ADIABATIC COMPRESSION IN A DIESEL ENGINE

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Reference: Daniel V. Schroeder, *An Introduction to Thermal Physics*, (Addison-Wesley, 2000) - Problem 1.37.

As an example of adiabatic compression of an ideal gas, consider the compression of air in a diesel engine. Atmospheric air (at a temperature of, say, 10°C = 283 K) is quickly compressed to $\frac{1}{20}$ of its original volume. From the relation

$$VT^{f/2} = \text{constant} \tag{0.1}$$

where f is the number of degrees of freedom of a gas molecule, we can estimate the temperature of the air after compression. As most air molecules are diatomic, we can take $f = 5$ (3 translational + 2 rotational degrees of freedom; this assumes that vibrational modes are frozen out, although I'm not sure that's true for higher temperatures), so the temperature T_f after compression is

$$T_f = \left(\frac{V_i}{V_f}\right)^{2/f} T_i \tag{0.2}$$

$$= 20^{2/5} \times 283 \tag{0.3}$$

$$= 938 \text{ K} \tag{0.4}$$

$$= 665^\circ \text{ C} \tag{0.5}$$

The autoignition temperature for diesel is 256° C so the fuel will automatically ignite when the air is compressed, which is why diesel engines don't need spark plugs.