Safety coatings reduce risk of molten aluminium explosions

Working under demanding conditions with hazardous materials and processes certainly constitutes severe HSE risks. For example, incidents of molten metal explosions in production plants can be disastrous in terms of employees’ lives and also in relation to plant, property, and environmental and collateral damage. Here, Alex W. Lowery, General Manager, Wise Chem LLC, examines the background and causes of such incidents, along with certain preventive measures centred on special safety coating products, which are used effectively in production practice.

For more than 60 years, studies of molten aluminium-water explosions have been conducted within companies’ in-house laboratories, at government establishments and at independent facilities, to understand all aspects of these types of explosions. Some of the earliest tests were performed by George Long in the late 1950’s at Alcoa’s Research Laboratories in New Kensington, Pennsylvania. Long pioneered experimental methods for investigating aluminium-water and steam explosions. In his experiments, various
Molten Metal Explosions

quantities of molten aluminium were poured over submerged surfaces, coated or uncoated and the elimination or occurrence of explosions was determined empirically. Much of Long’s research knowledge is still relevant today, and forms the basis for the current regimes for preventing molten metal explosions in casting pits.

Long determined that certain surfaces, such as rusted steel, gypsum and lime, promoted violent explosions, whilst other surfaces, such as polished steel and aluminium and those with organic coatings, were relatively resistant to spontaneous explosions. Subsequent studies found that an organic coating, Tarset Standard (TS), was the most practical medium available at that time to prevent molten metal explosions. Unfortunately, over time, Tarset Standard was shown not to adhere well to wet concrete walls of casting pits. In response, Wise Chem E-212-F was introduced to the market, because of its effective adherence in these situations. Subsequent testing showed that Wise Chem E-212-F offered the necessary protection required to prevent molten metal explosions.

Due to environmental regulations, the manufacturer subsequently discontinued the production of Tarset Standard and so the aluminium industry was left with just one available organic coating that had been thoroughly tested — Wise Chem E-212-F. The Aluminium Association, in conjunction with aluminium companies and coating manufacturers, sponsored a programme of testing at Alcoa’s Technical Center. The objective was not to find a replacement for Wise Chem E-212-F, but to identify additional environmentally-friendly coatings for application in the aluminium industry.

Two explosion test methods were performed for each additional new coating – a standard explosion test and a shock impact test. The standard explosion test was performed utilising an 0.028 cu m open steel box and the protective coatings were applied to the interior surface. The open-topped steel container was filled with approximately 15 cm of water and a clay/graphite crucible, containing 23 kg of molten aluminium at 760°C, was positioned 40 cm above the open container. Metal was released through an 8 cm diameter opening at the bottom of the crucible. One particular coating initially passed the test because it prevented an explosion, but then failed when it combusted and produced sizable flames after a few seconds in contact with the molten aluminium.

In the past, some molten metal-water explosions that were investigated were found to have resulted from a mechanical shock prior to the explosion. The researchers added a swinging hammer that would provide extra force on impact with the steel container, in order to further investigate the effect this would have on risks of explosion.

Safety coatings pass the test

Four coatings passed the standard explosion test: Wise Chem E-212-F; Wise Chem E-115; Multigard 955CP; and Intertuff 132.

Larger explosions, and some instances, multiple incidents, were generated when the shock impact test was performed on bare substrates. Each of the three new coatings that passed the standard explosion test also passed the shock impact test. Each coating was tested only once, due to budget constraints. Plant accidents in the past have demonstrated that the effect of a protective coating can be overridden by a sufficiently large shock during the casting process.

Further studies have shown that a bare exposed area as small as 100 sq cm of substrate can initiate an explosion. Consequently, the maintenance of the existing coating surfaces is an integral part of preventing molten aluminium-water incidents. With feedback and input from the aluminium industry, certain coating manufacturers developed repair kit versions of their products, and these contents, as supplied to customers, are pre-measured and ready to mix in the correct proportions.

Wise Chem products are supplied by Pyrotek Inc. under licence from the manufacturer.

Product Advantages:
- Single-coat application in most conditions
- Exceptional chemical resistance
- Suitable for short periods of immersion in concentrated acids and alkalis
- Unharmed by splash, spillage, or fumes of petroleum products, alkalis, acids, alcohols and other solvents
- Excellent adhesion to damp surfaces
- Suitable for both salt and fresh water immersion
- High solids and high film build

Wise Chem E-115 and E-212-F are also both available in the form of Patch Kits, as 1-litre tubs, designed especially for smaller-scale jobs and repairs. The contents, as supplied to customers, are pre-measured and ready to mix in the correct proportions.

Reader Reply No.120A

Wise Chem is an amine epoxy material that provides a high-performance, two-component, multi-purpose coating, which is truly surface-tolerant. Wise Chem coatings require only a single-coat application that cures quickly and adheres well to itself. Tested by the Aluminium Association, they are proven to create an effective safety barrier between a wet substrate and molten aluminium to reduce the risk of molten aluminium explosions.

The coating is effective in inhibiting rust formation on exposed steel components and also develops excellent adhesion to damp surfaces. This allows casting pits to be coated without waiting for the walls to fully dry, which also minimises process down time.

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