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Thermite reactions

In facilities that cut, grind, weld, or process metal, combustible dust is already a known hazard. What may be less familiar is the risk of a thermite reaction—a chemical reaction capable of producing temperatures around 4,000°F and generating molten metal.

While uncommon, these incidents can cause significant damage and are extremely difficult to extinguish. Understanding how thermite reactions occur can help policyholders identify hazards and put effective controls in place before an incident occurs.

What is a thermite reaction?

A thermite reaction is an extremely hot chemical reaction that occurs when certain metal dusts come into contact with metal oxides. The most common example is aluminum dust mixing with iron oxide (rust or steel scale).

Other examples include:

- Copper thermite: Aluminum + copper oxide (commonly used in cadwelding for electrical bonding)
- Chromium thermite: Aluminum + chromium oxide (used to produce high-purity chromium)

Thermite reactions are most often associated with metal fabrication, metal processing, chemical plants, and steel mills, with metal fabrication representing the most common exposure.

Why are thermite reactions dangerous?

Thermite reactions can generate temperatures of approximately 4,000°F and produce molten metal.

Unlike a typical fire, a thermite reaction creates its own oxygen supply. As a result:

- It can occur in almost any environment, including underwater
- Smothering the reaction is ineffective
- Water may cause a violent reaction, including steam explosions and the dispersal of molten metal
- Extinguishment can be extremely difficult

Because of these characteristics, preventing the conditions that allow thermite reactions to occur is critical in facilities that handle these types of fine mental dusts.

Key risks

A thermite reaction can lead to:

- Extreme heat, sparks, and rapid combustion
- Molten metal production
- Damage to equipment and dust collection systems
- Secondary combustible dust fires or explosions

What agents should look for

When evaluating a policyholder's operations, focus on processes that generate fine ferrous and non-ferrous metal dust, including:

- Cutting
- Grinding
- Welding
- Additive manufacturing

Also identify the types of metals being processed, particularly where aluminum dust or other reactive metal particulates may be generated.

Dust Hazard Analysis (DHA)

If a significant dust hazard is present, a DHA should be completed at least every five years in accordance with NFPA 652.

Policyholders should maintain a copy of the analysis and review findings related to:

- Combustible metal hazards
- Cross-contamination risks
- Changes in operations or materials

If operations, equipment, or materials change before the next scheduled review, a new analysis should be completed to evaluate the updated hazards.

Evaluate dust collection and equipment segregation

Dedicated or segregated equipment and dust collection systems for different material types is the most effective way to reduce thermite reaction hazards.

Separating ferrous and non-ferrous metal processes helps prevent incompatible dusts from mixing, whether it's within the machinery or equipment, or the associated dust collection system.

Review cleaning and maintenance practices

If dedicated or segregated equipment is not feasible, written cleaning procedures become critical.

Review maintenance and cleaning practices for:

- Laser cutting operations
- Plasma cutting operations
- Grinding operations
- Polishing operations
- Associated dust collection systems

Particular attention should be given to procedures used when switching between ferrous and non-ferrous metals. Policyholders should follow all equipment maintenance and cleaning guidance provided by the manufacturer.

Verify available fire protection

Areas where combustible metal dust or metal chips are present should be equipped with Class D fire extinguishers designed for combustible metal fires.

Reducing the risk

Thermite reactions may not be an everyday exposure, but the consequences can be severe when combustible metal dusts are allowed to mix. By understanding where these hazards exist and verifying that appropriate dust management, cleaning, and fire protection measures are in place, agents can help policyholders reduce the likelihood of a costly and potentially catastrophic event.

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