LEVAN ENGINEERING LTD
www.LevanEngineering.com
Phone: (403) 701-2466

Weld Corrosion in Icebreakers, Produced Water Lines and Sweet Gas Pipelines

Weld metal or the heat affected zone can preferentially corrode in these services. Ship builders have adjusted their weld metal composition and welding procedures to prevent this corrosion. And it seemed natural to use their methods to prevent weld corrosion in sweet gas pipelines. But sometimes it does not work.

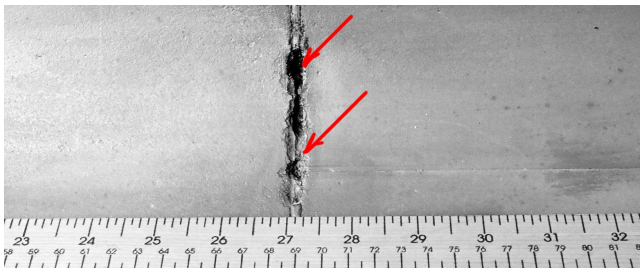
The first investigation on weld corrosion in icebreakers was 60 years ago. Ships builders tried coatings but by the end of the ice season, the coatings were scraped off the hull. Or the hull plates flexed in heavy ice and this disbonded the coating. When this happened, the steel corroded.

If the weld is anodic to the hull plates, the weld corrodes preferentially. This is called galvanic corrosion. This example of galvanic corrosion may seem unusual to most engineers. They are accustomed to galvanic corrosion between much different metals such as copper and steel. They don't expect galvanic corrosion between carbon steel and carbon steel. But it is the large ratio of cathode area to anode area that causes severe galvanic corrosion. Corrosion rates up to 10 mm per year were measured.

ESAB, an electrode manufacturer, developed a test in 1961 to simulate corrosion in arctic seawater. And from these tests they manufactured an electrode for icebreakers. ESAB added ½% Nickel plus ½% Copper to the carbon steel weld metal and this prevented galvanic corrosion. These electrodes are available from other manufacturers.

Despite these new electrodes, the HAZ corroded. HAZ corrosion was caused by a hard microstructure in the HAZ. Unlike modern pipeline steels, the old hull plates were thicker and had higher carbon equivalent. Hard HAZ were common. To prevent this

corrosion, ship builders placed limits on the maximum manganese content and this reduced the carbon equivalent. And they used preheat to reduce the cooling rate. As a result the HAZ was softer and did not corrode.



As shown here, weld corrosion also occurs in produced water lines. The brackish water corrodes the weld. It was natural to try the "icebreaker" electrodes. And these electrodes prevented the produced water corrosion. The ½% Ni plus ½% Cu weld metal makes the weld slightly cathodic to the pipe.

There was no problem with HAZ corrosion in these produced water lines since the pipe is thin and low carbon equivalent. Therefore, the HAZ is soft.

There are only a few icebreakers being fabricated. It is a small market. Therefore, you likely won't find these electrodes at your local distributor in landlocked Alberta.

Sweet gas pipelines also corrode preferentially at the weld. Again it seemed natural to use electrodes that performed successfully in icebreakers and produced water lines. But there have been corrosion failures. Unfortunately there were no failure analysis reports. There is one test in a CO_2 environment[1] but they did not use the common ½% Ni ½% Cu electrodes. They used 1% Nickel electrodes and this higher nickel content increased corrosion.

You should be cautious. Small amounts of Cu and Ni in the electrodes may not prevent corrosion in your sweet gas pipelines.

[1] C-M Lee, *Preferential Weld Corrosion: Effects of Weldment Microstructure and Composition*, Corrosion/2005