Thermodynamics
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Lecture 87
Tutorial problem (1 number)

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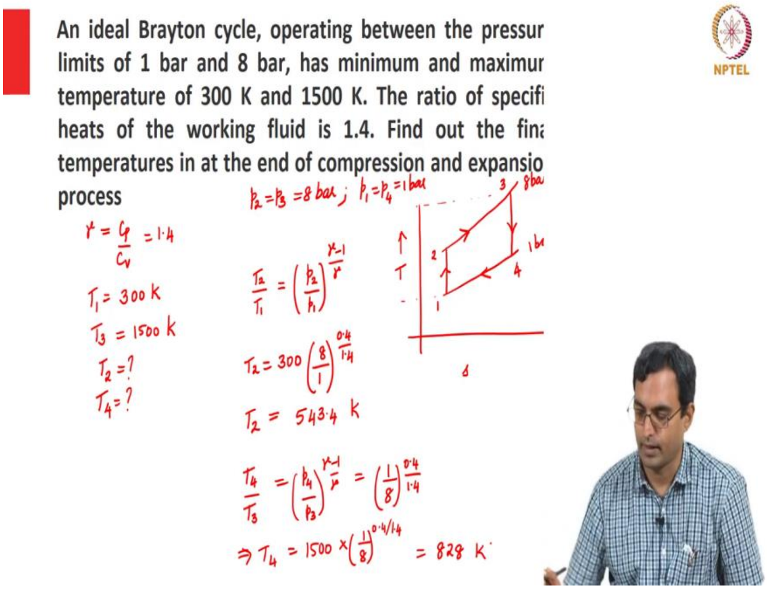

Figure 1.

Solution of the problem in Fig. 1:

The Brayton cycle is shown on a T-s diagram in Fig. 1.

$p_2 = p_3 = 8\ bar, p_1 = p_4 = 1\ bar, T_1 = 300\ K, T_3 = 1500\ K, \gamma = 1.4$

We have, $\frac{T_2}{T_1} = \left(\frac{p_2}{p_1}\right)^{\frac{\gamma-1}{\gamma}}$ and $\frac{T_4}{T_3} = \left(\frac{p_4}{p_3}\right)^{\frac{\gamma-1}{\gamma}}$

Hence, $T_2 = 300\left(\frac{8}{1}\right)^{\frac{0.4}{1.4}} = 543.4\ K$ = temperature at the end of the compression process

$T_4 = 1500\left(\frac{1}{8}\right)^{\frac{0.4}{1.4}} = 828\ K$ = temperature at the end of the expansion process.

We can also find turbine work output (w_t), compressor work input (w_c), amount of heat added (q_{in}), amount of heat rejected (q_{out}) and efficiency (η).

