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FAILURE ANALYSES OF A CORRODED PULSE GENERATOR

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Revisions			
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B			
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Acknowledgement/Preface

This investigation was performed by order of Sperry Sun Halliburton, Mr F. de Waal, Amperestraat 1G, 1976 BE IJmuiden, The Netherlands under ECN projectnumber 7.3330-01.

Abstract

Sperry-Sun Halliburton experienced an increased corrosion rate on 17.4PH parts of their Pulse Generator systems, with respect to previous experience. The corrosion results in leakage of hydraulic fluid and premature failure of the Pulse Generator.

Corrosion testing revealed that a potential difference exists between the corroded 17.4PH part and a Nitronic60SH austenitic stainless steel part, which it was galvanically coupled to. The 17.4PH part is the least noble in this combination. Metallographic investigation showed general corrosion of the 17.4PH part of the top end assembly. Since the 17.4PH was partly shielded leaving a small surface area exposed to the environment (mud, rich in chlorides) and the Nitronic60SH part had a relatively large surface area, it is concluded that the 17.4PH part suffered from galvanic corrosion. Another 17.4PH part, coupled to a Titanium part, showed a similar form of corrosion. Since the potential difference between Titanium and 17.4PH is higher, it is concluded that also here the 17.4PH is subjected to galvanic corrosion. Reference samples of less corroded material and environment were not available, hence the reason for the excellerated corrosion could not be determined.

During the investigation, cracks were observed in the Nitronic60SH part. The morphology of these cracks implies (stress) corrosion supported fatigue cracking. The temperature (80-120°C) and high chloride concentrations make stress corrosion possible. To determine the cause of cracks in the Nitronic60SH, a more detailed investigation needs to be performed. Since this was no subject of this investigation, this is not performed so far.

Keywords

Galvanic corrosion, Stress corrosion, Fatigue, 17.4PH, Nitronic60SH, Drilling, Pulse generator, Metallography, Corrosion testing

CONTENTS

LIST OF TABLES

LIST OF FIGURES

SUMMARY

Sperry-Sun Halliburton experienced an increased corrosion rate on 17.4PH parts of their Pulse Generator systems, with respect to previous experience. The corrosion results in leakage of hydraulic fluid and premature failure of the Pulse Generator.

ECN-TS&C Materials Technology was asked to investigate a corroded pulse generator in order to determine the nature of the attack and its cause.

A corroded pulse generator was submitted for investigation. Two 17.4PH parts show corrosive attack on surfaces exposed to mud, pumped past the surface. A sample of this mud was also supplied but was already investigated in detail. A metallographic examination was performed on the corroded top end assembly and corrosion tests were done to determine possible corrosion mechanisms.

The corroded 17.4PH parts were galvanically coupled to a Nitronic60HS part and a Titanium part. In both combinations, 17.4PH is the least noble material when exposed to the mud environment. A potential difference of 46mV was determined for the 17.4PH-Nitronic60SH combination when submerged in the mud-suspension supplied. The 17.4PH was partly shielded from the environment while the Nitronic60SH was exposed for the greater part of its surface. It is expected to result in a relative high corrosion current density on the 17.4PH part and by this to galvanic corrosion.

Since in the 17.4PH-Titanium combination an even higher potential difference is expected on the basis of the galvanic series, also for this combination galvanic corrosion is the most likely mechanism resulting in corrosive attack of the 17.4PH.

Reference samples of less corroded material and environment were not available, hence the reason for the excellerated corrosion could not be determined.

During the investigation it was observed that the Nitronic60SH part suffered from severe transgranular cracking. Considering the crack morphology, the operating temperature of 80-120°C and the presence of chloride, (stress) corrosion enhanced fatigue cracking can not be excluded. More detailed investigations are needed to determine the nature and cause of the cracking. Since it was no matter for this investigation, this was not yet pursuid.

1. INTRODUCTION

SperrySun, a Halliburton division, located in IJmuiden the Netherlands, experiences localised corrosion in specific parts of their Pulse Generator. The corroded areas were restricted to a precipitation hardened stainless steel, 17.4PH, exposed to mud which is pumped through the system. This corrosion finally results in leakage of hydraulic fluid and less performance of the probe. Up till now the corrosion rate was limited, however, lately higher corrosion rates occurred resulting in failure after e.g. 200h of operation at 120°C. ECN-TS&C-Materials Technology was asked to investigate cause of the corrosion and make suggestions to solve the problem.

2. BACKGROUND INFORMATION

2.1 Pulse generator serial number 1435

For the construction of the probe, several materials were used, Figure 2.1. A nominal chemical composition of these materials is presented in Table 2.1.

The corroded locations are indicated in Figure 2.1, while details are presented in Figure 2.2. During operation, the greater part of the corroded 17.4PH material is shielded from the environment by a nose cap and additional flow gear, see Figure 2.3. The submitted pulsar, serial number 1435, was operated for 97 below rotary hours and 60 circulation hours at an estimated temperature of 100°C. The pulse generator was operated during run 4 and 6 in well L5-B2.

