

Condenser Restoration
At
Exelon's Schuylkill Station
Philadelphia, PA
April, 2008

Presented for the
EPRI Condenser Technology Conference
August 12-14, 2008
St. Petersburg, FL

Kevin Shugrue
CTI Industries

Introduction

In late 2007, CTI Industries was contacted to consider installing our Full Length Tube Liners into the Main Condenser at Exelon's Schuylkill Station in Philadelphia, PA. The Air Removal tubes in the main condenser were constructed of 304 Stainless Steel and were suffering from a form of Microbe Induced Corrosion (MIC) that was caused by chlorides in the cooling water supply from the Delaware River. The 15,000+ tubes in the rest of the condenser were 90/10 CuNi and showed no effects from the chloride attack on the stainless.

The Condenser

The condenser at the Exelon Schuylkill Station is an older vintage CH Wheeler, two pass divided water box configuration with 16,500 tubes. The 7/8' x 18 BWG Admiralty tubes were retubed roughly 28 years ago with a thinner 20BWG 90/10 CuNi in the main body and an 18BWG 304 Stainless Steel into the air removal section. The upper and lower halves of the condenser feature access doors located in the center of the unit.



Figure 1

Schuylkill Unit 1 Tube Sheet Maps

Schuylkill Station
Main Condenser - Alpha Box
Inlet Pass (top) - View from North
PRELIMINARY MAP

