ADIABATIC COMPRESSION IN A DIESEL ENGINE

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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

\[
VT^{f/2} = \text{constant}
\]

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

\[
T_f = \left( \frac{V_i}{V_f} \right)^{2/f} T_i
\]

\[
= 20^{2/5} \times 283
\]

\[
= 938 \text{ K}
\]

\[
= 665 \text{°C}
\]

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.