UPDATE

CONVENTIONAL ABRASIVES CARRY HEALTH RISKS

ABRASIVE BLASTING IS THE MOST COMMON WAY TO CLEAN, REMOVE COATINGS AND PROVIDE ANCHOR PROFILES ON SHIP HULLS, METAL BRIDGES, FUEL AND WATER TANKS, MASONRY AND OTHER SUBSTRATES BUT IT ALSO POSES A MAJOR HEALTH RISK AND PPE SHOULD ONLY BE A LAST LINE OF DEFENCE BY JACK INNIS

The coatings industry has long been aware of extreme health hazards associated with sand as an abrasive blast media. But according to the US Centers for Disease Control report *Evaluation of Substitute Materials for Silica Sand in Abrasive Blasting*, sand substitutes give off toxins "in a higher geometric mean concentration of the agent than that of silica sand." In light of extensive litigation involving silica sand, employers are examining lessons learned from the era of sand as they seek to develop adequate engineering controls to mitigate health hazards connected with sand substitutes.

Abrasive blasting is the most common way to clean, remove coatings and provide anchor profiles on ship hulls, metal bridges, fuel and water tanks, masonry and other substrates.

Silica sand, once widely used in abrasive blasting, typically fractures into fine particles upon impact with a substrate and becomes airborne. Sandblasters, pot tenders, cleanup crews and those who work nearby—such as painters, electricians, welders, office workers and neighbours—who inadvertently inhale crystalline silica dust may develop a lung condition called silicosis, which may lead to respiratory ailments, tuberculosis and death.

The silica dust problem came to light more than 75 years ago when a study conducted in The UK in 1936 by E R Merewether concluded that 5.4% of a population of sandblasters (24 of 441) died from silicosis or silicosis related issues over a 3.5-year period. Similar studies across the globe led to banning of silica sand as a blast agent, beginning in 1947, in the UK, Germany, Sweden, Belgium and other countries.

BETTER EQUIPMENT

Through development of better personal protective equipment (PPE) such as air supplied hoods and sand substitutes (including coal slag, copper slag, nickel crushed glass, steel grit, specular hematite or "barshot," garnet, staurolite and treated sand), incidences of silicosis and silicosis-related health problems lessened considerably.

But recently the question has been raised, "Are substitute abrasives actually less harmful than sand?"

'DOZENS DIE'

According to January 2012 petition filed with US Occupational Safety and Health Administration (OSHA) by consumer advocacy group Public Citizen, workers using coal slag abrasive media are exposed to excessively high rates of beryllium, which causes lung cancer and chronic beryllium disease, a debilitating lung condition.

"OSHA's enforcement staff has known about this issue for several months, and we are calling on them to do the right thing," the petition states. "Dozens of blasting workers die each year from beryllium exposure. If OSHA just enforces the rules that are already on the books, it will save lives."

Beryllium is not the only toxic by product produced by sand substitutes. The list includes aluminium, arsenic, cadmium, chromium, cobalt, crystalline silica, lead, manganese, nickel, silver, titanium and vanadium: all toxic air pollutants harmful or fatal when breathed.

An OSHA report titled, Abrasive Blasting Hazards in Shipyard Employment links contaminants to specific health hazards that range from mild to severe. These findings were bolstered by Evaluation of Substitute Materials for Silica Sand in Abrasive Blasting, which concluded that while two studied abrasives were less toxic than sand, the remainder were either more toxic or equally toxic.

OTHER TOXINS

Toxins created by sand substitutes are not the only Hazardous Air Pollutants (HAPS) created by blasting. Airborne constituents from the blast process include those from the substrate, the coatings, and abrasive contaminants in and on the coatings from previous blast operations.

Steel, aluminium, stainless steel, galvanized steel, copper-nickel and other substrates may release aluminium, cadmium, chromium, copper, iron, lead, manganese, nickel and zinc into the atmosphere, according to Abrasive Blasting Hazards in Shipyard Employment.

Surface coatings (some of which contain silica) including primers, anticorrosive and antifouling paints may release copper, barium, cadmium, chromium, lead and tributyl tin, the report stated. The roster of potential toxins lurking in or atop a substrate includes silica sand from previous blast operations.