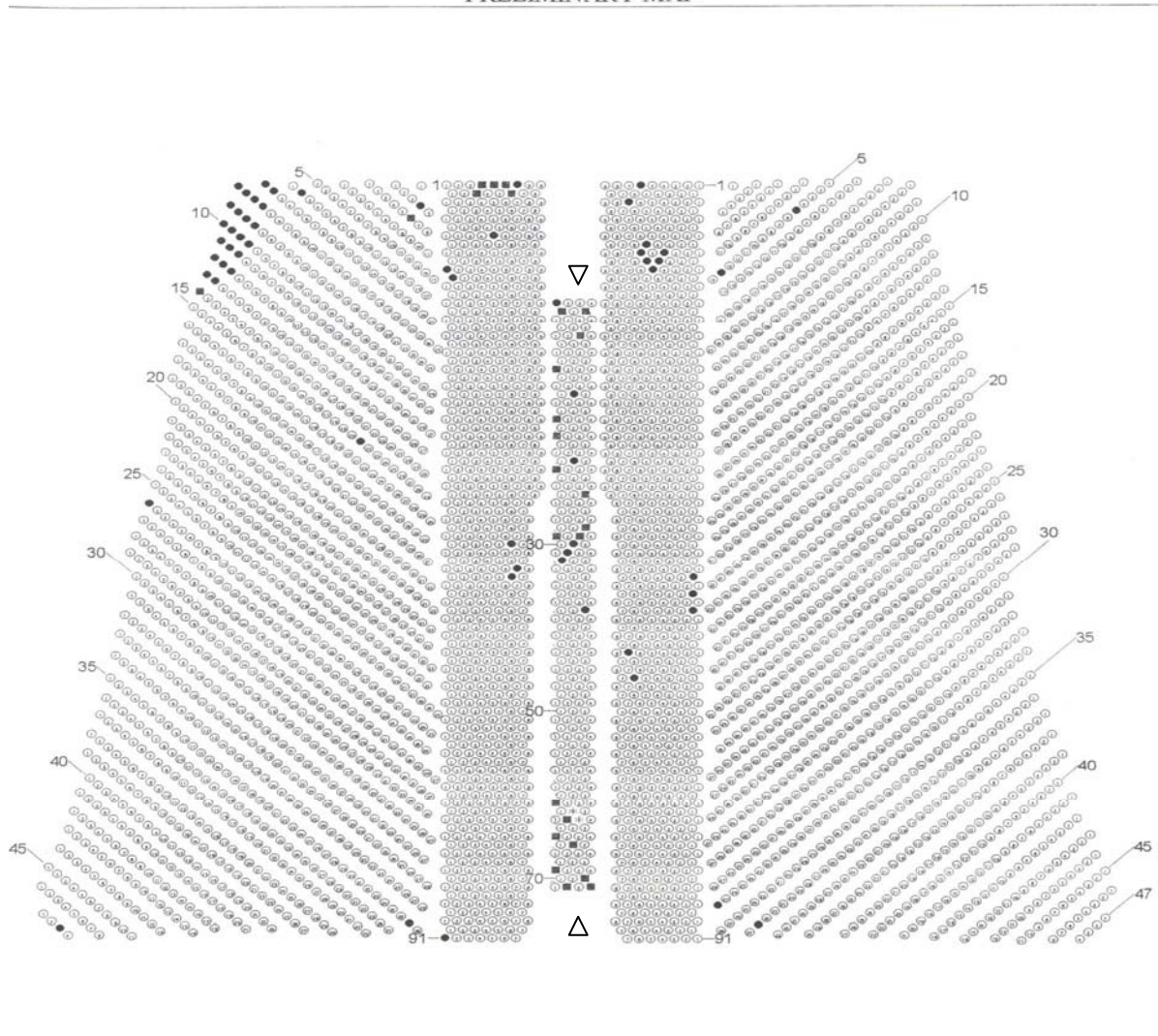


Figure 2

The Air Removal tubes are located directly in the center of each of the upper water boxes and contain 252 tubes in each of the inlet passes for a total of 504 tubes. These 304 Stainless Steel tubes were found to have a corrosive film resembling an aggressive MIC attack which became a reliability issue of having to frequently identify leaking tubes and plug them. Other than some tubes being plugged in the upper few rows from a turbine blade problem years ago, the condenser tubes overall are in great shape and should provide years of trouble-free service.

Options

With the presence of a severe attack on only the Stainless Steel tubes in the condenser the plant personnel were faced with what to do. The Air Removal tubes in the condenser numbered only 504 tubes in the upper half of both water boxes, a very small percentage (3+%) of the condenser tube total. Existing options included...

Do nothing- The reliability and efficiency of the condenser would suffer greatly. The introduction of chlorides into the boiling water chemistry could result in even more damage to boiler tubes and other peripheral equipment.

Partial retube- A partial retube of only the Stainless Steel tubes was considered. The first step in removing such a small percentage of tubes would still require the rigging and removal of the water boxes on at least one end of the condenser. The costs and labor for removing an almost 20' x 10' steel waterbox were extremely prohibitive. Along with the potential of snapping tubes while extracting them, this option proved too costly.

Full Length Tube Liners – The flexibility of thin-walled tube liners allows for access through the manways. Using the inlet and outlet manways for access, an estimated strike zone was developed. It was thought that we could install liners in a large percentage of the middle column of tubes. While not guaranteeing 100% coverage, we would be able to recover plugged tubes already lost to MIC, and furthermore, with the 90/10 CuNi completely covering the tubes they would eliminate the potential for lost/leaking tubes down the road.

The CTI Tube Liners TM

Exelon elected to install CTI Full Length Tube Liners into every tube that was reachable in the targeted area of the Air Removal Section. Based on past experience with access and the flexibility of the liners we elected to size the liner material at .742"OD x .028" wall thickness. The length was established as 1' (foot) longer than the tubesheet to tubesheet dimension which allows the attachment of the OD pump chucks which in this case the liners measured in at 27 feet long.

Testing on similar tube liners established the premium expansion pressure was set for 3,800 psig. The dual-action, high pressure reciprocating piston pumps are customized to CTI specs and used in conjunction with a pressure chuck on one end, and a bleed chuck on the other. We are able to preset the pump shut-off to achieve optimum performance without hunting for the proper expansion. The dead-head also eliminates the possibility of over-pressurizing the liners, but if that does happen, the thin-walled tube liner will split outside of the parent tube. The added wall thickness of the parent tube is greater than the burst pressure of the thin liner,



Figure 3

The Repair Method

The first step in the repair process is to remove all the tube plugs in the target zone. The goal is to get the tube ID's as clean as possible.

The use of high pressure pumps shooting metal scrapers through the entire length of the tube will usually eliminate anything that might act as an insulator.

Once the tubes are cleaned and dry, the liners are loaded from a staging area, on an every other tube-every other row to allow proper clearance for the OD pump chucks which are used to expand the liners hydraulically.

Once expanded, the liners will be cut close to the tube sheet, milled flush to the tube sheet to establish a uniform surface profile for mechanically expanding the liners at the tube sheet.

Roller expansion will reinforce the tube to tube sheet joint which forms the seal.

