

IRIS TUBE INSPECTION REPORT THE OIL COMPANY DEMOSTRATION REPORT

Client THE OIL COMPANY

Facility THE REFINERY

Item Inspected FINFAN COOLER

Inspection Method IRIS

Date Commenced 11 MARCH 2008

Date Completed 12 MARCH 2008

Type of Report FINAL

Report Number J0028-08ME



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1. Distribution of damage
2. Statistical data from the Survey.
3. IRIS Result
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5. Equipment settings

PLEASE NOTE

This report is purely for demonstration purposes only. Your final report can be adapted to your requirements. Special requests can be considered and will be subject to an additional quotation

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1.0 Test Object

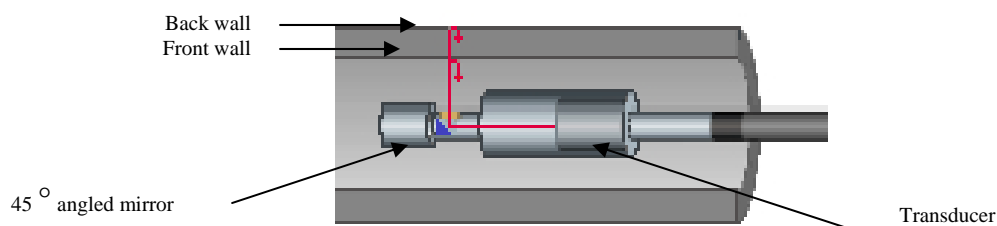
Item	:	Finfan cooler
Material	:	Carbon Steel (SA 179) with Aluminium Fin
Diameter	:	25.4mm
Wall Thickness	:	2.16mm
Tube Length	:	5.587 m
Quantity	:	180 tubes in each Bank

2.0 Inspection Task

As per instruction a Magnetic Biased Eddy Current inspection was carried out on selected 24 tubes as listed in **1.0** above.

A MS5800 Multi Function NDT system was used to affect the inspection. All tubes were recorded to disk with manual on screen analysis. A standard IRIS set-up was used to establish and verify system response while the final calibration was performed on tubes under test. A tube with known dimensions was tested and the ultrasonic measurements were cross referenced with actual measurements. The IRIS equipment set-up is given in Appendix 6.

The principles of IRIS inspection: A beam from an ultrasonic transducer is reflected from a mirror set at 45 degrees so that the reflected ultrasonic beam impinges on the tube I.D. at right angles. Part of this beam is then reflected from the tube I.D., while the remainder is transmitted through the wall thickness and is reflected from the tube O.D. The time difference between the two reflected signals is then used to measure the tube wall thickness.



Probe manipulation was carried out manually, therefore defect positions identified on any graphs (if applicable) in this report should be taken as approximate.

Purpose of the inspection was to survey for evidence of corrosion and to determine the integrity of the tubing and to monitor the general condition of the heat exchanger

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3.0 Inspection Personnel

Innospection Inspector: Andre van Vuuren: ASNT UT Level 2.
 Innospection Assistant: Arno Pretorius ASNT UT Level 1

4.0 Applicable Documentation

- Innospection procedure: - INNO T IRIS-001-09 Rev1. General procedure for the inspection of Ferrous and Non Ferrous tubing

5.0 Calibration Control

The general setting and calibration was performed at the beginning of the inspection and at the beginning of every shift.

A check of the calibration was done after any larger breaks and or changes in any equipment. All calibration data is stored digitally.

Calibration samples are used for initial set-up and also for the random check of operator settings.

6.0 Unit & Tube Identification

Bank Identification

West (Inspection Side)



Tube Identification

In order to be able to identify and locate each tube, and thereby create full traceability the grid coordinates of Row & Tube were used.

