ALUMINUM and HALOGENATED HYDROCARBONS

Aluminum and aliphatic halogenated hydrocarbons react under normal conditions to form aluminum alkylhalides e.g.:

$$2Al + 3CH_3Cl \longrightarrow (CH_3)_2AlCl + CH_3AlCl_2$$

These products are known to ignite spontaneously (pyrophoric) in contact with air :

$$(CH_3)_2AlCl + O_2\ (air) \longrightarrow (CH_3O)_2AlCl \qquad \textit{exothermic}$$

$$2CH_3AlCl_2 + O_2\ (air) \longrightarrow 2CH_3OAlCl_2 \qquad \textit{exothermic}$$

The intermediate aluminum alkyl ethers react further to carbon monoxide and/or carbon dioxide, water and aluminum oxide generating an additional amount of heat.
The oxide layer common on the surface of aluminum does not protect it from the above described reaction.

Scope - Applications

Aluminum is frequently used in process equipment and scaffolds. Because of its low density it is often used in containers for transportation purposes.

Other dangerous reactions (Reference L. Bretherick 4th edition)

- Finely divided aluminum powder has a severe dust explosion hazard potential in air.
- Finely divided aluminum powder reacts with boiling water to form hydrogen and aluminum hydroxide: $2Al + 6H_2O \longrightarrow 2Al(OH)_3 + 3H_2$
- Aluminum reacts easily with alkaline materials (e.g. sodium hydroxide, amines) with formation of hydrogen: $Al + OH^- + 3H_2O \longrightarrow Al(OH)_4^- + H_2$
- The reaction with acids results also in the formation of hydrogen gas: $2Al + 6HCl \longrightarrow 2AlCl_3 + 3H_2$
- Halogenated hydrocarbons are also not compatible with other metals (magnesium, titanium, sodium, etc.) and amines.

Significant incidents

Total number of Dow incidents in 1981 - 1990 : 28 cases, e.g.

1981 Transport : A trailer started leaking on the road when transporting 1,1,1-trichloroethane. The container was made of aluminum.

1984 Research : To generate aluminum chloride in-situ, ethyl chloride was circulated through a fixed bed of aluminum pellets while HCl was added. The reaction became uncontrolled and the liberated vapors exploded damaging the building.

1988 Transport : Two aluminum containers on tank cars were used for propylene dichloride. These corroded and lost their product within 48 hrs, leading to serious environmental problems.

1990 Research : A recently delivered ethyl chloride cylinder (lecture bottle) exploded on a lab bench. The supplier had mistakenly used aluminum material instead of carbon steel.