

ALUMINIUM INSIGHT

Improving Performance in Production

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MOLTEN ALUMINIUM / WATER EXPLOSIONS RISKS AND PREVENTION



In the late '50s, George Long, working at Alcoa's Research Laboratories said "A violent explosion occurs when a thin layer of water is trapped under a sudden rush of molten metal and can be avoided by greasing or painting the bottom of the water container". Long's research findings led to further studies that showed organic paints could be applied to aluminium production equipment and materials to prevent these explosions and the first used was Tasset Standard, a bituminous coal tar pitch. When this product was removed from the market due to health risks, Wise Chem E-212-F, a two-part epoxy, became the standard. Pyrotek's Joe Roberts, Global Product Manager, Wise Chem, fills in some of the background.

In the aluminium industry the term "pop" is often heard, being used to describe a non eventful splash of liquid metal. This is actually a Force 1 explosion as defined by The Aluminum Association who has categorized water / molten aluminium explosions into three levels.

A Force 1 explosion is also referred to as a steam explosion. This occurs when molten aluminium traps water which is then quickly vaporized to steam. The metal is shot up to 15 ft (~4.5 m) and normally involves less than 10 lb (~4.5 kg) of metal. Typical incidents occur for example with damp moulds, wet starting blocks, or water on the casting table top. In these cases injuries are minor and often involve minor burns.

A Force 2 explosion results from a violent steam reaction. Metal is ejected 15–50 ft (~4.5–15 m) and involves much more than 30 lb (~14 kg) of metal. Metal can often be seen on the inside roofs and walls of the casting area as a result of these explosions. Serious injury and fatalities can result from these incidents. They are a result of wet scrap, improperly preheated sows, massive bleedouts, or molten metal being drained into wet or contaminated moulds.

A Force 3 explosion is a catastrophic event where a large volume of metal is projected more than 50 ft (~15 m). Fatalities often occur along with near total destruction of the immediate area. A Force 3 explosion is identified by the extent of destruction and a white powder (aluminium oxide) covering

the area. One pound of aluminium in a Force3 explosion is equal to 3 lb (1.4 kg) of TNT.

Molten aluminium can also explode as a result of violent reactions with certain metal oxides, such as iron, lead, copper and bismuth. Some of these oxides also have attached waters of hydration which makes the situation even worse. Most people are aware that rusted iron or steel will react when in contact with molten aluminium. However, one major aluminium producer experienced a Force 3 explosion in the furnace without any water at all in the area. This was on a Monday morning after a weekend shut down.

On Friday, the furnace was charged and alloy additions made to produce 2014AA. The furnace was then adjusted to low fire for the weekend. Alloy 2014 contains high amounts of copper and during the weekend, the chopped copper wire alloy addition oxidized. When the roof was removed and the crane started the stirring process, a large chunk of dross containing a large amount of oxidized copper was pushed against the furnace wall. The oxidized copper could not alloy into the melt and a Force 3 explosion resulted when the liquid aluminium came into contact with the oxide. This was all caught on video from a surveillance camera. No one was injured, but safety procedures in the plant were modified accordingly.

An Alcoa paper titled "Molten Aluminum / Water Explosions" published in 1979, points out another problem. This was a test to evaluate various coatings. It involved the standard 12 x 12 x 12 in box half full of water into which 50 lb (~23 kg) of molten aluminium is dropped and an impact hammer hits the side to initiate the explosion. Various coatings are tested this way. In one test, Red Rustoleum was used, but before the explosion could be initiated it went off by itself. Red Rustoleum contains large amounts of iron oxide, which reacted with the molten aluminium and caused the explosion. The experiment was stopped and the aluminium industry was made aware of this problem.

With the advent of new technology, new explosion sites have been identified and these will require attention. The latest

involves the pit beneath tilting furnaces and the hydraulic cylinders that tilt the furnace. Only the bottom 36 in of the pit requires coating but the appearance is enhanced if completely covered. This improves housekeeping and does eliminate a potential explosion site. One coating will last for years.

WISE CHEM COATINGS

Wise Chem E-115 & E-212-F coatings, marketed under licence by Pyrotek, are two-component Amine Epoxy materials that provide a high performance, multi-purpose, surface tolerant coating.

Wise Chem coatings require only a one-coat application that cures quickly and adheres well to itself. Tested by the Aluminum Association, they create an effective safety barrier between a wet substrate and molten aluminium to effectively reduce the risk of molten aluminium explosion.

The coating is effective at inhibiting rust formation on exposed steel parts. Wise Chem coatings develop excellent adhesion to damp surfaces, which allows casting pits to be coated without waiting for the walls to fully dry, thus minimizing down time.

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Wise Chem coatings applied to aluminium production equipment and material surfaces