

## Safety Alert: Incident at a Chemical Plant

### Summary of Event

A fire was reported inside a tower at a Chemical Plant. The emergency response organization responded immediately and brought the incident under control. One minor first aid injury occurred to an employee who was treated and released to return to work that afternoon. As a result of the fire, the vessel was burned through, around the entire circumference of the shell, in two places. No other equipment in the structure sustained damage.

### Background

The tower is a 316 stainless vessel that is 42 inches in diameter and 73 feet tall. It contains three beds of packing. The top and middle beds were titanium, the bottom bed was Inconel. This metallurgy was changed from stainless steel during a recent turnaround due to severe corrosion of the packing material. This was the first time the tower had been opened for work since that time.

On Sunday, two days before the incident, the tower experienced an operational upset caused by a plug in the tower that prevented the downward flow of liquid. The tower was taken out of service Sunday night. Gas freeing and mechanical preparation took place on Monday. Final preparations for vessel entry were being made on Tuesday morning when the fire occurred.

### Data/Observations

- The titanium packing in the top bed had broken into small pieces and was falling through the top bed support tray. Before the fire, significant quantities of small pieces of titanium were observed on the liquid redistribution tray above the middle packing bed.
- Unit operations first became aware of the incident when a manway was moved and a flash fire occurred. This phase of the incident was over very quickly, however, several minutes later a bright spot of glowing metal appeared on the tower that rapidly grew in size and intensity. Shortly thereafter, a second glowing spot appeared on the tower about 10 feet above the first.
- The lower tower burn-through occurred just above the mid-point of the middle packing bed. The upper tower burn-through occurred in the area of the liquid redistribution tray above the middle packing bed.
- Titanium is classified as a flammable metal. Depending on size, titanium auto-ignites at temperatures between 630 and 2050 deg-F (lower temperature for powder, higher temperature for solid). The presence of steam reduces the amount of air and/or the temperature required for auto-ignition. Once small shavings are ignited, the fire is self-sustaining.
- Analytical results and consultation with titanium manufacturing experts confirmed a Class D metal fire involving titanium inside the tower.

### Conclusions

- A titanium fire caused the extensive damage to the tower. The presence of small particles of titanium in the middle packing bed significantly contributed to the ease of ignition of the titanium and accounted for the tower burn-through in these locations.
- The most likely mechanism for ignition is the presence of pyrophoric residue.

- The presence of metal oxides accelerated the oxidation of the titanium via a mechanism known as the Thermite Reaction in which the oxygen for combustion is taken from a less reactive metal oxide.
- The investigation was unable to determine if the Class D fire at the mid-bed point started before or after the observed flash fire at the manway.
- Until more is known, extreme caution should be used when working on any vessel with titanium internals. This is especially true if damage has occurred that has resulted in the presence of small titanium particles or if other metal oxides are present that might provide a source of oxygen.

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