Thermodynamics
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Lecture 65
Tutorial Problems (2 numbers)

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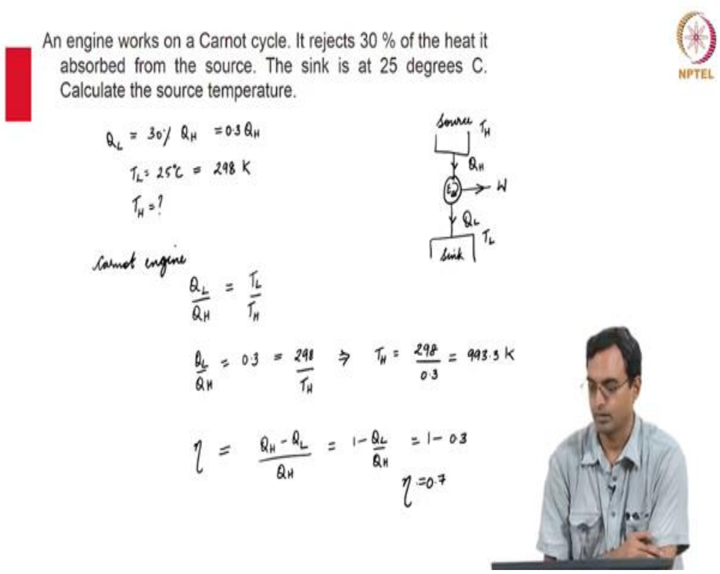

Figure 1.

Solution of the problem in Fig. 1:

$Q_L = 0.3\ Q_H, T_L = 25\ ℃ = 298\ K, T_H = ?$

A schematic of the engine is shown in Fig. 1.

Since the engine runs on the Carnot's cycle,

$$\frac{Q_L}{Q_H} = \frac{T_L}{T_H} \quad \rightarrow \quad T_H = 993.3\ K$$

$$\eta = 1 - \frac{Q_L}{Q_H} = 1 - 0.3 = 0.7$$

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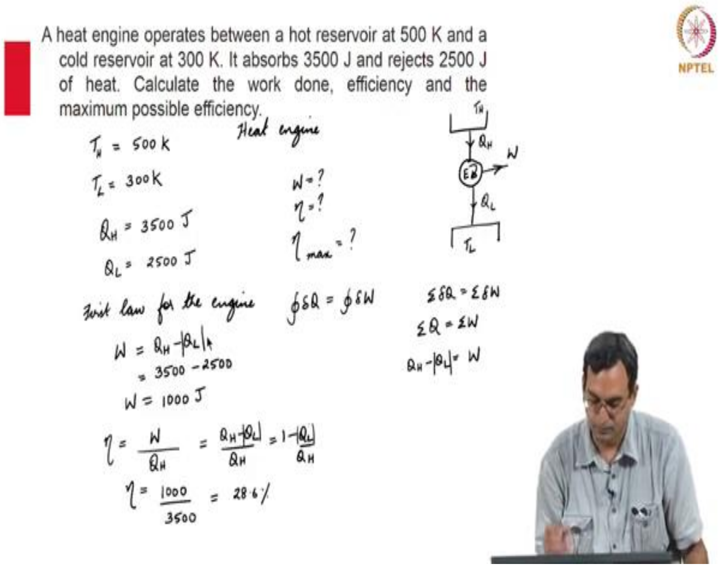


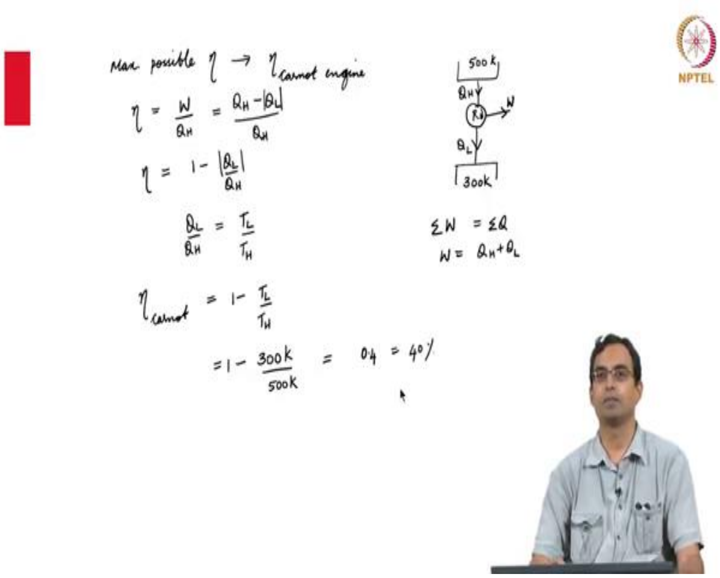
Figure 2.

Solution of the problem in Fig. 2:

$T_H = 500\ K, T_L = 300\ K, Q_H = 3500\ J, Q_L = 2500\ J$

The first law for a heat engine, $\oint \delta Q = \oint \delta W$.

Hence, $W = Q_H - |Q_L| = 3500 - 2500 = 1000\ J$



$$\eta_{actual} = 1 - \frac{|Q_L|}{Q_H} = \frac{W}{Q_H} = \frac{1000}{3500} = 28.6\ \%$$

Out of all the engines operating between the given temperature sources, the Carnot's engine or a reversible engine has the maximum efficiency. For the Carnot's engine,

$$\eta_{Carnot} = 1 - \frac{Q_L}{Q_H} = 1 - \frac{T_L}{T_H} = 0.4 = 40\ \%$$

$$\eta_{actual} < \eta_{Carnot}.$$