RELIANCE INDUSTRIES LIMITED
HAZIRA

TRAINING MODULE

On

MECHANICAL SEALS
In Centrifugal Pumps

Based On Failure Analysis Reports

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CES-Planning

MECHANICAL SEALS

INDEX

MECHANICAL SEALS

INTRODUCTION :

In process industry, reliability of rotating equipment's such as pumps, compressors, agitators, mixers etc., is of utmost importance, which depends largely on the ability to avoid leakage through shafts. The industry spent well over a billion dollars annually world over in maintenance of rotating equipment's and a substantial amount of this expenditure was leakage through shafts related. Mechanical seals play an important role in avoiding leakage.

In general today the process industry is demanding in terms of requirements for safety and component reliability that the industry is increasingly conscious of the need for safer improved performance of mechanical seals.

It is important that the mechanical seals are properly maintained by users / operators. Therefore it is important that a thorough functional understanding, installation requirement and failures of mechanical seals. Here an attempt has been made to compile the various failures that are encountered with mechanical seals by consolidating failure analysis report on mechanical seal failures in the complex. The study of this report and understanding the reason of seal failures will help to great extent, in avoiding premature failure of mechanical seal and costly shutdown of equipment's and in case of critical equipment's, the plant.

Struggling to meet ever-tightening, stringent emission regulations, hydrocarbon processing plants are evaluating all possible alternatives that can cut or eliminate fugitive releases. Nearly 70% of centrifugal pump maintenance is due to mechanical seal failures, a leading contributor to fugitive emissions. The new standard-API 682 was developed to set guidelines that dictate mechanical seal performance and specifications. API-682 defines centrifugal seal-sealing system performance and design criteria that will improve reliability and increase pump-seal life.

MECHANICAL SEALS

BASIC FUNCTIONS OF MECHANICAL SEALS :

Mechanical seal is one of the technique to seal the gap formed between a rotary shaft and a stationary stuffing box. This situation is mostly commonly encountered in centrifugal pumps. Mechanical seals are used to prevent leakage of gases and liquids in rotating shaft applications that exceeds the capabilities of radial lip shaft seals and packing. A rotating face forms a seal with a mating face or mating ring. Successful operation depends on maintaining a thin lubricating film of fluid between the faces.

Mechanical seals can withstand high operating pressure, temperature and shaft speeds and give longer life with less leakage than packing and radial lip seals. The initial cost of mechanical seal is high as compared to soft packings. However the power consumed, maintenance and down time spent in renewing or tightening the packings overweigh the initial cost of mechanical seals, which works unattended for a long time. From the ecological point of view also seals are preferred over packings. Mechanical seals functions, statistically and dynamically, can withstand large pressure changes, are compatible with many fluids and will function in applications where shaft rotation changes directions.

Mechanical seals of conventional design and material can be selected to function at pressures up to 200 atmosphere, at speeds up to 50,000 rpm and with a temperature ranging from -200 deg C to 650 deg C.

MECHANICAL SEAL COMPONENTS :

The Basic components in a mechanical seals include the following

1. A stationary sealing face.
2. A Rotating sealing face
3. A Static secondary seal for stationary face.
4. A Static secondary seal for rotating face.
5. A spring or a bellow to press the sealing faces together.
6. A system to flush seal area.
7. A method to prevent slippage of sealing faces (Keyways, pins or secondary seal friction).

In a simple mechanical seal the rotary sealing face acts as the primary sealing ring and stationary sealing face as mating ring. The primary seal ring is flexibly mounted in the seal head assembly which rotates with shaft and the mating ring is mounted on the pump gland plate. The seal head assembly consists of the method of driving and the method of pressing the two seal ring faces axially. The secondary seals (elastomers) is installed in the confined space between rotating seal ring and shaft or sleeve, and in the confined space between stationary ring and gland plate.

MECHANICAL SEALS

ADVANTAGES / DISADVANTAGES OF MECHANICAL SEALS :

Some of the advantage and disadvantage of mechanical seals over conventional packings and lip seals are listed below.

Advantages :