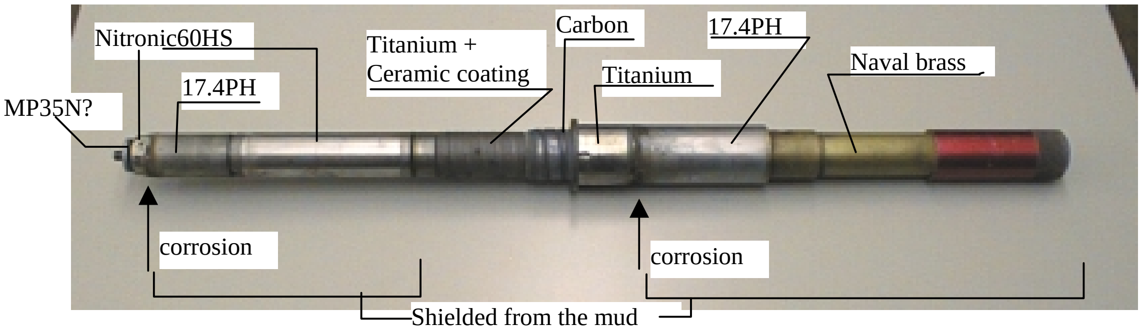

Figure 2.1 *Pulse generator in the as delivered condition, operated for 55h at 100°C. The different materials used and the corroded areas are indicated*

Figure 2.2 *Details of the corroded 17.4PH parts*

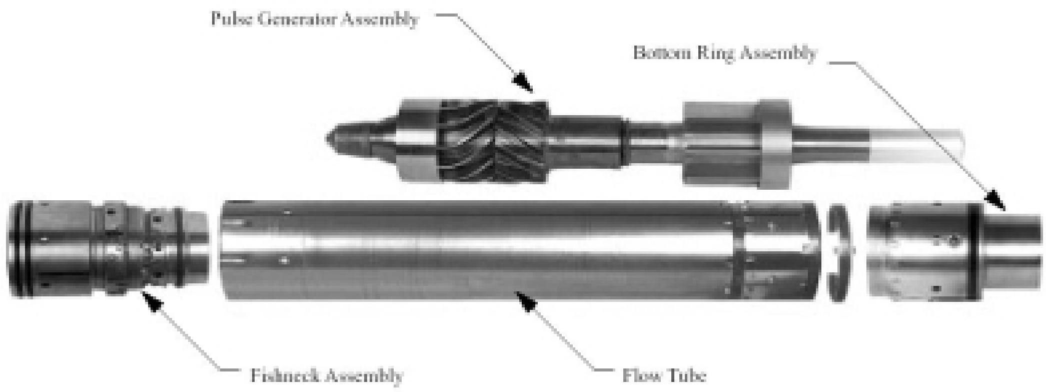

Figure 2.3 *Pulse generator as it is used, complete with nose cape and additional flow gear*

Table 2.1 *Nominal composition of the materials used in the probe of interest in the investigation*

	Alloy		
Element	MP35N	Nitronic60SH	17.4PH
C	-	Max. 0.10	Max. 0.07
Mn	-	7.00-9.00	Max. 1.00
Si	-	3.50-4.50	Max. 1.00
Cr	20.0	16.0-18.0	15.5-17.5
Ni	35.0	8.00-9.00	3.0-5.0
P		Max. 0.060	Max 0.04
S		Max. 0.030	Max. 0.03
Cu		-	3.0-5.0
Nb		-	0.15-0.45
Co	35.0	-	
Mo	10.0	-	
N		0.08-0.18	

2.2 General operating conditions submitted pulse generator

During operation a mud, containing high concentrations of chloride (Cl^-) and a pH of 6.6-6.8 is pumped along the outside of the probe. Operating temperature between 80°C and 120°C. Flow rate of the mud: 1008 gl/min. This mud has two functions:

- generating power by propelling a dynamo,
- enabling data transmission.

During operation a pulsed load is applied to the Cap Poppet Shaft F/BP-Top End and the End Plug F/BP Top End Assembly, see Appendix A. This results in a fatigue loading of these parts.

2.3 Environment

The mud is mixed with seawater during use and polluted with remnants of the drilling. The mud is recycled several times before it is disposed of and replaced by new mud.

A typical sample of the mud was supplied with the probe. This sample was identified as:

Wintershall L5-B2
MWD run 700
13-03-03
M Drilling fluids
KCl-Polymermud

A typical analyses is presented in Appendix B, mud report No. 24. Mud properties influencing the corrosive attack of materials are:

- pH: which according to the mud report No.24 is 8.5 at 20°C,
- Chloride (Cl^-) concentration: 188,000 mg/l,
- Solids: 23 %Vol (erosive),
- Sand: 0.2 %Vol (erosive).

3. EXPERIMENTAL AND RESULTS

The following investigations were performed and will be addressed here after:

- metallographic investigation,
- analyses of corrosion products,
- determination of the galvanic potential differences between materials,
- establishing normal corrosive attack after a short (6 days) immersion in the mud at 50-70°C.