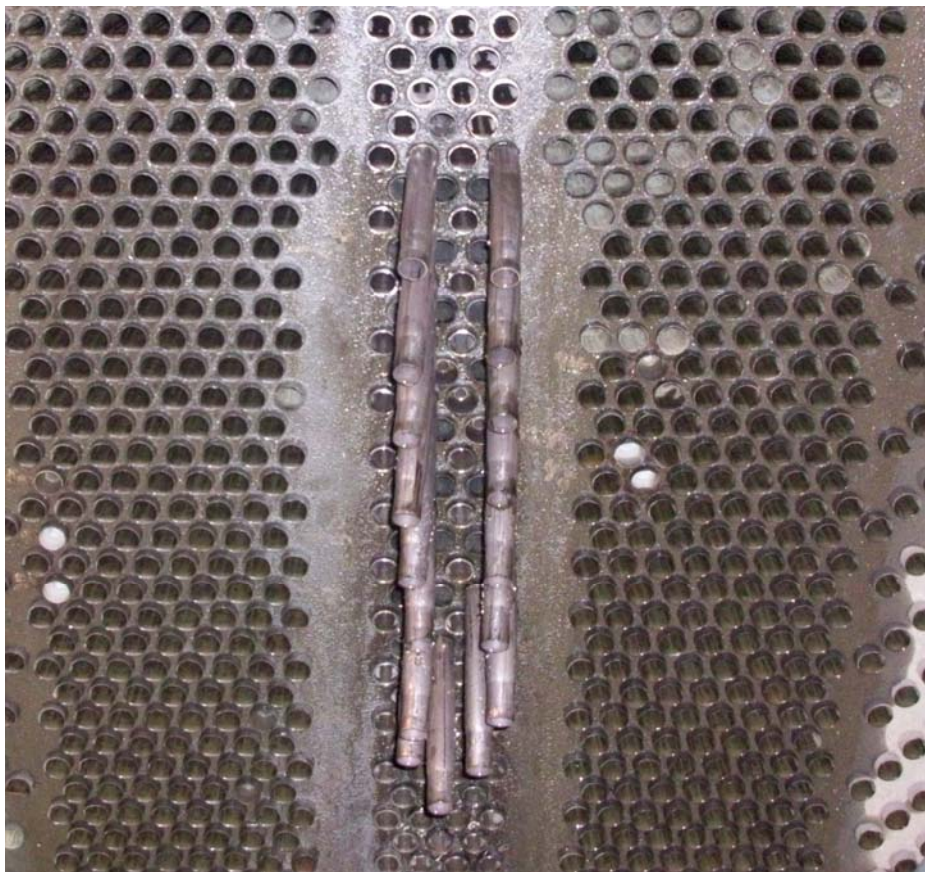


Figure 4

Conclusion

The finished product shows installed liners which will provide years of additional service with the reliability of new tubes without the painful removal of the waterbox. The flexibility of the thin-walled tube liners along with the 6-foot depth of the inlet water box allowed CTI to get 100% coverage of the targeted 504 tubes. Our initial concern on the tubes located half-way between the two manways which were on 42" centers, were shortly overcome when we reached those selected tubes to load. A few had to be slightly coerced with the help of an air hammer, but we completed all the targeted tubes in less than four days working around the clock. We were also able to recover over 30 tubes that were randomly plugged in the main body of the condenser, which we lined and returned to service.

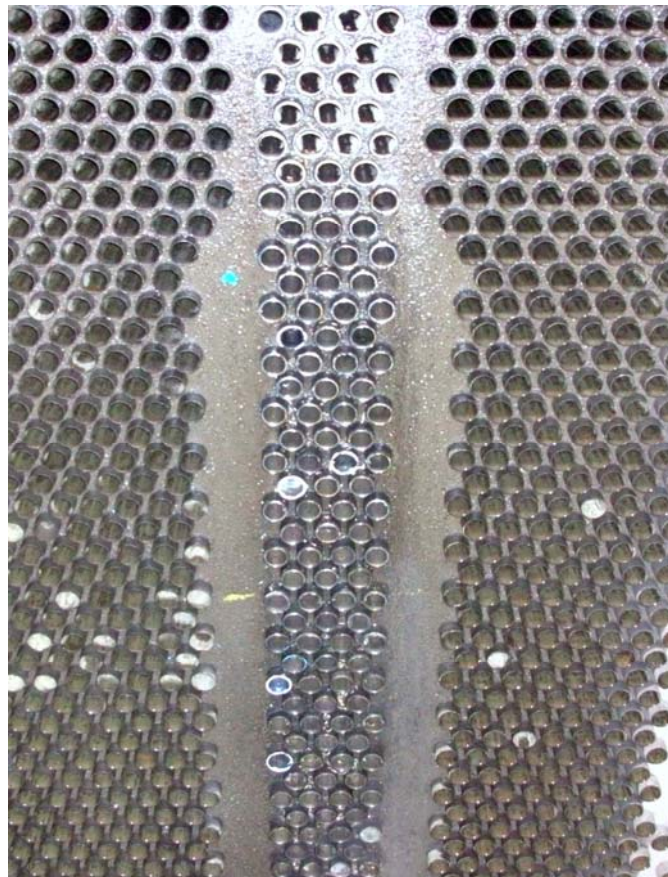


Figure 5

Kevin Shugrue
CTI Industries
Orange, CT