

## 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,  $10^\circ\text{C} = 283\text{ K}$ ) is quickly compressed to  $\frac{1}{20}$  of its original volume. From the relation

$$(1) \quad VT^{f/2} = \text{constant}$$

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

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

$$(3) \quad = 20^{2/5} \times 283$$

$$(4) \quad = 938\text{ K}$$

$$(5) \quad = 665^\circ\text{ C}$$

The autoignition temperature for diesel is  $256^\circ\text{ C}$  so the fuel will automatically ignite when the air is compressed, which is why diesel engines don't need spark plugs.