State 7

$s_6 = s_7 = 7.301$ kJ/kg.K

$s_7 = s_f + x_2 s_{fg}$ at 0.035 bar

$7.301 = 0.391 + x_2\, 8.130$

$x_2 = 0.85$

$h_7 = h_f + x_2 h_{fg}$ at 0.035 bar

$h_7 = 2184.3$ kJ/kg

State 3

$h_3 = 112$ kJ/kg

state 4

$h_3 = h_4 = 112$ kJ/kg because neglecting the work pump.

ork turbine $= (h_1 - h_2) + (h_6 - h_7) \times \dot{m}$

$= (3094 - 2778) + (3158 - 2184) \times 1$

$= 1290$ kJ/.

#

eat supply $= Q_{in} = (h_1 - h_4) + (h_6 - h_2)$

$= (3094 - 112) + (3158 - 2778)$

$= 3362$ kJ

S.S.C $= \frac{1}{W_{net}} \times 3600$

$= 2.79$ kg/kwh.

$\eta_{th} = \frac{W_{net}}{Q_{in}}$

$= 0.384$ @ 38.4 %

✓

8.3 Steam supplied to a two-stage turbine at 40 bar and 350° C. It expands in the first turbine it is just dry saturated, then the reheat to 350°C and expanded through the second stage turbine. The condenser pressure is 0.035 bar. Calculate the work output and the heat supplied per kilogram of steam for the plant, assuming ideal processes and neglecting the feed-pump term. Calculate also the specific steam consumption.

given :-

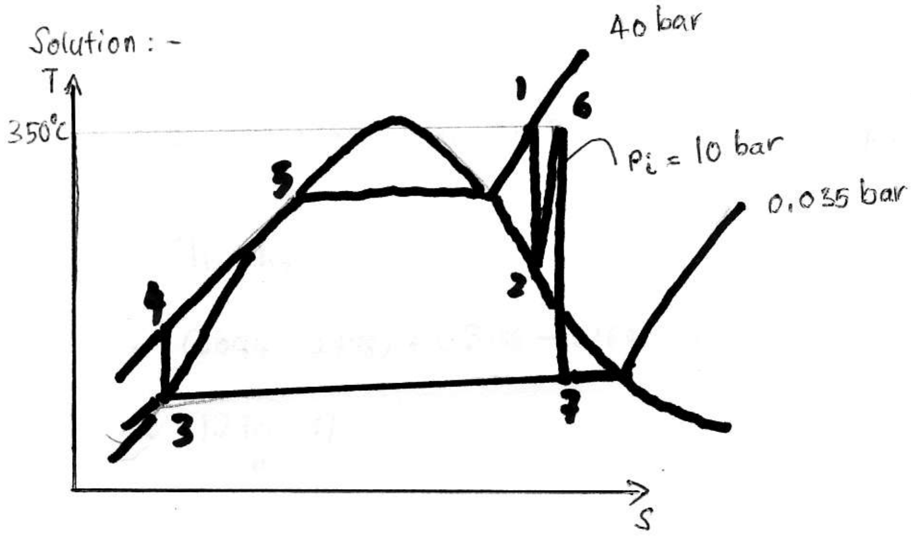
$P_1 = 40$ bar

$T_1 = 350°C$

$P_2 = 0.035$ bar

Reheat temperature = 350°C

Solution : -




State 1

$S_1 = S_g$ at 40 bar , T = 350°C

= 6.584 kJ/kg.k

$h_1 = h_g$ = 3094 kJ/kg

State 2

$S_1 = S_2$ = 6.584 kJ/kg.k Find the P at State 2

at 6.584 kJ/kg.k = P is 10 bar (Read From Saturated Water and Steam)

∴ $h_2$ = 2778 kJ/kg at 10 bar

State 6

$S_6 = S_g$ at 10 bar and T = 350°C

= 7.301 kJ/kg.k .

$h_6 = h_g$ at 10 bar and T = 350°C

= 3158 kJ/kg

8.6 A steam turbine is to operate on a simple regenerative cycle. Steam is supplied dry saturated at 40 bar, and is exhausted to a condenser at 0.07 bar. The condensate is pumped to a pressure of 3.5 bar at which it is mixed with bleed steam from the turbine at 3.5 bar. The resulting water which is saturation temperature is the pumped to the boiler. For the ideal cycle calculate, neglecting feed pump work,

i) The amount of bleed steam required per kilogram of supply steam
ii) The cycle efficiency of the plant
iii) The specific steam consumption.