7.0 Inspection Results

Cleaning: Tubes were found to be in a good clean condition, having been cleaned by HP water jetting prior to the survey. No restricted tubes were encountered during the survey

IRIS Inspection: The inspection was carried from the West collector box. Due to the length of the tubes a flooding device was inserted approximately 25mm into the far end of the tube (East Collector box) and the IRIS turbine was inserted till it made contact the flooding device. The tube was then flooded with water and the complete section of tubing was scanned. Due to the nature of wastage that occurs in air coolers both through wall thickness and ID profile scans were monitored. During this survey only evidence of internal pitting corrosion was noted. The measured depth of these pits did not exceed 30% of ultrasonically measured wall thickness. The wastage was found to be occurring along the complete length of the tube. The Un-finned sections of tubing just behind both collector boxes were found free of any

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corrosion. As this was only a partial inspection significant wastage could have easily been missed in tubes not selected for inspection.

Tubes were classified as follows:



- Grey:** No Defect Detected
- Yellow:** Wall loss between 1 and 20%
- Green:** Wall loss between 20 and 40%
- Light Blue:** Wall loss between 40 and 60%
- Dark Blue:** Wall loss between 60 and 80%
- Red:** Wall loss greater than 80%



A tube sheet layout showing the distribution of wastage and tubes inspected is shown in Appendix 1 with statistical data presented in Appendix 2

8.0 Data Storage

This inspection data and report is stored on disk in the Innospection Limited documentation system.

9.0 Signatures



 Andre van Vuuren
 Lead Inspector

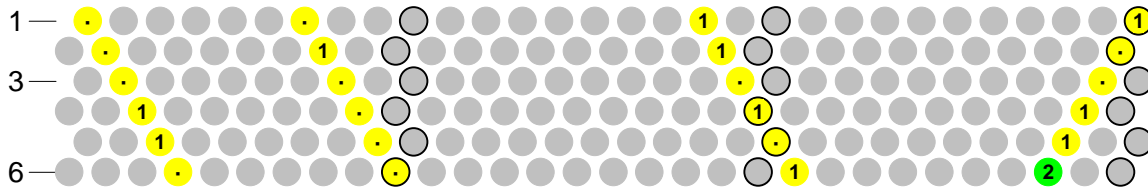


 Innospection Limited
 Mr. M. Churchill Senior Engineer
 ET PCN Level 3 (200046)
 Mike Churchill
 Senior Engineer



UNIT 51C
 Defect Picture
 final result - Diff/Abs



NORTH 03



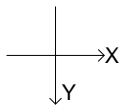
internal defects

- ① 10% - 19%
- ② 20% - 29%
- ③ 30% - 39%
- ④ 40% - 49%
- ⑤ 50% - 59%
- ⑥ 60% - 69%
- ⑦ 70% - 79%
- ⑧ 80% - 89%
- ⑨ 90% - 100%

external defects

- ① 10% - 19%
- ② 20% - 29%
- ③ 30% - 39%
- ④ 40% - 49%
- ⑤ 50% - 59%
- ⑥ 60% - 69%
- ⑦ 70% - 79%
- ⑧ 80% - 89%
- ⑨ 90% - 100%

view : OUTLET



- No defect
- Dent
- Not decideable
- Plug
- No throughpass

- R R
- T T
- W W
- Z Z
- Tube not to be inspected
- Tube to be inspected

subject : UNIT 51C

page(s) : 1 from 1

client : SAUDIARAMCO

site :

order-no. :

K.-No. :

Date : 11.03.2009

Material :

