Hydrazine, \( \text{N}_2\text{H}_4 \), is a colorless liquid with an ammonia-like odor that freezes at 2 °C and boils at 114 °C. This powerful reducing agent reacts with oxygen in a highly exothermic reaction,

\[
\text{N}_2\text{H}_4(\ell) + \text{O}_2(\text{g}) \rightarrow \text{N}_2(\text{g}) + 2\text{H}_2\text{O}(\text{g})
\]

which produces 622 kJ of energy per mole of \( \text{N}_2\text{H}_4 \). Substituted hydrazines, where one or more of the hydrogen atoms are replaced by other groups, are useful as rocket fuels. For example, methylhydrazine (\( \text{CH}_3\text{N}_2\text{H}_3 \)) is used with the oxidizing agent \( \text{N}_2\text{O}_4 \) (dinitrogen tetroxide) to power the U.S. space shuttle orbiter. The reaction is

\[
5\text{N}_2\text{O}_4(\ell) + 4\text{CH}_3\text{N}_2\text{H}_3(\ell) \rightarrow 12\text{H}_2\text{O}(\text{g}) + 9\text{N}_2(\text{g}) + 4\text{CO}_2(\text{g})
\]

Because of the large number of gaseous molecules produced and the highly exothermic nature of this reaction, a very high value of thrust per gram of fuels is achieved. The reaction is also self-starting. That is, it begins immediately when the fuels are mixed—a useful characteristic for rocket engines that must be started and stopped frequently.