METAL TREATMENT PROCESSES

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1.0 SCOPE

This data sheet covers fire hazards inherent in metal (ferrous and non-ferrous) treatment and finishing processes, including coating and pickling treatments for steel. Further guidance on plastic tanks that contain heating systems can be found in Data Sheet 7-6, *Plastic and Plastic-Lined Tanks*. Heat treatments such as annealing are covered in Data Sheet 6-10, *Process Furnaces*. This data sheet does not cover treatment or finishing processes for non-metal materials.

1.1 Changes

January 2013. This is the first publication of this document.

2.0 LOSS PREVENTION RECOMMENDATIONS

2.1 Construction and Location

2.1.1 Use noncombustible construction for all pickling and electroplating tanks, fume collection, and exhaust equipment and ducts. If combustible construction cannot be avoided, protect the picking and electroplating tanks and fume collection and exhaust equipment and ducts in accordance with Section 2.2 of this data sheet.

2.1.2 Provide adequate containment where acidic solutions in plastic tanks are used. A minimum curb height of 3 in. (76 mm) is recommended to prevent the acidic liquid splashing over the curb.

2.1.2.1 An alternative to containment is to provide emergency bottom drains on the pickling tanks that drain to a safe location. Ensure the drains are able to be operated remotely if they are to be used in place of containment.

2.1.3 Provide a minimum 1-hour fire separation between pickling or electroplating operations and other operations at the facility.

2.2 Protection

2.2.1 Provide fire protection for pickling and electroplating operations in accordance with Table 1.

2.2.1.1. In regard to deluges systems for combustible pickling tanks (see Table 1), if the tank lid cannot be opened during a fire, or if opening the tank lid takes several minutes, provide deluge sprinkler protection over and inside the tank. Design the sprinklers inside the tank to provide 0.3 gpm/ft^2 (12 mm/min) over the entire area of the tank, with a maximum sprinkler spacing of 100 ft^2 (9 m^2).

2.2.1.2. In regard to ceiling sprinkler protection for combustible pickling tanks (see Table 1), provide an interlock that will automatically open the lids when a water flow alarm activates; otherwise, provide deluge sprinkler protection above the tank.

Table 1. Sprinkler Protection for Pickling and Electroplating Operations

Equipment	*System Type*	*Design Requirement*	*Spacing*
Bulk acid storage tanks	Refer to DS3-26, *Fire Protection Water Demand.* Use a hazard category rating of HC-3.		
Combustible pickling tanks	Deluge[a]	0.3 gpm/ft^2 (12 mm/min) over the entire area of the pickling tank	Max. 100 ft^2 (9 m^2)
	Ceiling wet sprinkler system[b]	Refer to DS3-26, *Fire Protection Water Demand.* Use a hazard category rating of HC-3.	
Combustible exhaust ductwork	Refer to Data Sheet 7-78, *Industrial Exhaust Systems*.		
Combustible scrubbers and exhaust stacks	Refer to Data Sheet, *7-78, Industrial Exhaust Systems*.		

[a]. But see Section 2.2.1.1.
[b]. But see Section 2.2.1.2.

2.2.2 Use automatic sprinklers that are appropriate for the corrosive environment (such as FM Approved corrosion-resistant sprinklers) or protect the sprinklers using a thin plastic cover.

2.2.3 Provide automatic sprinklers on the discharge side of the scrubber fan as well as in the exhaust stack discharging to atmosphere and over fans constructed of combustible materials.

2.2.4 Install automatic sprinkler systems in accordance with Data Sheet 2-0, *Installation Guidelines for Automatic Sprinklers*. If specific installation recommendations in this data sheet conflict with guidance in Data Sheet 2-0, adhere to the recommendations in this data sheet.

2.2.5 Provide a water supply capable of delivering the full demand from the fire protection for the pickling tank and within the fume collection system, plus an additional 500 gpm (1900 L/min) for hose streams for a minimum duration of 60 minutes.

2.2.6 Install corrosion-resistant linear heat detection on the outside of the pickling tanks if deluge automatic sprinkler protection is provided. The linear heat detection can be used to trigger multiple systems.

2.2.7 Install linear heat detection within combustible exhaust ducts and combustible scrubbers in accordance with Data Sheet 7-78, *Industrial Exhaust Systems*.

2.3 Equipment and Process

2.3.1 Provide a heat detection system arranged to shut down the ventilation fans for the exhaust and scrubbing systems in the event of a fire.