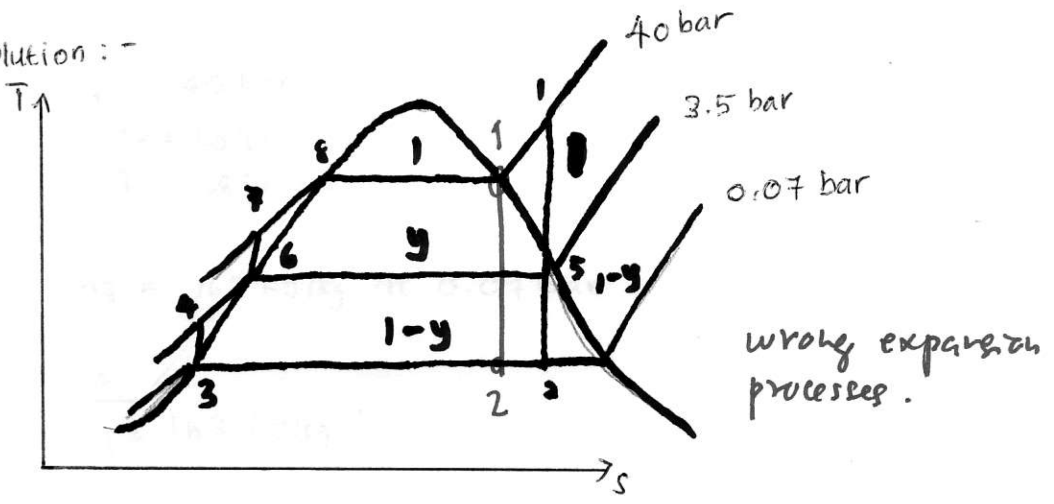
given: -

$P_1 = 40 bar$

$P_2 = 0.07$ bar

$P_5 = 3.5$ bar

Solution: -




State 1

$h_1 = h_g = 2801$ kJ/kg at 40 bar

Find the $T_1 = 250.3\,°C$

$s_1 = S_g = 6.070$ kJ/kg.k.

State 2

$S_1 = S_2 = 6.070$ kJ/kg.k.

$S_2 = Sf + x_2 Sfg$ at 0.07 bar

$6.070 = 0.559 + x_2\, 7.715$

$x_2 = 0.7141$

$h_2 = hf + x_2 hfg$ at 0.07 bar

$h_2 = 163 + 0.7141(2409)$

$h_2 = 1883.026$ kJ/kg

Find $T_2$

$T_2 = 39\,°C$ at 0.07 bar.

$T_s$ bleed $= \frac{1}{2}(T_1 + T_2)$

$= 144.65\,°C$

State 5

$s_1 = s_5 = 6.070$ kJ/kg·K

$s_5 = s_f + x_3 s_{fg}$ at 3.5 bar

$6.070 = 1.727 + x_3\, 5.214$

$x_3 = 0.848$

$h_5 = h_f + x_3 h_{fg}$ at 3.5 bar

$= 584 + 0.848(2148)$

$= 2409.8$ kJ/kg

State 6

$h_6 = h_f$ at 3.5 bar

$= 584$ kJ/kg

State 8

$h_8 = h_f$ at 40 bar

$= 1087$ kJ/kg

$h_7 = h_8 = 1087$ kJ/kg

State 3

$h_f = h_3 = 163$ kJ/kg at 0.07 bar

State 4

$h_3 = h_4 = 163$ kJ/kg

a) $y = \frac{h_6 - h_4}{h_5 - h_4}$

$= \frac{584 - 163}{2409.8 - 163}$

$y = 0.19$

b) $W_{net} = 1(h_1 - h_5) + (1-y)(h_5 - h_2)$

$= (2801 - 2409.8) + (1 - 0.19)(2409.8 - 1883.03)$

$= 319.2 + 426.68$

$= 817.88$ kJ

$Q_{in} = (h_1 - h_6)$

$= 2801 - 584$

$= 2217$ kJ/