"This means employees can have exposures to multiple air contaminants from both the abrasive and the surface being blasted," the report states.

PPE A 'LAST RESORT'

The coatings industry depends upon PPE (Personal Protective Equipment) to safeguard the health of abrasive blast crews. And there's no denying the efficacy of well-maintained, properly fitted, supplied-air respirators being fed air from clean sources at proper pressures. But some safety experts believe PPEs represent the least desirable type of protection—a last line of defence, so to speak.

According to Queensland, Australia's, Abrasive Blasting Code of Practice, a hierarchy exists that ranks ways to minimize potential health issues. The best possible way (Elimination) eradicates a hazard by removing the associated risk. The second best (Substitution) replaces a substance or a process with one that has less potential to cause injury. The next best solution (Isolation/Engineering) changes the work environment or process to interrupt the path between the worker and the risk. The penultimate solution (Administration) reduces risk by upgrading training, changing rosters, or other administrative actions. The least desirable option (Personal Protective Equipment) should be used only, "if risk cannot be reduced in any other way, as a last resort."

Composite abrasive blast systems employ various combinations of abrasives encapsulated within a non-toxic, non-hazardous urethane sponge material to suppress dust at the source

This hierarchy is echoed in Abrasive Blasting Hazards in Shipyard Employment, but in the face of mounting evidence that airborne toxins are being released by sand substitutes, coatings and substrates, the industry still leans quite heavily on least desirable option, PPE.

UNDERSTANDING THE SHORTCOMINGS

To understand the shortcomings of relying on PPEs to safeguard blast crews using sand substitutes, it may be useful to examine lessons learned in the era of sand. Thousands of abrasive blasters died of silicosis worldwide, each a sad story, but the following case study seems especially pertinent today. While this investigation focused on silica, lessons learned could apply across the board to all airborne toxins.

In January 1992 in the United States, the Ohio Department of Health investigated a silicosis death of a sandblaster who worked at a metal preparation shop. Investigators visited the shop, where they learned the victim been employed 10 years as a sandblaster. The man wore a supplied-air respirator during his six-hour sandblasting shifts and spent the remaining two hours of his work days shovelling sand into the floor pit for recycling.

Closer investigation unearthed numerous problems. A full-shift personal sample collected

"WORKERS ADJACENT TO ABRASIVE BLASTING OPERATIONS OFTEN WEAR NO RESPIRATORY PROTECTION"

outside the sandblaster's helmet measured potential exposure nearly 10 times the Recommended Exposure Limit (REL) allowable for the sandblaster's helmet. It uncovered the startling revelation that the man wore only a disposable particulate respirator while shovelling sand. The study also noted issues regarding air-flow pressures at the supplied-air respirator helmet, improper ventilation, sporadic respirator use and dust accumulation throughout the facility.

Equally telling, company records showed, was that the man's co-workers had developed health problems related to sandblasting and that the employer typically hired six to seven new sandblasters each year to replace those who quit.

Despite that it focuses on silica-related health problems, the case study carries information useful today. It supports the contention of Queensland's Abrasive Blasting Code of Practice that PPE, while effective and necessary, should be viewed as a last line of defence. There are simply too many ways those holding a blast nozzle may be exposed to toxic air contaminants from abrasives and the associated surface being blasted. The same holds true for those working nearby.

"Workers adjacent to abrasive blasting operations (for example, painters, welders, and labourers) often wear no respiratory protection," states one NIOSH report.

KNOCK DOWN DUST

Fortunately, the coatings industry is trending toward methods closer to higher orders of the safety hierarchy to minimize exposure to toxic dusts produced by abrasive blasting. While it would be impossible within the scope of this article to list all safety precautions in use—they range from selecting abrasive materials that produce lower amounts of known toxins to better PPE maintenance to improved training, monitoring and health surveillance—one area of keen focus is the amount of dust produced by the blast process. If by selecting alternative blast processes airborne dust can be significantly lowered, then abrasive blasters and adjacent workers will be less reliant on PPE. Popular commercial alternatives include wet abrasive blasting, high- and ultra-high pressure water jetting, centrifugal wheel blasting, vacuum blasting and composite abrasive blasting. The US Army Corps of Engineers Engineer and Design Manual EM 1110-2-3400, (Painting New Construction and Maintenance) provides an overview:

Wet abrasive blast systems work by forcefully projecting a mixture of abrasive and water onto a surface, or by shrouding a dry abrasive blast nozzle with a curtain of water. Wet abrasive blasting substantially lowers dust emissions and can produce an anchor profile. Wet abrasive blasting is not suitable for use near sensitive machinery, may require the use of additives to inhibit flash rust and generally produces liquid waste that requires special handling.

