Chapter 18 Problem 19 [†]

Given
$Q/\Delta t = 68\ kW$
$\frac{W}{\Delta U} = 17\% = 0.17$

Solution
What is the engine's mechanical power output?

By the 1st Law of Thermodynamics

$$\Delta U = Q + W$$

The total energy released in burning the gas will change the internal energy, which includes chemical energy. This energy goes towards doing work and releasing heat into the environment. Since 17% of the energy is converted to work, then 83% is released as heat output. Therefore,

$$\frac{Q}{\Delta U} = 0.83$$

Since we are interested in a rate of heat output, we can calculate a rate of internal energy change as

$$\frac{Q/\Delta t}{\Delta U/\Delta t} = 0.83$$

Solving for the rate of change in internal energy gives

$$\Delta U/\Delta t = \frac{Q/\Delta t}{0.83} = \frac{68\ kW}{0.83} = 81.9\ kW$$

Now the rate of work done compared to the rate at which the internal energy changes is

$$\frac{W/\Delta t}{\Delta U/\Delta t} = 0.17$$

Solving for rate of work done gives

$$W/\Delta t = (0.17)(\Delta U/\Delta t) = (0.17)(81.9\ kJ) = 13.9\ kW$$

[†]Problem from Essential University Physics, Wolfson