3.1 Metallographic investigation

Details are presented in Figure 3.1. The metallographic investigation was limited to the Pulser Top End Assembly. For this investigation the Pulser Top End Assembly was removed from the outer pump case and the Cap Poppet Shact F/BP Top End was dismantled. All in accordance with document P01864 Rev A. A cross section was taken across the location as indicated in figure 3.1 and prepared using standard metallographic techniques. The cross-section shows the general corrosion in the 17.4PH material and several cracks in the Nitronic60SH material. These cracks appeared to be similar to fatigue cracking.

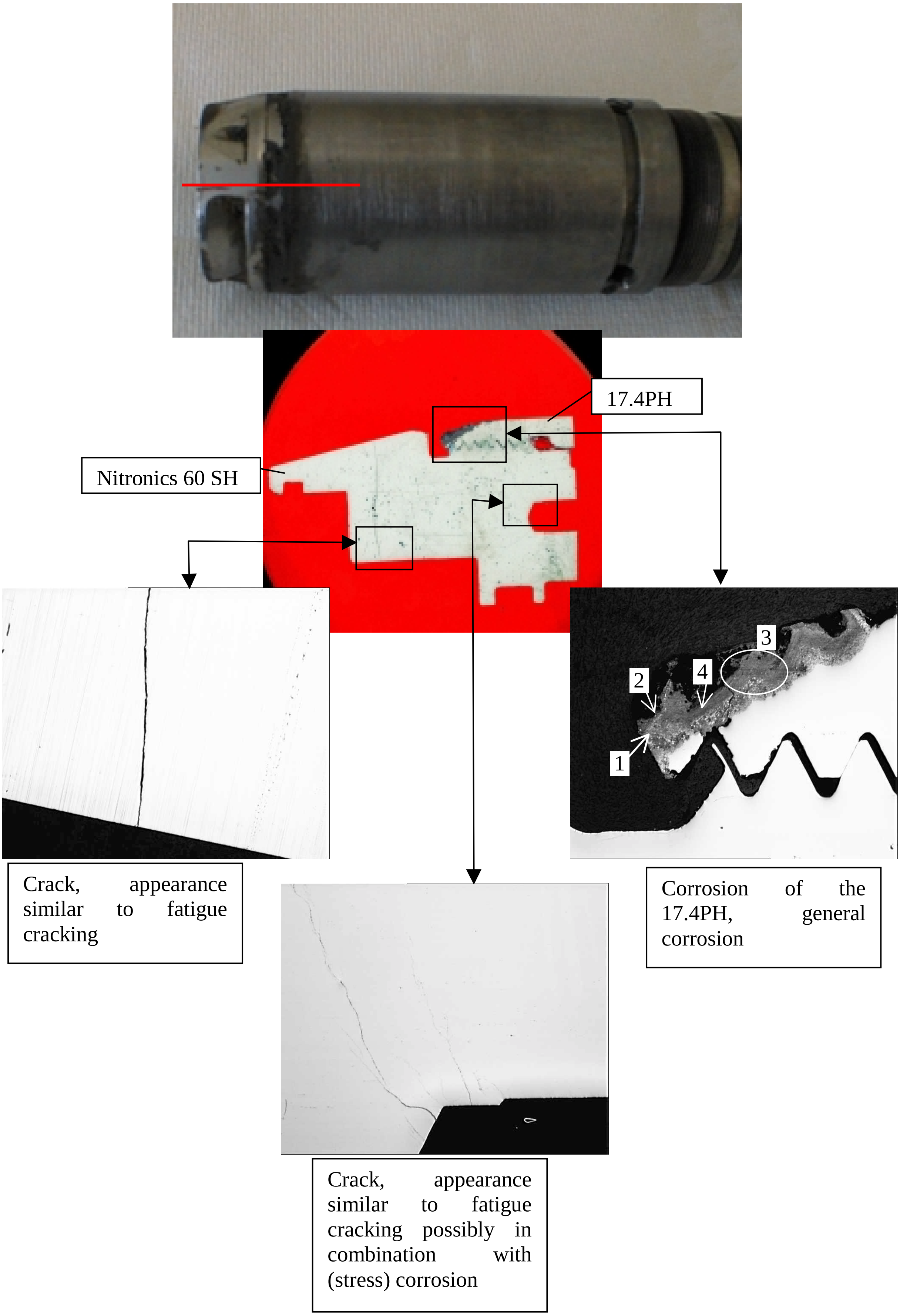

Figure 3.1 *Overview of the head of the Pulse Generator #1435 and metallographic examination*

3.2 Analyses of corrosion products.

The corrosion products as shown in Figure 2.2, were analysed (see Table 3.1). The usual corrosion products were observed, being Fe-(Cr)oxides. The high amount of Cu can be explained by the naval brass components. Possibly small particles were embedded in the corrosion product.

