$

$$855 = 177.5 + 2755x + 917x$$

$$677.5 = 3672x \qquad x = 0.184\ \text{kg}$$

Pump 1 $P = 8 \text{ kJ/kg}$

$= 8 \times 0.184 \text{ kW}$

$= 1.6 \text{ kW}$

Pump 2 $P = 10 \text{ kJ/kg}$

$= 10 \times (1 - .184) \text{ kW}$

$= 8.16 \text{ kW}$

Based on 1 kg/s total flow