# Rapid degradation of Copper Nickel Condenser Tubes (UNS C71500) in refinery sour environments with life cycle cost study on suitable material upgrade

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Use of non-ferrous alloys such Aluminum brass, copper nickels & titanium is common in refinery shell & tube heat exchangers that employ sea water as the cooling medium. Copper nickel alloys are used extensively in seawater applications because of their natural antifouling properties, good thermal conductivity and corrosion resistance at a reasonable cost. The most widely used copper-nickels are 90-10 (UNS C70600) & 70-30 (UNS C71500) alloys but its vulnerability to erosion corrosion at high flow rates and environment containing ammonia and sulfides can result in localized selective attack. The primary material selection basis for tubes in such heat exchangers are resistance to sea water corrosion which is normally in the tube side without giving much consideration to the contaminants present in the shell side hydrocarbon fluid.

During the initial design of the refinery, Al brass (UNS C68700) tubes were installed which failed within a span of 2 years primarily due to sea water side tube end erosion as well as some failures due to ammonia stress corrosion cracking from the shell side. Subsequently, all the exchangers were replaced with 70-30 Cu Ni tubes in a phase wise manner. Although Cu-Ni has relatively better resistance to erosion and ammonia stress cracking, but still has velocity limitations as well as suffer from severe corrosion in the streams contain high sulfide and ammonia. Eventually, the refinery experienced severe integrity and reliability issues as the Cu-Ni tubes began to fail prematurely with a mean time between failure of 6 years, resulting in extensive inspection, & replacements. Accelerated corrosion damage was observed on the tubes external surface due to presence of high amounts of ammonia and sulfides in the hydrocarbon side with some damage also seen in the sea water side in the form of tube end erosion corrosion.

To overcome the reliability challenge a detailed life cycle cost was conducted considering different material options such as Copper Nickel/Titanium/Super Duplex and Super Ferritic stainless steel grades. This article describes the various corrosion issues experienced by the Copper Nickel tubes and discusses the outcome of the lift cycle cost study.

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