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High- and ultra-high pressure water jet systems rely on engine-driven high-pressure pumps (in the approximate range of 5,000 to 50,000 psi) to propel large volumes of water onto surfaces to be cleaned. Water jetting systems substantially lower dust emissions. They may be fitted with recirculation systems that automatically remove paint chips or stripped materials from the water. Inhibitors may need to be used to prevent flash. Water jetting does not produce a significant anchor profile.

Centrifugal wheel blast systems employ high-speed rotating blades inside enclosures equipped with dust collector to propel abrasives against the surface to be cleaned. Because blasting occurs within an enclosure there is little operator contact with airborne dust. Centrifugal wheel blasting is employed primarily where the rotating wheel assembly remains fixed and the surface to be cleaned is passed through the enclosure. But in the field, centrifugal wheel blasting systems may be outfitted to work on large, flat horizontal surfaces such as ship decks or uniform vertical surfaces such as storage tanks. Centrifugal wheel blasting systems can create an anchor pattern.

Vacuum blast systems comprise a standard abrasive blast nozzle that operates inside a shroud that seals tightly against the work surface. Capture and collection systems recover spent abrasive and coatings. Vacuum blasting may produce an anchor profile. Interchangeable heads provide tight seals while working on inside or outside corners and flat surfaces. But in practice, instead of changing heads to clean odd shapes and irregular surfaces, operators tend to lift the somewhat awkward assemblies from the surface, defeating the vacuum and creating HAPS.

Composite abrasive blast systems employ various combinations of abrasives encapsulated within a non-toxic, non-hazardous urethane sponge material to suppress dust at the source. The pliant sponge material flattens on impact, which exposes the abrasive and entraps more than 90% of what would have become HAPS. Composite abrasive blasting is similar to open nozzle blasting so operators can easily adjust to the process. Composite abrasive blasting can remove mill scale and create specific anchor profiles. The media is recyclable.

Abrasive blast cleaning is perhaps the most productive method of surface preparation for coatings that require both an anchor pattern and a high degree of surface cleanliness. Constituents from the substrate, coatings system, surface contaminants and abrasives can become airborne during the blast process and remain suspended in the air long after the blast process has ended. These constituents have been shown to contain toxins linked to specific ailments that may occur when employees receive too great exposure. While all safety measures are important, an established hierarchy of control dictates that the most effective practical way to maintain a safe and healthy work environment is to reduce airborne dust at the source.

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Below: The mess from with Coal Slag Blasting

AILMENTS LINKED TO TOXIN OVEREXPOSURE

ALUMINIUM: Respiratory inflammation

ARSENIC: Skin, lung and lymphatic cancers

BARIUM: Respiratory inflammation

BERYLLIUM: Lung cancer and chronic beryllium disease, a debilitating lung condition

CADMIUM: Kidney disease, pulmonary fibrosis and emphysema, lung and prostate cancer

CHROMIUM (metal, trivalent, hexavalent): Skin irritation, lung disease, asthma, sinus damage

COBALT: chronic lung inflammation or cancer, pulmonary fibrosis, allergic dermatitis

COPPER: Respiratory inflammation

LEAD: Peripheral neuropathy, kidney failure, infertility, cancer

MANGANESE: Parkinson's Disease-like movement disorder

NICKEL: Lung and nasal cancers, asthma, allergic dermatitis

SILVER: Gray pigmentation disorder of skin and eyes

TIN: Headaches and neurological disturbances

TITANIUM: Lung inflammation and pulmonary fibrosis

VANADIUM: Lung inflammation, chronic bronchitis, pulmonary fibrosis

ZINC: Acute pneumonia-like symptoms