Corrosion of aluminium skin-and-pontoon Internal Floating Roofs

Aluminium internal roofs are used frequently in all sectors of petroleum related operations without many incidents or problems. Corrosion in the form of serious pitting is not usually considered a potential problem for crude oil, wastewater, or refined product service. However, in some cases the roof has been severely damaged by corrosion where a caustic wash carries over into finished storage or the product is contaminated in some way with chemicals that rapidly attack aluminium.

The aluminium alloys used in floating roofs vary by component, roof type, and manufacturer, but some generalities about material usage are possible. Probably the biggest factor affecting material selection is the roof type. There are two types of aluminium roofs: the full contact type, or honeycomb roof, and the skin and pontoon type.

The full contact type is made of sheet 3003 H14 aluminium in most cases, since it is constructed as a honey comb like structure sealed by a top and bottom sheet. The 3003 series aluminium grade has about 0.12 percent copper alloyed into it. There are few cases where pitting has been a serious problem in these roofs in petroleum service. In other roof applications such as wastewater tanks or crude oil where there is a significant level of hydrogen sulphide, the 3003 aluminium stands up well and keeps the appearance of newness. The structural extrusions which support the 3003 sheets are usually made of 6061 aluminium extrusion, and these do show "white rust" and spot pitting. However, the pitting is usually acceptable from a mechanical integrity point of view.

Skin and pontoon roofs use a sheet deck of 3003 or 3004, and the actual buoyancy is provided for in the pontoons that are semi submerged in the liquid. The skin is in the vapor space. The pontoons are often made of 6061 or 3004 or 3003. The aluminium roof vendors have consistently offered 3004 aluminium. The reason is that the 3004 series is readily available as irrigation tubing. Therefore, the bulk of the tanks use internal floating roofs with 3004 series pontoons in them.

The 6061 aluminium has 0.28 percent copper, whereas the 3004 has no copper in it and 3003 has 0.12 percent copper. The higher copper in 6061 does seem to cause spot pitting but not sufficiently to cause problems in normal refinery and marketing applications.

In sour services where there is a water layer at the tank bottom, severe corrosion of the roof legs occurs. This happens presumably because the H2S reacts with the water to form sulphurous and/or sulfuric acid. In any case, the corrosion is so severe that most companies specify stainless steel legs for these services or insulating leg caps which reduce corrosion.

The skin-and-pontoon problems may be characterized as follows:

Crevice corrosion. This usually occurs on the ends of the pontoons where structural brackets that support the deck are welded to the endcaps on the pontoons. Another likely location for crevice corrosion to occur is where straps encircle the pontoons for attaching the deck. Although a white rust occurs, it has not caused failures or severe pitting is not considered a serious problem. However, the white rust can develop significant forces between plates or surfaces, causing failure of fasteners, or lead to cracking.

Pitting. This occurs and does cause failures at two places. Any sub merged surface that can accumulate sediment causes pitting. A roof skirt that forms the periphery of the roof is often used which is a plate rolled into a channel section. The submerged leg of the channel is subject to rapid and severe pitting. Pitting in structural members is not serious provided that the strength is not reduced substantially.

Another area where pitting occurs is at the interface between the liquid and vapor on the pontoons (the 9 and 3 o'clock positions). A brown build up that varies from a stain to a deposit approximately 1 to 2 in thick occurs here. One company has done elemental analysis of this and reported the presence of iron. This is presumably iron oxide whose presence forms a corrosion cell. Pitting does occur at the interface in the form of pinholes approximately 0.5 to 1.0 mm in diameter.

They are very difficult to detect as the deposits tend to hide them, and they are not always visible to the naked eye. One technique they use to search for these pits is "feel." The pitting forms an elevated crater that may result from the iron oxide and aluminium oxide build up within the pit, causing higher pressures and plastic deformation of the adjacent metal into a crater. These craters are detectable by running the hand against this area.

The problem of fuel entering the pontoons is serious for two reasons:

- The buoyancy of the floating roof depends on the vapor tightness of the pontoons over the life of the pontoon. However, pitting can occur within a 6 to 8 year period.

- The presence of flammable liquids in the pontoons can be a fire and explosion hazard. One company has experienced an explosion that blew the endcaps off the pontoon when a welder inadvertently struck an arc against a pontoon while making repairs inside the tank.

Fabrication. Many pontoons leak because of porosity in the welds and because of weld failures. Welds frequently fail at the endcaps of the pontoon because of the loads transferred to it from the brackets supporting the deck. These cracks have allowed gasoline to enter the pontoon.

Design and Maintenance Considerations

1. In design, consider the alternative to skin and pontoon roofs: the full contact, or honeycomb, roof. This design may be more costly, but it is more effective from a fire protection point of view. The roof has a good long term service history. Although initial capital cost may be higher than that for the skin and pontoon design, the overall costs, given early inspections and repairs, may make it the economical choice.

2. Sniff and inspect pontoons for the presence of hydrocarbon on the interior when the opportunity presents itself or when any internal tank inspection or work is being conducted.

3. Assume that the pontoons have something flammable in them for the purposes of hot work or for inspection.

4. Monitor the buoyancy of internal floating roofs using the skin and pontoon design by checking the levelness of the deck during inspections and for tanks that have had these in service for more than 8 years. ·

5. Reduce the internal inspection period for tanks with internal floating roofs using the skin and pontoon design to a maximum interval of 10 years.

6. Use designs and specifications that address materials, fabrication and welding, and other causes of known failures.

Corrosion resulting from hydrostatic test water

In the past it was common to treat test water with chromate corrosion inhibitors, but this practice has died out because of the associated environmental problems. Currently, it is necessary to consider the disposal of the test water. One method of ensuring reduced corrosion resulting from hydrostatic testing is to raise the alkalinity of the test

water to pH 10 to 12 by using soda ash. There is the possibility of residual alkalinity causing potential stress cracking problems, however. Probably the best and most reliable method is to drain the water from the tank as soon as possible and dry it out over a short time.

For tanks constructed of stainless steel, the chloride level should be limited to 50 ppm, or else the possibility of inducing stress corrosion cracking exists.

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