2.3.2 Provide a dynamic braking system to stop scrubber fan motors in the event of a fire.

2.3.3 If the covers for combustible pickling or electroplating tanks can be remotely operated, interlock them to open on activation of a water flow alarm.

2.3.4 Maintain the liquid level in the combustible pickling or electroplating tanks for as long as possible during a fire. Keeping the liquid in the tank will help prevent the fire from spreading below the liquid level.

2.3.5 Design the heating systems for plastic tanks and plastic-lined tanks in accordance with Data Sheet 7-6, *Plastic and Plastic-Lined Tanks*.

2.4 Operation and Maintenance

2.4.1 Conduct quarterly visual inspections of the fire protection system (sprinklers, valves, pipe work, and detectors) for signs of corrosion. Replace components as needed. (Figure 1 shows examples of corrosion-damaged fire protection components.)

Fig. 1. Corrosion-damaged fire protection components

2.4.2 Maintain plastic tanks and plastic-lined tanks in accordance with Data Sheet 7-6, *Plastic and Plastic-Lined Tanks*.

2.4.3 Do not allow hot work of any kind in areas where plastic tanks or duct work is present. Relocate any hot work to a nonhazardous location.

2.4.3.1 When relocation is not possible, use a documented permit system in accordance with Data Sheet 10-3, *Hot Work Management*, to strictly control all hot work operations.

3.0 SUPPORT FOR RECOMMENDATIONS

3.1 Pickling

Prior to the cold rolling and finishing of most steel products it is necessary to remove the surface oxides or scale. The oxides are the result of slab reheating and hot rolling; they typically give the steel a blue/gray color that is most notable along the edges and ends of the strip. The scale is formed when the iron in the steel reacts with the oxygen in the air. The amount and chemical composition of the scale is dependent on the temperature of the hot strip and the amount of oxygen available to the strip surface while it is hot. Once the strip is coiled, the amount of exposed surface is limited so the reaction of the steel with oxygen is decreased.

If the scale is not removed prior to cold rolling, several undesirable results will occur. If the strip is cold rolled and annealed, the surface will be susceptible to rust. If the strip is coated with zinc or some other rust inhibitor, poor adhesion will result. If the scale is severe, the degree of reduction achieved in the cold-rolling process may be affected.

Once the scale has been removed the strip can be coated with a rust-resistant material such as tin, zinc, aluminum, and related alloys. These coatings can be applied via a spray process, a dip tank process, or electroplating.

Pickling to remove scale is also undertaken for some aluminum, tin, and copper products.

3.1.1 Batch Pickling

Batch tanks are generally used for pickling and rinsing of tubing, pipe, bars, plate, rod, wire, and shapes. A load of product is placed in a bath of heated pickling solution using a crane or other mechanical means such as a chain conveyor and hook arrangement. The load remains in the bath for a certain period of time, usually a few minutes. The pickling tank may be provided with a means of agitating or circulating the solution. The load is then removed from the pickling tank and lowered into a rinse tank containing a neutral solution to dilute any remaining pickling solution on the product surface and to stop the chemical reaction. These are generally open-top tanks and processes since they require a vertical entry of product from an overhead crane. Fumes are drawn off the sides of the tank above solution levels and are exhausted through a fume-collection system and then into a scrubber system.

3.1.2 Continuous Pickling

The continuous strip coil pickling process is similar to the batch strip coil pickling process in that it involves chemical cleaning of the metal strip surface. However, the continuous process uses a looper beneath the pickling line. (The loopers can also be vertical, but the majority are horizontal.) In the steel industry, the looper uses several traveling looper cars that can maintain various levels of strip steel, up to several hundred feet (meters) long, one above the other, by looping the steel back over the top of the previous level. By doing this, the pickling process does not need to stop for the butt-welding of coils at the entry end of the line because sufficient steel strip has been looped, or stored, and can be used to continue the pickling process section of the line while there is a short delay to complete the butt weld and trim.

3.2 Plating and Electro-Galvanizing

Corrosion protection is often applied to metals by means of electroplating and electro-galvanizing. Electroplating is the electrochemical bonding of a coating to a base metal. Steel is passed through a cell or tank that holds a solution that supports electrolytic deposition. The steel wraps around a conductor roll as it passes through the cell. An electrical charge passes through the solution from anodes to the conductor roll. The metal ions are taken from the solution and are deposited onto the steel. The most common coatings in the steel industry are tin, nickel, chromium, and zinc.