Table 3.1 *Analyses of corrosion products found on the 17.4PH material*

	Corrosion analyses general corrosion 17.4PH material (Locations are indicated in Figure 3.1)			
Element	Location 1	Location 2	Location 3	Location 4
O	16.39	12.54	17.73	16.15
Al	0.31	0.51	0.09	0.25
Si	0.88	1.26	1.27	6.22
P	0.08	0.00	0.09	0.43
S	0.11	0.02	0.24	0.14
Na	0.00	0.00	1.29	0.00
K	1.25	1.17	1.43	1.11
Mg	0.20	0.71	0.10	0.44
Ca	1.51	3.13	2.19	2.43
Fe	48.75	25.77	45.29	44.52
Cr	19.27	16.66	21.92	13.73
Mn	1.28	0.71	1.16	1.54
Ti	0.01	0.00	0.00	0.07
V	0.33	0.12	0.05	0.01
Cl	0.00	0.28	0.28	0.15
Ni	7.41	4.57	5.37	8.46
Cu	2.21	32.55	1.49	4.35

3.3 The galvanic potential differences between materials.

The galvanic series for metals in seawater revealed that 17.4PH material is the material with the most negative, or anodic, corrosion potential connected to the Nitronic60SH, the material with the most positive or noble potential. The galvanic potential difference is expected to be approximately 50 mV when Nitronic60SH is in passive state and 17.4PH in active state.

An electrochemical cell was set up for 4 days to determine the galvanic potential difference between the electrodes consisting of the materials Nitronic60SH and 17.4PH, while the solution contained the mud. The Electromotive Force varied in the range of 20 – 100 mV, average 46±30 mV at room temperature.

After the test, the material samples were visually examined. The 17.4PH sample showed a corrosion spot at the saw-cut of the sample, see figure 3.2. A cross-section was taken across this spot, see figure 3.3, and revealed slightly corrosive attack at this location, see figure 3.4.

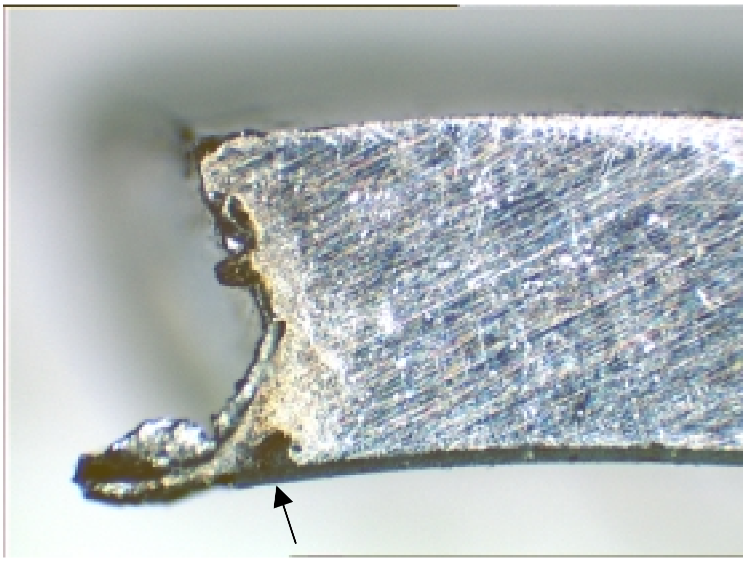

Figure 3.2 *The 17.4PH sample subjected to the electrochemical cell. The corrosion spot at the saw-cut of the sample is indicated by an arrow*

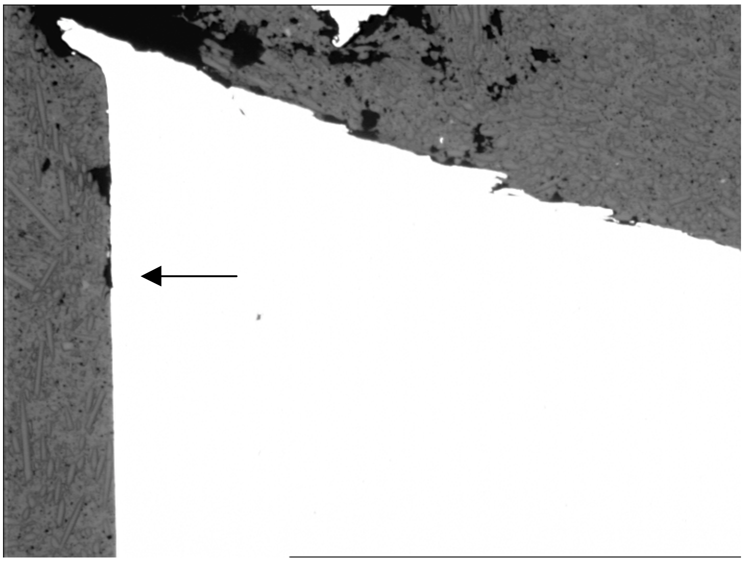

Figure 3.3 *Section across the corrosion spot of figure 3.2. Slightly corrosive attack can be observed*

