Given: $kJ := 1000J$

A coal burning steam power plant produces a net power of 300 MW with an overall thermal efficiency of 32%. The actual air-fuel ratio in the furnace is calculated to be 12:1 (air:fuel). The heating value of the coal is 28,000 kJ/kg.

Required:

Determine the amount of coal consumed during a 24 hour period and the rate of air flowing through the furnace.

Solution:

The net work out of the power plant is defined as

$$W'_{net,out} := 300MW$$

The thermal efficiency is defined as

$$\eta_{th} := 32\%$$

The air to fuel ratio is defined as

$$r_{af} := \frac{12 \cdot kg}{1 \cdot kg}$$

The heating value of the coal is defined as

$$HV := 28000 \frac{kJ}{kg}$$

The period of interest is defined as

$$\Delta t := 24hr$$

From the definition of thermal efficiency, the heat supplied to the furnace is

$$\eta_{th} = \frac{W'_{net,out}}{Q'_H} \quad \text{or} \quad Q'_H := \frac{W'_{net,out}}{\eta_{th}} = 937.5 \cdot MW$$

The rate at which coal is consumed is then given by

$$m'_{coal} := \frac{Q'_H}{HV} = 33.482 \frac{kg}{s}$$

The total amount of coal consumed in a 24 hour period is then given by

$$\boxed{m_{coal} := m'_{coal} \cdot \Delta t = 2.893 \times 10^6 \cdot kg}$$

The rate of air flowing through the furnace is then given by

$$\boxed{m'_{air} := r_{af} \cdot m'_{coal} = 401.8 \frac{kg}{s}}$$

Additionally, the heat rejected by the furnace may be found by

$$Q'_L := Q'_H - W'_{net,out} = 637.5 \cdot MW$$