tubelength : mm

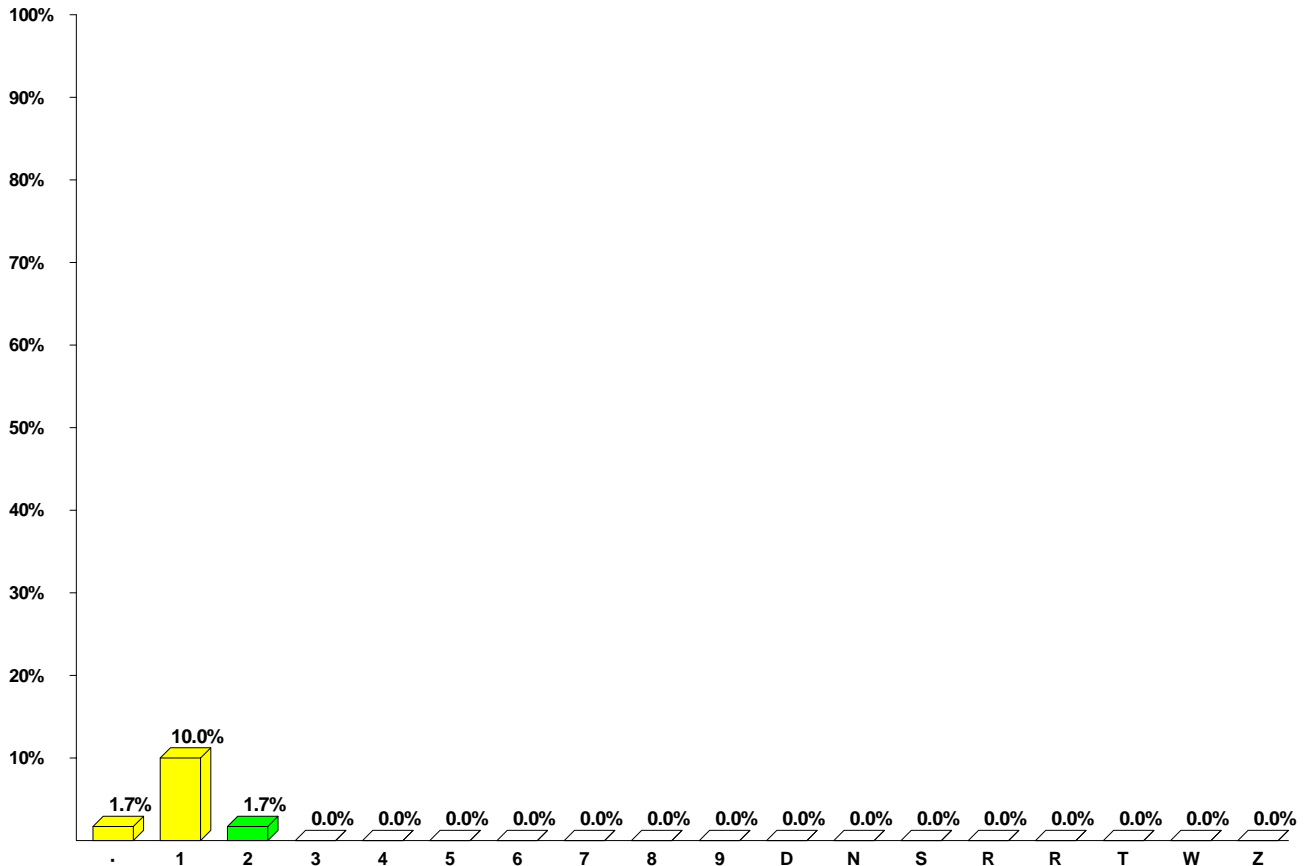
∅ external : mm

∅ internal : mm

wall thickness : mm

WinDevos Ver. 2.07.720 build 2038

UNIT 51-N2 - Statistic
final result - Diff/Abs - all section
(100% = All Tubes)