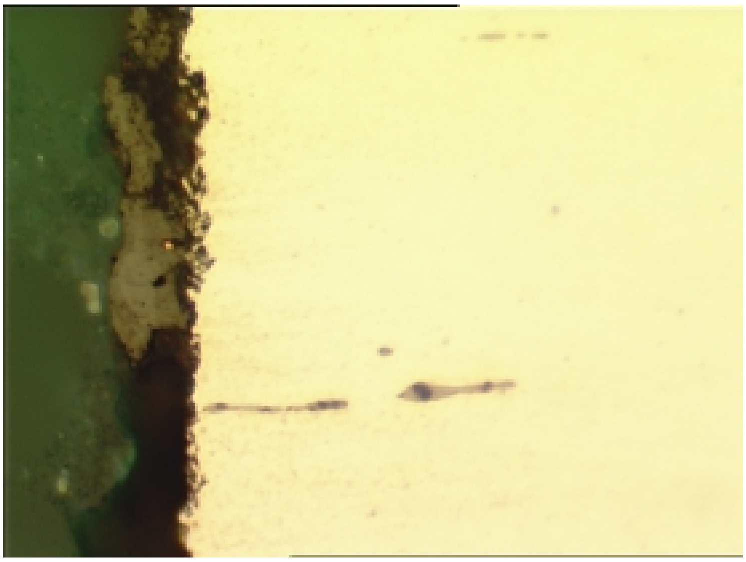

Figure 3.4 *Detail of figure 3.3 (indicated by the arrow), showing the corrosive attack at this location after 4 days of exposition at room temperature*

3.4 Normal corrosive attack due to immersion in the mud.

A sample of only 17.4PH material was subjected to the flowing mud for 7 days at the temperature of 70°C. After the test, no corrosive attack was observed at the sample.

4. DISCUSSION

The investigation of corrosive attack as a result of immersion in the mud showed that the 17.4PH material is able to resist the flowing mud.

There is a potential difference of about 46 mV between the 17.4PH and the Nitronic60SH material when coupled in a sample of the mud supplied with the pulse generator. This indicates a potential danger for galvanic corrosion of 17.4PH. The test with the electrochemical cell revealed that corrosive attack of the 17.4PH material occurs. Whether corrosion occurs and its rate depends on the corrosion current density, which depends on the ratio of the exposed surface of both materials (Nitronics 60SH and 17.4PH).

The greater part of both corroded 17.4PH parts presented in Figure 2.2 are shielded by a nose cap and additional flow gear during operation. This implies that the surface area exposed to the mud of the material with the most negative or anodic corrosion potential, 17.4PH, is much smaller than that of the material with the more positive corrosion potential, Nitronic60SH which is more noble. As a result of this phenomenon, the corrosion current density at the 17.4PH material will increase and with that the corrosion rate.

The corroded 17.4PH part of the magnet housing (2 inch case) was not investigated in more detail because destructive examination will destroy the most expensive part of the pulse generator. However, macroscopic examination revealed that the corrosion appearance is similar. Also in this case, the 17.4PH part was partly shielded, while galvanically contacted with a Titanium part. Titanium is more noble than Nitronic60SH, so it can be expected that the potential difference between the Titanium part and the 17.4PH part is higher. This increases the possibility of galvanic corrosion. Therefor it is justified to imply that also on this location 17.4PH is subjected to galvanic corrosion.

The metallographic investigation revealed that the cracks in the Nitronic60SH material appeared to be similar to fatigue cracking or (stress)corrosion-fatigue. Together with the fact that a pulsed load will be applied to these parts during operation, is it reasonable to assume that the observed cracks in the Nitronic60SH material are most probably a result of fatigue cracking. Further investigation should be necessary to confirm this statement.

Nitronic60SH is austenic stainless steel type with high Manganese and Silicon. This type of materials is inherent sensitive to stress corrosion in Chloride containing environments. So, stress corrosion can not be ruled out completely, since high Chlorine concentrations are present, the temperature is above the critical value of 50°C for stress corrosion and high stresses might be introduced during operation, pulsation. To determine the occurrence of stress corrosion, more research is needed. This was not performed in this investigation, since this investigation was focussed on the corrosion of 17.4PH.

No reference samples of less corroded 17.4PH material and the environment were available. Therefore, the reason for excellerated corrosion could not be determined.

5. CONCLUSIONS

- 17-4PH suffered from a general corrosive attack on areas exposed to the mud.
- A potential difference between 20-100 mV, average 46±30 mV, exists between the coupled 17.4PH and Nitronic60SH when coupled in the mud suspension, in which the 17.4PH is the anodic alloy and has a low surface area exposed to the mud compared to the Nitronic60SH which is cathodic (noble). This will result in a relatively high corrosion current density and so a relatively high corrosion rate of the 17.4PH.
- 17.4PH proved to be resistant in a 7 days exposition test at 70°C in flowing mud, when 17.4PH was exposed.
- 17.4PH is subjected to galvanic corrosion when submerged in the mud and coupled with Nitronic60SH.
- To prevent galvanic corrosion, 17.4PH is to be disconnected from the Nitronic60SH or to be replaced by this alloy or vice versa.
- Corrosion of the 17.4PH part of the magnet housing (2-inch case) is most likely caused by galvanic corrosion, since it is coupled to a noble Titanium part.
- The Nitronic60SH housing seal pack F/BP top end shows heavy cracking. The exact cause of cracking is still unknown, but appears to be related to fatigue or (stress) corrosion-fatigue.

