

APR INSPECTION ON CONDENSATE STABILIZER REBOILER

- Mr. Jeff Lew

DATE OF INSPECTION	26 March 2011	TOTAL NO. OF TUBES INSPECTED	154 (U)
LOCATION	Singapore	CONFIGURATION	U-type
		MATERIAL	Duplex Stainless Steel
		TUBE OUTER DIAMETER	19.5mm
		TUBE THICKNESS	2.11mm
		TUBE LENGTH	10m

THE CHALLENGE

The client was having problems inspecting U-type condensate stabilizer reboilers in a short amount of time. His usual inspection procedure used eddy current testing (ECT) but ECT can not inspect the U-bend area and was time consuming.

SOLUTION

Acoustic Pulse Reflectometry technology (APR) can identify holes and blockages in a tube of regardless of tube configuration and material. It is quick as it takes only 10 seconds per tube for measurement and can give the location and size of the defects.

APR inspection was conducted on the U-tube bundle and followed by eddy current testing. The tube bundle was first cleaned and blow-dried as a prerequisite before the inspection (Figure 1).

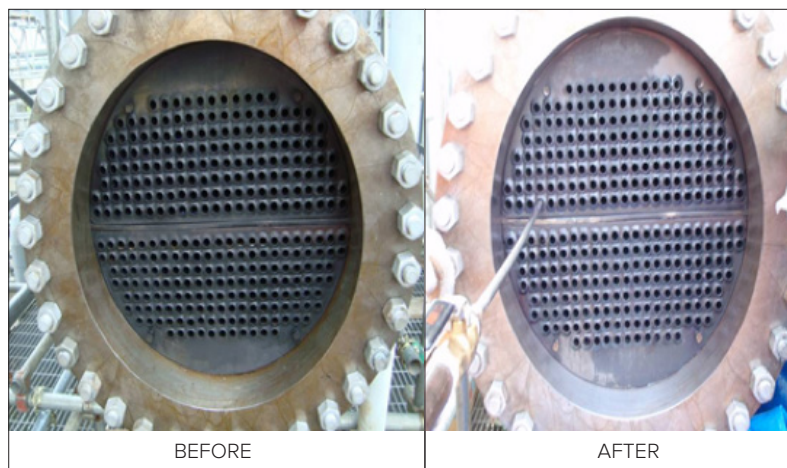


Figure 1: Before and after cleaning

APR INSPECTION

START TIME	10.00am
END TIME	11.15am
INITIAL SETUP TIME	15 minutes
MEASUREMENT	60 minutes
TOTAL DURATION	75 minutes

On completion of APR measurement, the measurement data was handed over to the supervisor for evaluation. The APR inspection report was ready after 2.5 hours. The defects found as shown in Table 1. A fault distribution chart is created on the faceplate for quick visual identification is shown in Figure 2.

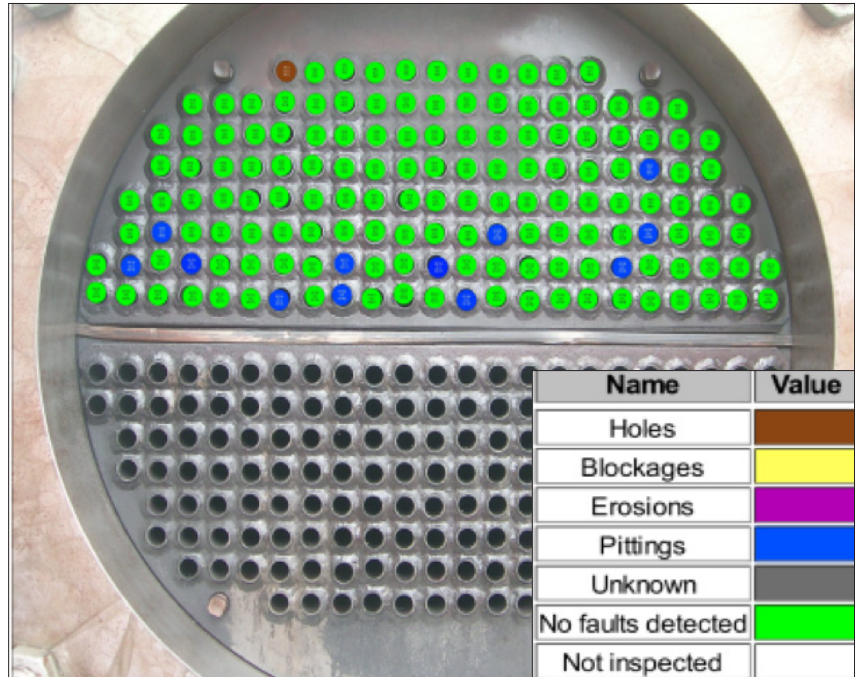


Figure 2: Fault distribution on faceplate.