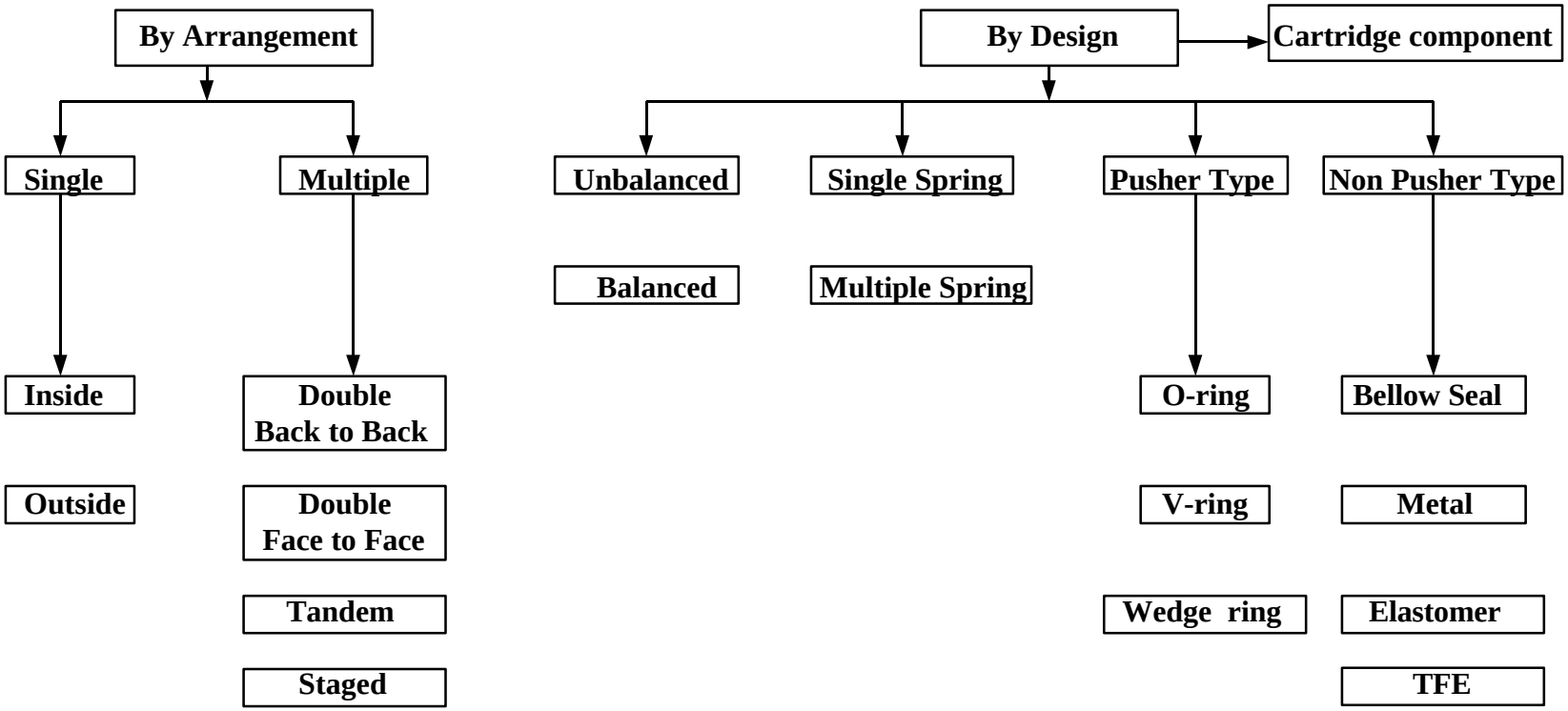
1. Handles all types of fluids (Acids, salts and abrasive particles)
2. Handle slightly misaligned / non concentric
3. Handle Bi-directional shaft rotation, large pressure, temperature and speed excursions.
4. Shaft condition is not critical (Finish roughness, roundness, hardness and material)
5. Operation does not cause shaft wear.
6. Long operating life.
7. Positive sealing for food processing, hazardous chemicals and radioactive fluids.

Disadvantages :

1. Requires more space than radial lip seals.
2. Cannot handle axial end play.
3. Sealing faces must be finished smooth (0.08 to 0.4 micrometer) and can get easily damaged.
4. High initial cost.

MECHANICAL SEALS

CLASSIFICATION OF MECHANICAL SEAL DESIGNS :



MECHANICAL SEALS

CLASSIFICATION OF MECHANICAL SEAL DESIGNS (Contd.) :

A. SINGLE SEAL :

90% of the installations are of single seal type. Single seal is the most economical sealing device among mechanical seals as it has minimum number of parts. Further generally pumping fluid is used for seal lubrication.

Generally in single seals the pumped fluid should be cool, non volatile, have good lubricity, not contain abrasive or dissolved solids. If the pumped fluid is not satisfactory as a sealing fluid, an auxiliary fluid can be injected across the seal face.

The limitations with single seals is that, in case seal leaks there is no back up available. Also system upset causes the flashing of liquid and flashing causes damage of faces.

a) Inside Seal :

Figure 1 illustrates a single inside mechanical seal. The material of construction for the inside seal are selected to withstand corrosive liquids in the stuffing box. Inside seals requires a suitable stuffing box housing for installation and cannot be adjusted without dismantling the equipment unless they are cartridge mounted. In inside mounted seals the fluid under pressure acts with spring load to keep the seal faces in contact. Inside seals are easily modified to accommodate environmental controls and can be balanced to withstand high stuffing box pressures.