6. RECOMMENDATIONS

- The cause for excellerated corrosion of the 17.4PH material as reported by Halliburton could not be identified, since reference samples were not submitted. Hence, to determine the cause for excellerated corrosion, it is recommended to investigate:
  - old, lesss corroded, probes
  - different samples from the environment.

  These should be investigated for differences enhancing corrosion, like:
  - microstructure, indicating different heat treatment,
  - chemical compositions, Cr, C content,
  - Oxygen concentration, pH, conductivity of the environment.

APPENDIX A BALANCED PISTON TOP END ASSEMBLY (P/N 046842)

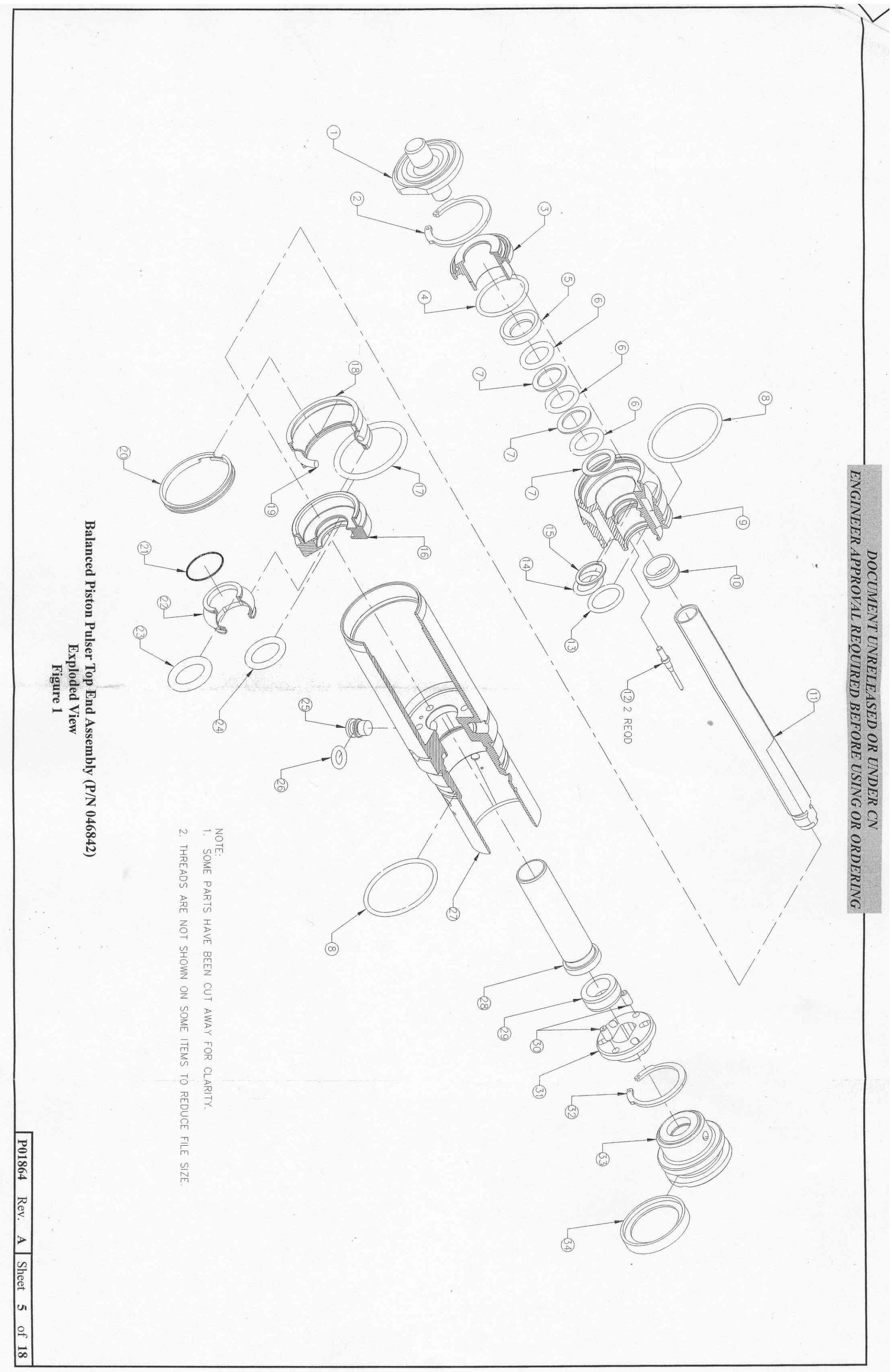

Figure A.1 *Piston Pulser Top End Assembly (P/N 046842)*

Balanced Piston Pulser Top End Assembly (P/N 046842)
Figure A-1
Exploded View Parts List

