

Nitriding in a Synthesis Loop Steam Generator

Here's a quick look at how two cases of nitriding in an ammonia plant synthesis loop were discovered and repaired.

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The synthesis loop steam generator at ARCO Chemical's 1,000 ton/day ammonia plant in Fort Madison, Iowa has two annular flow converters in series with attendant external preheat, feed effluent and boiler exchangers. This article discusses two problems of nitriding in the synthesis loop.

Nitriding in boiler E-116 was first indicated when tests of the synthesis loop revealed leaks in the tube to tube sheet weld which permitted gas at process conditions to contact the unprotected area of the exchanger tube sheet. The exchanger was removed from service in October 1970 and sent to a shop for repairs.

Exchanger repairs

Inspection in the repair vendor's shop revealed that nitriding had occurred in certain areas of the exchanger. The first part was in the heat effected zone where the partition plate is welded to the channel barrel. Repairs were made by grinding out the entire area to full depth and filling in with Inconel 182 stick electrode.

When the original tube sheet Inconel overlay was being machined off, small parts of the base metal of the tube sheet started snapping off with the overlay. Inspection of the base metal in the tube sheet revealed nitriding. Since no new tube sheet and channel forging was available we decided to machine off part of the tube sheet face and lower the exchanger differential pressure.

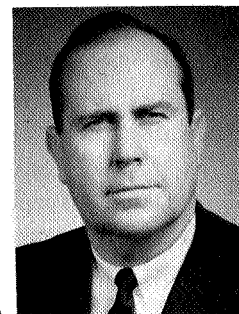
Further inspection of the tube sheet tube holes revealed nitriding in the tube sheet ligaments. After machining the tube sheet to the new thickness it was dye checked and

there were indications of superficial cracks in the inlet pass. The cracks were ground out satisfactorily.

Repairs were made and the shell side test was satisfactory. However, a tube side test at 900 lb./sq. in. gauge revealed two leaks in the diaphragm closure to the channel barrel weld. The cracks started in the Inconel overlay which is used as a sealing surface for the diaphragm. The leak was under the overlay next to the chrome-moly channel forging. Unique repairs were made by cutting a 23 in. hole in the diaphragm and using a welder inside to butter up the overlay inside rather than remove the entire diaphragm and start over.

Expansion joint failure

The second problem, failure of the expansion joint in feed effluent exchanger E-115, was discovered when a piece of nitrified metal cracked and was loose within the exchanger. It was repaired and revised by providing an interliner circumferentially within the bellows. The amount of contraction that the new Inconel 600 bellows would travel was calculated to be less than 1 in. Consequently, the interliner, after being placed circumferentially within the bellows, was anchored on the tube bundle side and allowed to grow a 1 in. distance within holding dogs provided on the stationary side of the bellows. The original bellows was type 321 and had nitrified 2 mils on the ID, and 1 mil on the OD. The 321 stainless steel bellows was replaced with the Inconel bellows and protected as mentioned above with an Inconel interliner. #



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