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TITANIUM

Properties

Titanium, like magnesium, is classified as a combustible metal, but again the size and shape of the metal determine to a great extent whether or not it will ignite. Castings and other massive pieces of titanium are not combustible under ordinary conditions. Small chips, fine turnings, and dust ignite readily and, once ignited, burn with the release of large quantities of heat. Tests have shown that very thin chips and fine turnings could be ignited by a match and heavier chips and turnings by a Bunsen burner. Coarse chips and turnings 0.79 by 2.7 mm (1/32 by 3/28 in.) or larger may be considered as difficult to ignite, but unless it is known that smaller particles are not mixed with the coarser material in significant amounts, it is wise to assume easy ignition is possible.

Finely divided titanium in the form of dust clouds or layers does not ignite spontaneously (differing in this respect from zirconium, plutonium, and certain other metals). Ignition temperatures of titanium dust clouds in air range from 332 to 588 degrees C (630 to 1,090 degrees F), and of titanium dust layers from 382 to 510 degrees C (720 to 950 degrees F). Titanium dust can be ignited in atmospheres of carbon dioxide or nitrogen. Titanium surfaces that have been treated with nitric acid, particularly with red fuming nitric acid containing 10 to 20% nitrogen tetroxide, become pyrophoric and may be explosive.

The unusual conditions under which massive titanium shapes will ignite spontaneously include contact with liquid oxygen, in which case it may explode on contact. It has been found that under static conditions spontaneous ignition will take place in pure oxygen at pressures of at least 2,413 kPa (350 psi). If the oxygen was diluted, the required pressure increased, but in no instance did spontaneous heating occur in oxygen concentrations less than 35%. Another requirement for spontaneous heating is a fresh surface which oxidizes rapidly and exothermically in an oxygen atmosphere.

Storage and Handling

Titanium castings and ingots are so difficult to ignite and burn that special storage recommendations for large pieces are not included in NFPA 481, *Standard for the Production, Processing, Handling, and Storage of Titanium.* Titanium sponge and scrap fines, on the other hand, do require special precautions, such as storage in covered metal containers and segregation of the container from combustible materials. Because of the possibility of hydrogen generation in moist scrap and spontaneous heating of scrap wet with animal or vegetable oils, a yard storage area remote from buildings is recommended for scrap that is to be salvaged. Alternate recommended storage locations are detached scrap storage buildings and fire resistive storage rooms. Buildings and rooms for storage of scrap fines should have explosion vents.

Process Hazards

Contact of molten metal with water is the principal hazard during titanium casting. To minimize this hazard, molds are usually thoroughly predried and vacuumed, or inert gas protection is provided to retain accidental spills.

The heat generated during machining, grinding, sawing, and drilling of titanium may be sufficient to ignite the small pieces formed by these operations or to ignite mineral oil base cutting lubricants. Consequently, water-based coolants should be used in ample quantity to remove heat, and cutting tools should be kept sharp. Fines should be removed regularly from work areas and stored in covered metal containers**. To prevent titanium dust explosions, any operation which produces dust should be equipped with a dust collecting system discharging into a water-type dust collector.**

Descaling baths of mineral acids and molten alkali salts may cause violent reactions with titanium at abnormally high temperatures. Titanium sheets have ignited upon removal from descaling baths. This hazard can be controlled by careful regulation of bath temperatures.

There have been several very severe explosions in titanium melting furnaces. These utilize an electric arc to melt a consumable electrode inside a water-cooled crucible maintained under a high vacuum. Stray arcing between the consumable electrode and crucible, resulting in penetration of the crucible, permits water to enter and react explosively with the molten titanium. Indications are that such explosions approach extreme velocities. The design and operation of these furnaces require special attention in order to prevent explosions and to minimize damage when explosions do occur.

Extinguishing Titanium Fires

Tests conducted by Industrial Risk Insurers (IRI) on titanium machinings in piles and in open drums showed that water in coarse spray was a safe and effective means of extinguishing fires in relatively small quantities of chips.

Carbon dioxide, foam, and dry chemical extinguishers are not effective on titanium fires, but good results have been obtained with extinguishing agents developed for use on magnesium fires.

The safest procedure to follow with a fire involving small quantities of titanium powder is to ring the fire with a Class D extinguishing agent and to allow the fire to burn itself out. Care should be taken to prevent formation of a titanium dust cloud.