[1]: All Tubes	180			
[2]: All Tubes with Indication	21	11.7% from [1]		
[3]: All inspected Tubes	24	13.3% from [1]		
internal defects	number	% [1]	% [2]	% [3]
1 10% - 19%	18	10.0	85.7	75.0
2 20% - 29%	3	1.7	14.3	12.5
3 30% - 39%	0	0.0	0.0	0.0
4 40% - 49%	0	0.0	0.0	0.0
5 50% - 59%	0	0.0	0.0	0.0
6 60% - 69%	0	0.0	0.0	0.0
7 70% - 79%	0	0.0	0.0	0.0
8 80% - 89%	0	0.0	0.0	0.0
9 90% - 100%	0	0.0	0.0	0.0
external defects	number	% [1]	% [2]	% [3]
1 10% - 19%	0	0.0	0.0	0.0
2 20% - 29%	0	0.0	0.0	0.0
3 30% - 39%	0	0.0	0.0	0.0
4 40% - 49%	0	0.0	0.0	0.0
5 50% - 59%	0	0.0	0.0	0.0
6 60% - 69%	0	0.0	0.0	0.0
7 70% - 79%	0	0.0	0.0	0.0
8 80% - 89%	0	0.0	0.0	0.0
9 90% - 100%	0	0.0	0.0	0.0
	number	% [1]	% [2]	% [3]
● No defect	3	1.7		12.5
● Dent	0	0.0	0.0	0.0
● Not decideable	0	0.0	0.0	0.0
● No throughpass	0	0.0	0.0	0.0
● Plug	0	0.0		
● Tube not to be inspected	0	0.0		
● Tube to be inspected	156	86.7		
● R	0	0.0	0.0	0.0
● T	0	0.0	0.0	0.0
● W	0	0.0	0.0	0.0
● Z	0	0.0	0.0	0.0
● V To be plugged	0	0.0		
● X Extra to be plugged	0	0.0		

subject : UNIT 51-N2
 section : all
 client : SAUDIARAMCO
 site :
 order-no. :
 K.-No. :
 Date : 12.03.2009
 Material :
 tubelength : mm
 Ø external : mm
 Ø internal : mm
 wall thickness : mm
 WinDevos Ver. 2.07.720 build 2038

test parameter
 Operator : A van Vuuren
 equipment :
 probe type :
 calibr. tube :
 calibr. defect :
 frequency : 50.0/50.0/50.0 kHz

Plug criteria
 internal defects : From: 70%
 external defects : From: 70%

updated:
 plugged tubes: 0 0.0%
 available tubes: 180 100.0%

IRIS RESULT



MultiView R/D Tech 6.0R4 - [IDPIT1]

File View Mode Setup Operation Layout Special Help

Setup | Inspect. | Analysis

C:\Documents...\A\

- * 001005
- * 001008
- * 001030
- * 001032
- * 002002
- * 002015
- * 002020
- * 002029
- * 003001
- * 003007
- * 003016
- * 003029
- * 004008
- * 004010
- * 004025
- * 004032

Start Next

C-Scan - ID - X: 5260.11 mm dX: 3458.09 mm Y: 232.52 ° dY: 178.52 °

INTERNAL PITTING

Cursor cut: WT: 4.56 mm ID: 11.51 mm OD: 11.51 mm

ID OD

Cursor cut: WT: 0.00 mm ID: 0.00 mm OD: 0.00 mm

ID OD

Statistics

	WT	WL (%)	
	4.20	0	Report entry
	3.68	12	Report entry
	WT	ID	OD
Min.	1.65	10.72	10.72
Max.	4.83	14.28	14.28
Avg.	4.26	11.82	11.79
Nomin.	4.20	17.00	25.40

I Scale: 0a X: 0.500m Y: 180.000° Y: 0 smpl. Rot: 61.52

001005 Manual 12:29



Analysis Report

Inspection Summary

Client:	Method:	IRIS
Site:	System:	MS5800
Exchanger:	Probe:	15 mHz
Section:	Comment:	
Outage:		
Operator:		
Analyst:		
Contract:		