1. Cap Poppet Shaft F/BP Top End	046852
2. Ring Retainer Truarc 5008-112C	046895
3. Housing Seal Pack F/BP Top End	046851
4. O-Ring 568-019 Flo 90 DR	037710
5. Shaft Wiper FIBP Top End	046896
6. O-Ring 568-111 Flo 90 DR V23	046856
7. Ring Backup F/111 O-Ring	046855
8. O-Ring 568-025 Flo 90 DR V23	046857
9. End Plug FIBP Top End Assembly	046848
10. Bushing Upper for BP Impregnated	047860
11. Shaft Poppet FIBP Top End	046850
12. Pin Piston Limit	047548
13. O-Ring 568-015 Flo 90 DR	016684
14. O-Ring 568-013 Flo 90 DR	001202
15. Ring Backup F/O13 O-Ring PPT	047547
16. Piston Compensation FIBP	046847
17. O-Ring 568-122 Flo 90 DR "	038399
18. Bladder Shaft Housing FIBP Top End	046893
19. O-Ring 568-215 Flo 90 DR	02806
20. Spring Retaining FIShaft Housing Bladder	046894
21. Spring Garter Inconel FIBB	047823
22. Bladder Guide Sleeve FIBP Top	046859
23. O-Ring 568-207 Flo 90 DR	040069
24. O-Ring 568-113 Flo 90 DR	038553
25. Plug Fill Port FIBP Top End	046858
26. O-Ring 568-008 Flo 90 DR	000880
27. Poppet Shaft Housing BP Pulser	046843
28. Guide Sleeve	046844
29. Bushing Lower for BP Impregnated	047861
30. Pin Antirotation PPT Pulser	047541
31. Sleeve Antirotation FIBP	046846
32. Ring Retainer Truarc 5008-106C	047542
33. Piston Modified FIBP Top End	046853
34. Seal Special Composite	803732

PO1864 Rev. A

APPENDIX B WATER-BASED MUD REPORT NO. 24

Drilling Fluids

WATER-BASED MUD REPORT No. 24

Operator :	Wintershall	**Field/Area :**	L-field	**Depth/TVD :**	2856 m / 2740 m
Report For :	R. van Doorne	**Description :**	Development	**Date :**	05/03/2003
Well Name :	L5-B2	**Location :**	Offshore Netherlands	**Spud Date :**	13/02/2003
Contractor:	Noble	**Water Depth :**	36.7 m	**Mud Type :**	KCl/NaCl/Pol. Mud
Report For :	M. Spittle	**M-I Well :**	0	**Activity :**	Run 9 5/8" Casing

DRILLING ASSEMBLY	CASING
2802 m, 9.625-in Casing	30-in @131 m (131 TVD) 13.375-in @1768 m (1752 TVD)

MUD VOLUME (bbl)	
Hole	Active Pits
1264.3	476.7
Total Circulating Volume	1712.6
Depth Drilled Last 24 hr	m
Volume Drilled Last 24 hr	bbl

CIRCULATION DATA		
Pump Make	NATIONAL 1700 PT	NATIONAL 1700 PT
Pump Liner x Stk	5.5x12 in	5.5x12 in
Pump Capacity gal/stk	3.591	3.591
Pump stk/min	0@97%	0@97%
Flow Rate	gal/min	
Pump Pressure	psi	
Bottoms Up		
Total Circulation		

MUD PROPERTIES

Sample From		Pit 15:00				
FlowLine Temp	°C					
Depth/TVD	m	2856/2740				
Mud Weight /Temp	lb/gal	12.8@20				
Funnel Viscosity	s/qt	61				
Rheology Temp	°C	50				
R600/R300		51/35				
R200/R100		27/20				
R6/R3		7/4				
PV	cP	16				
YP	lb/100ft²	19				
10s/10m/30m Gel	lb/100ft²	4/7/				
API Fluid Loss	cc/30min	7.5				
HTHP Fluid Loss	cc/30min	.0@				
Cake API/HT	1/32"	1/				
Solids	%Vol	23				
Oil/Water	%Vol	/77				
Sand	%Vol	0.2				
MBT	lb/gal	5				
pH / Temp		8.5@20				
Alkal Mud (Pm)		0				
Pf/Mf		.05/.20				
Chlorides	mg/L	188000				
Hardness (Ca++)		560				
Reserve Volume	bbl	477				

PRODUCTS USED Last 24 hr

Products	Size	Amount
BARITE	1 MT BK	5
ENGINEER LEAD	1 EA	1
SALT	25 KG BG	90

SOLIDS CONTROL EQUIPMENT Last 24 hr

Type	Model/Size	Hrs Used
524 Centrifuge		
524 Centrifuge		
D-Sander		
VSM 300	20/20/30/120/120/1	
VSM 300	30/30/30/120/120/1	
VSM 300	20/10/10/120/120/1	

MUD PROPERTY SPECS		Actual
Weight	9.5-13.5	12.8
Viscosity	ALAP	61
Filtrate	max 10	7.5

REMARKS AND TREATMENT

Received sacks of NaCl from the Field Express. Used 90 sacks of Salt and 5MT of Barite for cementing. No chemicals were used on drilling fluids on todays report.

REMARKS

RIH clean out assy and flush MLS area. R/U Wheaterford and run 9 5/8" casing TO 2802m.

