Question 22: A) What has been your experience with hydrogen leaks to cooling water systems and the resulting impacts? B) What are your findings and recommendations from major associated incidents?

RAMACHANDRAN (Bharat Petroleum Corporation Limited)

Traditionally, the operating pressures of cooling water systems have been lower than the hydrogen generation sections, and any leaks would result in hydrogen ingression into the cooling water system. I know of an instance where construction was occurring on a spare cooling water cell and the hydrogen leaked into the cooling tower. There was a spark nearby and then an explosion that destroyed the cooling tower. But most often, one sees that it is the hydrogen, per se, that disturbs the pipeline's structures and creates destruction downstream.

There are two stages at which we need to take care to prevent such incidents. The first is to look at the design stage. Apply the 10/13 API 521 rule for pressure designations for the cooling water side. Look at tube metallurgy. Ensure that you have a tube metallurgy, as prescribed, for the service vibration analysis – both for the exchanger and to ensure that you have the right supports for the pipelines – and that it is carried out. Secondly, when you start operating a plant, you need to ensure that you have adequate corrosion protection.

We also have a typical system of a bubbler which is used as a simple and practical way of looking for and monitoring leaks. I have seen vents being constructed on cooling tower risers to ensure that when there is release of hydrogen, the cooling tower is protected.

AGGUS (Becht Engineering Co., Inc.)

As far as the findings and recommendations from major incidents, I want to tell you about an incident where there was a leak in the intercooler of our makeup compressor to a hydrocracker. It has a pinhole leak, so the only way it was picked it up was at the local VOC (volatile organic compound) monitor at the cooling tower. Underlying issues there were a lack of cooling water supply, low velocities, and a high return temperature. They were big problems to solve; but in this case, the facility replaced the bundles,

all the little hairpin intercoolers, and the aftercoolers on these compressors with 2205 Duplex. It was an easy, quick fix that is slightly expensive but less so than redoing your entire cooling water system. The up side is that it is this repair which gives you a service life that is four to five years longer than carbon steel would give in that situation. Cost-wise, it is better than your copper and nickel alloys and more economical.

A couple of things to watch out for, though: For a service like this, you will not see high local temperature; but if you do have local temperatures higher than 250°F, you will have to watch for chloride cracking on the cooling water side. Then in some services, depending on the geometry and exchangers, the Duplex will have some real limitations, as far as being able to bend the tube material. So, it may not be suitable for some services; but in this case, it was a good quick fix.

PAPPAL (Valero)

We had one experience that was unusual. The hydrogen leaked into the cooling water, causing a failure in a lube oil cooler on a recycle gas compressor. The hydrogen eventually leaked out of the lube oil reservoir vent. The event caused a unit shutdown.

AGGUS (Becht Engineering)

I have seen an instance where hydrogen leaking to a cooling water system was detected by a local VOC monitor at the cooling tower. The source was isolated as a pinhole leak at the hydrocracker unit's makeup hydrogen cooler. Prior to the failure, annual cooling water surveys had noted a high (150°F) cooling water return temperature. As there was no available footprint to increase the tube count of this cooler (hairpin), the bundle was upgraded from carbon steel to Duplex stainless steel. Duplex was selected because it would:

- Yield a service life four to five years longer than carbon steel in similar service and
- Be better, cost-wise, than the copper or nickel alloy upgrade options [Alloy 400, 70/30 CuNi (copper nickel), and 90/10 CuNi].

There are a few things to watch out for with a 2205 Duplex upgrade, though:

- High (greater than 250°F) local temperatures can lead to chloride cracking in CW (cooling water) services, and
- Duplex has bend radius limitations, so check with the vendor or materials engineer on suitability.

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