Results

ID	Zone	Row	Col.	Volts	Deg.	Depth	Side	Eval.	Channel	Location	Extent
1		1	5	0.000	0	9.66		COR		x:3.35 m y:171.07 °	0.000
										Comment: Wall thickness: 3.79 mm	
2		1	5	0.000	0	23.08		COR		x:2.83 m y:171.07 °	0.000
										Comment: Wall thickness: 3.23 mm	
3		1	5	0.000	0	7.87		COR		x:3.15 m y:199.28 °	0.000
										Comment: Wall thickness: 3.87 mm	
4		1	8	0.000	0	9.66		COR		x:5.12 m y:202.64 °	0.000
										Comment: Wall thickness: 3.79 mm	
5		1	30	0.000	0	12.35		COR		x:5.07 m y:226.19 °	0.000
										Comment: Wall thickness: 3.68 mm	
6		1	32	0.000	0	9.66		COR		x:4.05 m y:65.61 °	0.000
										Comment: Wall thickness: 3.79 mm	
7		2	2	0.000	0	14.13		COR		x:5.57 m y:260.37 °	0.000
										Comment: Wall thickness: 3.61 mm	
8		2	15	0.000	0	11.45		COR		x:1.77 m y:140.99 °	0.000
										Comment: Wall thickness: 3.72 mm	
9		2	20	0.000	0	11.45		COR		x:1.25 m y:201.15 °	0.000
										Comment: Wall thickness: 3.72 mm	
10		2	29	0.000	0	12.35		COR		x:1.93 m y:95.33 °	0.000
										Comment: Wall thickness: 3.68 mm	
11		3	1	0.000	0	4.64		COR		x:5.09 m y:240.03 °	0.000
										Comment: Wall thickness: 4.01 mm	
12		3	7	0.000	0	2.53		COR		x:3.26 m y:249.35 °	0.000
										Comment: Wall thickness: 4.09 mm	
13		3	16	0.000	0	10.56		COR		x:2.67 m y:219.28 °	0.000
										Comment: Wall thickness: 3.76 mm	
14		3	29	0.000	0	4.30		COR		x:2.05 m y:209.21 °	0.000
										Comment: Wall thickness: 4.02 mm	
15		4	8	0.000	0	12.35		COR		x:3.20 m y:302.59 °	0.000
										Comment: Wall thickness: 3.68 mm	
16		4	10	0.000	0	15.16		COR		x:3.16 m y:241.86 °	0.000
										Comment: Wall thickness: 3.56 mm	
17		4	25	0.000	0	10.25		COR		x:1.68 m y:152.89 °	0.000
										Comment: Wall thickness: 3.77 mm	
18		4	32	0.000	0	11.65		COR		x:3.02 m y:127.81 °	0.000

Setup Report

General informations

MultiView version:	6.0R4
Setup file:	C:\Rdtech\Mview\SETUP\QP3.set
Setup creation date:	2/25/2007
Setup modification date:	2/26/2007
Setup type:	Normal
Setup tag:	MSI
Setup description:	FINFAN
Data file:	D:\WORK IN PROGRESS
Zone:	
Row:	1
Column:	5
Summary layout type:	Universal
Measurement units:	Metric
Phase origin convention:	ASME
No defect code:	NDD
Default amplitude measurement:	Peak to peak
Default phase measurement:	Peak to peak
Save data directory:	D:\WORK IN PROGRESS\
Inspection list:	D:\WORK IN PROGRESS\
Report file:	D:\WORK IN PROGRESS\
Synchro mode:	Manual
Sampling clock type:	Internal clock
Sampling clock:	15,000.00
Sampling clock units:	samples/s
Actual sampling clock:	
Scan type:	2-axis tube
X-axis position from:	Continuous mode
Y-axis position from:	Toptour
X-axis encoder:	
Y-axis encoder:	US1T0
X-axis units:	mm
Y-axis units:	deg
Scan helicoidal:	True
X-axis from:	0.00
Y-axis from:	0.00
X-axis size:	10,000.00
Y-axis size:	360.00
X-axis resolution:	1.00
Y-axis resolution:	2.00
X-axis probe speed:	500.00
Y-axis probe speed:	0.00