$$w_t = h_3 - h_4 = C_p(T_3 - T_4) = 1223\frac{kJ}{kg}$$

$$w_c = h_1 - h_2 = C_p(T_1 - T_2) = -244.5\frac{kJ}{kg}$$

$$q_{in} = h_3 - h_2 = C_p(T_3 - T_2) = 960\frac{kJ}{kg}$$

$$q_{out} = h_1 - h_4 = C_p(T_1 - T_4) = -530\frac{kJ}{kg}$$

$$\eta = 1 - \frac{T_1}{T_2} = 44.8\ \%$$

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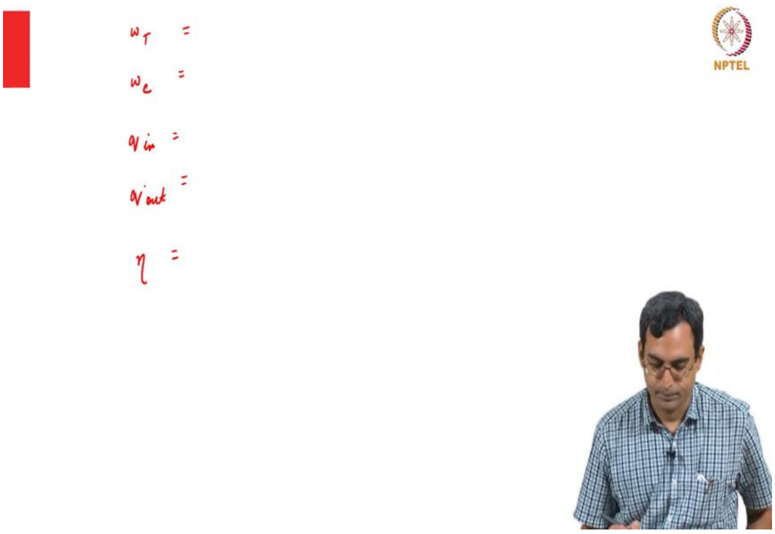

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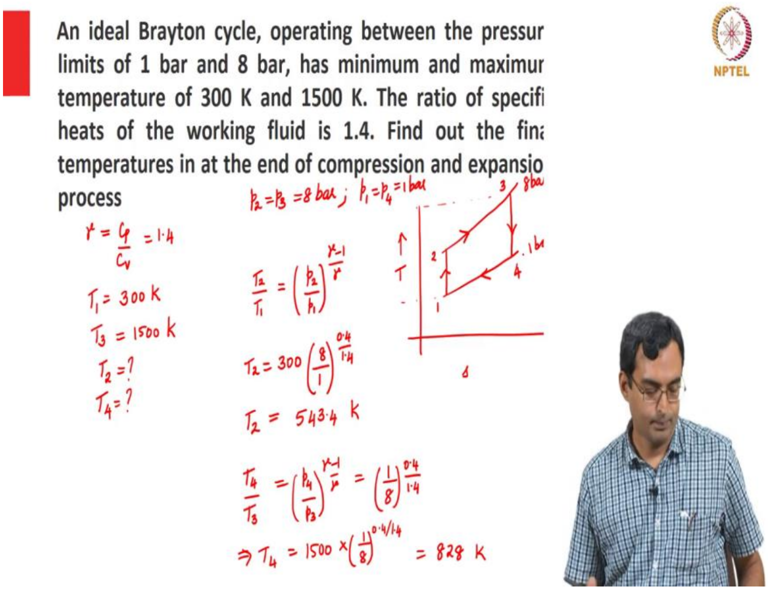

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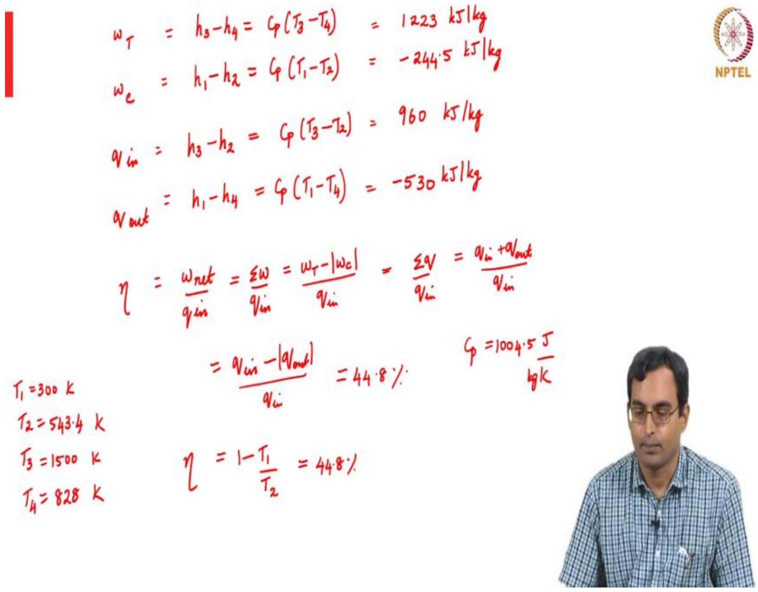

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