TIME DISTRIBUTION Last 24 hrs	
Rig Up/Service	
Drilling	
Tripping	0.5
Reaming	
Circulate B/U	
Logging	
Other	
Running Casing	20.75
Wear bushing	0.5
MLS	2.25

MUD VOL ACCTG (bbl)	
Oil Added	
Water Added	
Mud Received	
Mud Returned	
Disposed	
Shakers	
Evaporation	
Centrifuge	
Formation	
Left in Hole	
Other	34

SOLIDS ANALYSIS (%/lb/bbl)	
NaCl	5.9/ 60.5
KCl	4.1/ 36.8
Low Gravity	3.7/ 33.6
Bentonite	.2/ 2.1
Drill Solids	2.9/ 26.5
Weight Material	9.2/ 135.9
Chemical Conc	- / 5.
Inert/React	4.7132
Average SG	3.76

RHEOLOGY & HYDRAULICS	
np/na	0.543/0.459
Kp/Ka	1.262/2.019
Bit Pressure Loss %	
Bit HHP/HSI	
Jet Velocity	
Va Pipe	
Va Collars	
Cva Pipe	85
Cva Collars	85
ECD at Shoe	12.8

M-I Engineer	RIG PHONE	DAILY COST Chem&Fluid	DAILY COST Eng	CUMULATIVE COST Chemical & Fluid	CUMULATIVE COST Total
Marc Eigner	072-5408663	€1,085.40	€655.00	€245,059.27	€260,779.27

WELLSITE CHEMICAL INVENTORY

Daily Report

Operator : Wintershall
Well Name : L5-B2
Location: Offshore Netherlands

Date : 05/03/2003
Report No: 24
Page 1

Cost Summary

Total Daily Cost:	1740.40
Cumulative Cost:	260779.27

Product	Unit Size	Unit Price	Start Amount	Daily Used	Cum Used	Daily Rec'd	Cum Rec'd	Daily Return	Cum. Return	Final Stock	Daily Cost
BARITE	1 MT BK	136.08	175	5	202		322			170	680.40
BENTONITE	1 MT BK	178.35			78		69				
CALCIUM CHLORIDE	25 KG BG	10.29									
CALCIUM CARBONATE FIN	1000 KG BG	112.69									
CALCIUM CARBONATE ME	1000 KG BG	134.50									
CALCIUM CARBONATE CO	1000 KG BG	134.50									
CAUSTIC SODA	25 KG CN	25.00			32		32				
CITRIC ACID	25 KG BG	38.60	15							15	
CONQOR 404	55 GA DM	1148.00	4		4		8			4	
DEFOAMER	25 LT CN	59.00			13						
DRILLZAN D	25 KG BG	348.45	9		31		40			9	
EMPAC TLV	25 KG BG	99.00	80		120		200			80	
FLOVIS	25 KG BG	469.00									
POTASSIUM CHLORIDE (BI	1000 KG BG	215.31			8		8				
POTASSIUM HYDROXIDE	25 KG BG	26.00	3		37		40			3	
KWIKSEAL	40 LB BG	26.00	50				50			50	
LIME	25 KG BG	4.60	4		46		50			4	
MICA	25 KG BG	10.50	72		38		110			72	
MIKHART	25 KG BG	4.78	99		51		150			99	
SODIUM CHLORIDE	1250 KG BG	131.25			8		8				
NUT PLUG	25 KG BG	10.50	90				90			90	
PHPA (4PPB)1	1 BL TK	27.85			1289		1289				
POLYPLUS RD	25 KG BG	92.00					36		36		
POLYPAC	25 KG BG	108.25	70		50		120			70	
RIGWASH	55 GA DM	520.00									
SAFECIDE	25 LT CN	88.50	7		7		14			7	
SAFESCAF	1000 LT TK	1800.00			2		2				
SODA ASH	25 KG BG	8.35	59		29		88			59	
SODIUM BICARBONATE	25 KG BG	8.25	12		16					12	
ULTRAPLUG	25 KG BG	210.00	80				80			80	
ULTRAPLUG XCELERATOR	25 KG BG	98.00	40				40			40	
BENTONE 38	25 KG BG	113.50									
VERSA E MUL	55 GA DM	555.00									
VERSASURF	55 GA DM	395.00									
VERSATHIN	55 GA DM	898.00									
VERSATROL NS	25 KG BG	49.50									
VERSAMOD	55 GA DM	345.00									
VERSA SWA	55 GA DM	950.00									
ENGINEER LEAD	1 EA	655.00		1	24	1	24				655.00
KCl/NaCl-Brine	1 BL BL	8.80			1258		1258				
PHPA (1.5PPB)	1 BL EA	27.05			1220		1220				
KCl/NaCl-Mud	1 BL EA	23.15			1292		1292				
FLOWZAN	25 KG BG	389.00	15		29		44			15	
BASE OIL	1 BL BL	84.00	84							84	
Versaclean OBM	1 BL BL	79.38									
SALT	25 KG BG	4.50		90	90	120	120			30	405.00
SAFESURF	1 BL DM	945.00									
CONQOR 303	55 GA DM	398.00									
CALCIUM CHLORIDE BRINE	1 CM TK	111.00									
WELLCLEAN	55 GA DM	1595.00									
HEC	25 KG BG	259.00									
EMI-530	55 GA DM	987.00									
PHPA (4PPB)2	1 BL EA	34.00			1137		1137				
DRISCAL D	25 LB BG										