X-axis probe speed units:	
Y-axis probe speed units:	
X-axis encoder preset:	Manual
Y-axis encoder preset:	Manual
X-axis preset:	0.00
Y-axis preset:	0.00
Scan direction:	Inlet to outlet
PCU version:	
PIM version:	
I/O board version:	
Alarm board version:	
Dual encoder board 1:	
Dual encoder board 2:	
Number of pod slots:	
Key serial number:	838136573
Minimum gain limit:	0.00
Maximum gain limit:	10.00
Number of EC frequency:	1
Number of EC time slots:	1
EC frequency accuracy:	10.00
EC current source:	0.00
EC interpolation:	False
Pod boards config type:	Hardware in unit
EC-Generator boards:	0
EC-Acquisition boards:	0
Quadruple encoder boards:	0
RFT, MFL boards:	0
Dual encoder boards:	0
Ultrasound boards:	0
Scanned channel landmark:	

Pod Boards

Installation Options

Option no	Option description	Key	Select
Option-01	Tube analysis and report package	Installed	True
Option-02	Report package	Not installed	False
Custom-01	Multichannel C-scan and RPC	Installed	True
Custom-02	Ultrasound	Installed	True
Custom-03	Remote field	Standard	True
Custom-04	Analog output	Standard	False
Custom-05	Analog output 32	Standard	False
Custom-06	External DDE data transfer	Standard	False
Option-03	Receive position from external program.	Standard	False
Custom-07	Analysis access package	Not installed	False
Custom-08	TC7700 Annual Calibration Kit	Not installed	False
Custom-09	CESMAN tube inspection in subs	Not installed	False
Custom-10	EddyNet	Not installed	False
Custom-11	HP-UX file system	Not installed	False
Custom-12	Cryospace inspection	Not installed	False
Option-04	EDF devices	Not installed	False
Option-05	MOD	Standard	False
Option-06	EDF headers homogeneity	Standard	False
Custom-13	Estelle	Standard	False
Custom-14	Gigadisk	Standard	False
Custom-15	Gould recorder	Standard	False
Option-07	Maxtor drive	Standard	False
Option-08	RCCA inspection	Not installed	False
Custom-16	QV Condenser	Not installed	False
Option-09	QV bobbin	Installed	False
Option-10	QV TPLR	Standard	False
Option-11	CDS support	Standard	False
Option-12		Standard	False

Eddy Current Channels

Dual Encoder Channels

Quadruple Encoder Channels

RFT, MFL Channels

Filter Processed Channels

Gain Processed Channels

Mix Processed Channels

Remote Field Processed Channels

Alarms

Alarm Outputs

Analog Outputs

Analog Output 32

C-Scan

Name	Type	Channel name	Offset X	Offset Y
ID	UT ID			
		US1T0	0.00 mm	0.00 deg
OD	UT OD			
		US1T0	0.00 mm	0.00 deg
		US1T1	0.00 mm	0.00 deg
WT	UT WT			
		US1T0	0.00 mm	0.00 deg
		US1T1	0.00 mm	0.00 deg

Analysis Codes

Code name	Measurement channel	Curve	Extension
ERO	US1T0	None	
COR	US1T0	None	

Analysis Calibration Points

Analysis Indications

Analysis Landmarks

Analysis Curves

Ultrasound Setup

Inspection method: WT/immersion
Probe name: iris
Probe frequency: 10.00
Channel number: 1
External module: False
Couplant: Water 24°C 1,483.00 m/s
Outside diameter: 25.40
Outside diameter units: mm
Wall thickness: 4.20
Wall thickness units: mm
Material: Carbon steel 5,890.00 m/s
Pulse level: 200
Trigger function: Trigger level
WT calculations: T1 - T0
Iris target gate used: True
Iris target gate from: 28.02
Iris target gate to: 29.80
Iris target gate unit: µs
180 degrees channel pairing: False

Ultrasound Channels

X (mm)	Y (mm)	Z (mm)	Delay	Pulser	Tx	Rx	G1	G2	DAC slope	DAC blank	Pulse width	Filter	Trig. start	Trig. len.	Trig. blk.	Trig unit	Trig. level
0.00	0.00	0.00	0.00	Echo	0	0	35.00	70.00	0.94	2.10	35	High pass 10 MHz	1.89	5.04	1.65	mm	22