When zinc is applied, the process is referred to electro-galvanizing. Prior to being coated the steel must be clean, so in some cases the plating lines have integrated pickling lines.

3.3 Loss History

Several large pickle line fires have occurred at steel plants. The following are some examples from the industry.

A. In August 1989 a major pickle line fire occurred at a steel plant. The pickle line was located in a building that was approximately 400 ft (120 m) long. The building had corrugated metal panel walls and a wood on steel frame roof. There were wooden walkways that surrounded the pickling line. The pickling tanks consisted of granite- and rubber-lined steel. The tank tops, the exhaust system, and scrubber were made of FRP. Neither the building nor the pickling equipment had automatic sprinkler protection.

Shortly after the pickle line was down for maintenance, a fire started on part of the line. It quickly spread along the length of the line and consumed all the combustible materials. The fire reportedly burned for seven hours. All of the wood structures and the FRP portions of the line were destroyed. Major fire damage occurred to the structural building steel.

The cause of the fire was determined to be the failure of a bearing in a wringer roll section. The bearing overheated and ignited an FRP tank top. The pickling operation was down for approximately 8 months.

B. In December 2001, a fire occurred in an electro-galvanizing line. The process consisted of a pickle line followed by a double-sided electro-galvanizing line. The various tanks were made of plastic. The 300 ft (91 m) long exhaust hoods were made of FRP. The exhaust ducts were constructed of plastic, FRP, and metal. There were six outdoor scrubbers (one per zone), which were also made of FRP.

The production equipment was housed in a building that was approximately 60 ft (18 m) high. The walls were constructed of brick to 10 ft (3.0 m), with corrugated metal panels above. The roof consisted of concrete on exposed steel trusses and beams. Automatic sprinkler protection was not present at the ceiling or within the combustible equipment. The fire started in a cleaning section that was located on an upper level. An overheated bearing was the cause.

A plastic tank was ignited first and the fire quickly spread through the fume exhaust system. The public fire service fought the blaze for over nine hours. One of the scrubbers was destroyed. Three plating cells, a dryer section, a rinse section, several pickle tanks, an edge conditioner, a bridle roll section, a looper, and a control room were severely damaged. Several of the steel roof trusses were distorted by heat.

The estimated property damage was in excess of US$50 million (indexed to 2011 dollars). Production took almost a year to return to normal levels.

C. In March 2006, at an idle steel mill, hot work during a demolition project ignited an indoor plastic scrubber unit. The entire footprint of the scrubber, fans, and stack covered a 33 x 9 ft (10.1 x 2.7 m) area. The scrubber itself was approximately 23 ft (7 m) long x 6 ft (1.8 m) wide x 6 ft (1.8 m) tall. It sat on top of three 7 ft (2.1 m) diameter X 4 ft (1.2 m) tall recirculation tanks. The associated exhaust duct and stack was 2 ft (0.6 m) in diameter The stack was approximately 40 ft (12 m) tall and extended through the roof. All of this equipment was plastic. The building was virtually devoid of other equipment and other combustibles.

The public fire service was called shortly after ignition of the scrubber and arrived on site a few minutes later. They could do nothing to fight the fire until most of the plastic was consumed (only part of the recirculation tanks remained), after which cleanup was conducted using foam.

Due to the building being almost empty and the facility idle, the total property loss was less than US$250,000 (indexed to 2011 values), with most damage being to the building walls and roof steel. However, if this had been a fully functional working facility the potential loss would have been in the tens of millions. This loss highlights the need to quickly detect a fire and suppress it before it grows and involves combustibles beyond the immediate area of the fire origin.

4.0 REFERENCES

4.1 FM

Data Sheet 2-0, *Installation Guidelines for Automatic Sprinklers*

Data Sheet 3-26, *Fire Protection Water Demand*

Data Sheet 6-10, *Process Furnaces*

Data Sheet 7-6, *Plastic and Plastic-Lined Tanks*

Data Sheet 7-78, *Industrial Exhaust Systems*

Data Sheet 7-83, *Drainage and Containment for Ignitable Liquids*

APPENDIX A GLOSSARY OF TERMS

FM Approved: The term “FM Approved” is used to describe a product or service that has satisfied the criteria for Approval by FM Approvals. Refer to the *Approval Guide* for a complete list of products and services that are FM Approved.

APPENDIX B DOCUMENT REVISION HISTORY

January 2013. This is the first publication of this document.