Tube No	Faults								Row	Tube No
	Hole		Blockage		Erosion		Pitting			
	Position	Diameter	Position	Reduction	Position	Reduction	Position	Reduction		
	[m]	[mm]	[m]	[%]	[m]	[%]	[m]	[%]		
1	9.66	3.3							4	48 to 66
64							3.46	21.7	5	67 to 87
89							5.95	28.4	6	88 to 108
100							1.11	21.1	7	109 to 131
105							5.91	24.6	8	132 to 154
110							5.48	27.8		
112							7.56	44.7		
117							6.88	28.3		
120							8.15	57.2		
126							6	29.4		
138							5.85	26.9		
140							6.29	27.2		
144							5.89	32.1		

Table 1: APR Inspection Defect Table

EDDY CURRENT TEST

START TIME	10.00am
END TIME	11.15am
INITIAL SETUP TIME	30 minutes
MEASUREMENT	45 minutes
TOTAL NO. OF TUBES TESTED	13
TOTAL DURATION	75 minutes

On completion of eddy current testing, the report was ready after 6 hours. The defects found by eddy current testing as shown in Table 2.

TUBE	WALL LOSS
R[1] C[1]	60-80%
R[7] C[3]	40-60%
R[7] C[12]	40-60%

Table 2: Defects found with eddy current testing

RESULTS

ACOUSTIC PULSE REFLECTOMETRY		EDDY CURRENT TESTING	
Tube Numbering	APR defect indication	Tube Numbering	ECT defect indication
1	Type : Hole Size : 3.3mm Location : 9.66m	R[1] C[1]	Wall Loss : 60 - 80 %
112	Type : Wall Loss (pitting) Size : 44.7% Location : 7.56m	R[7] C[3]	Wall Loss : 40 - 60 %
120	Type : Wall Loss (pitting) Size : 57.2% Location : 8.15m	R[7] C[12]	Wall Loss : 40 - 60 %

Table 3: APR Inspection results vs ECT results

QUANTITATIVE RESULTS

- APR inspection: 154 U-bend tubes in 75 minutes.
- ECT inspection: only 13 tubes in 75 minutes
- APR Tube #1 shows that APR inspection found a hole of 3.3 mm at 9.66 m but ECT reported a 60-80% wall loss! This created confusion about which report is correct.

QUALITATIVE RESULTS

- The APR inspection report also indicated defects in the U-bend area whereas ECT reported the tubes as flawless.

VERIFICATION

The client verified the results by using remote visual inspection (RVI). Please see the images below.



Figure 3: APR Tube #1, 3.3mm hole at 9.66m



Figure 4: APR Tube #112, 44% wall loss (pitting) at 7.56m



Figure 5: APR Tube #120, 57.2% wall loss (pitting) at 8.15m



Figure 6: APR Tube #126, 29.4% wall loss (pitting) at 6m

CONCLUSION

APR technology was compared with ECT and verified with remote visual inspection to assess the reliability and accuracy of the results. The advantages of APR were demonstrated in the following aspects:

- 1. Speed of measurement : APR was able to quickly assess the condition of the U tube bundle in a fraction of the time ECT would have taken to inspect the bundle.
- 2. U-bend defect detection : APR was able to detect defects located in the U-bend area. ECT could not inspect the bend area.
- 3. Sizing and Location indicated : APR indicated the size and location of the defects. It was able to detect the hole, while ECT reported wall loss.

APR technology is recommended for applications such as condenser stabilizer reboilers which have defects originating from the inner diameter of the tubes and located in the U-bend. APR was proven to be useful in quickly detecting inner diameter surface defects.