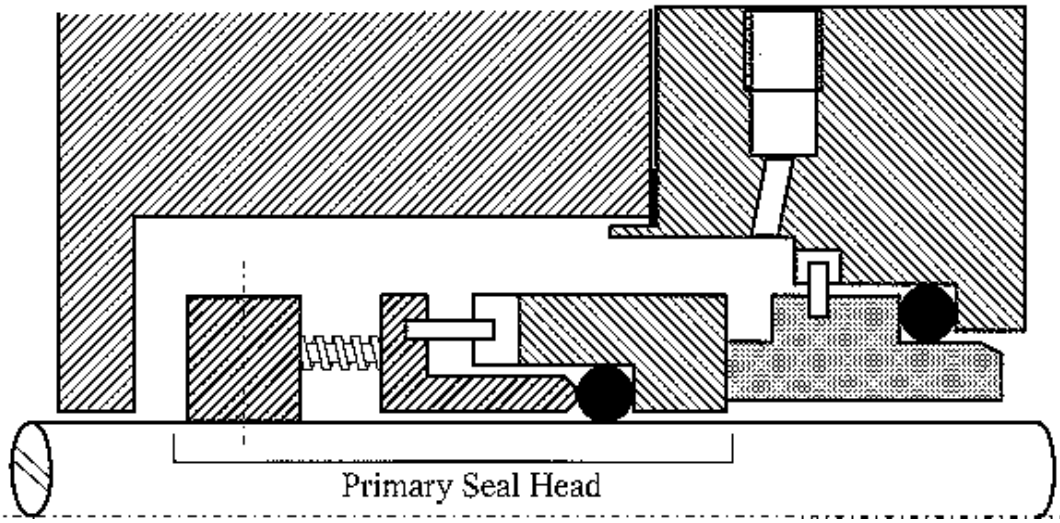
There are many advantages of locating seals inside. The liquid pressure acts on the OD of the seal. The pressure acts to force the seal faces together. Solids are thrown away from the seal faces by centrifugal force. Seal force leakage is opposite direction to centrifugal force. The seal is submerged in the liquid making it easier to flush and carry away heat.

b) Outside Seal :

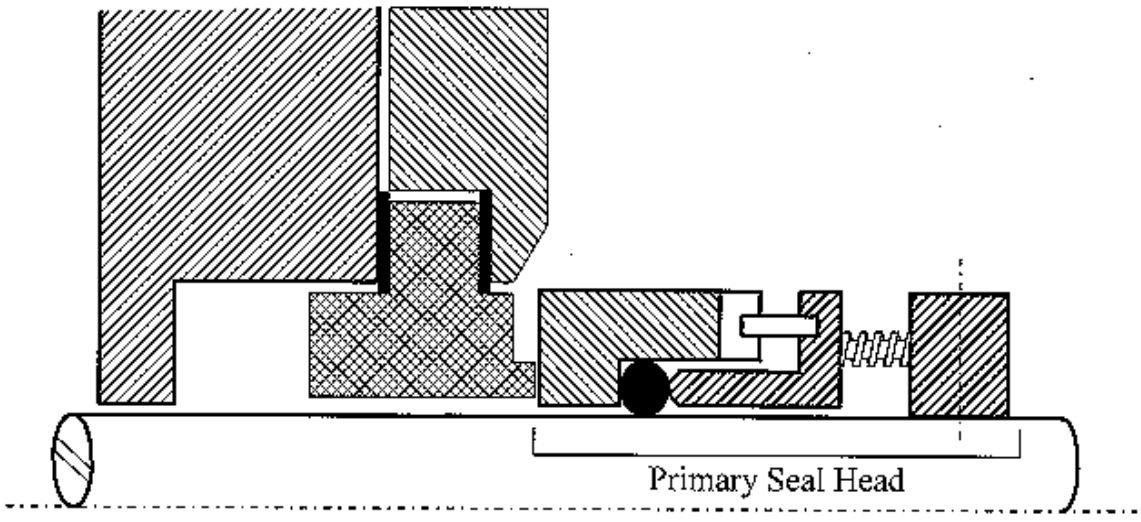
If an extremely corrosive liquid has satisfactory lubricating properties, an outside seal offers an economical alternative to the expensive metallurgy's required for an inside seal to resist corrosion. Seals are mounted outside in little pumps that have no room inside for a seal. **Figure.2** shows a typical outside seal arrangement in which only the insert seal ring and secondary seals are exposed to the product. All these components can be non-metallic. The metallic rotary unit parts are exposed to the atmosphere.

The outside seals are easier to access for adjustment and trouble shooting. The disadvantages being, it is difficult to flush this seal. The service must be free

Single Inside Mechanical Seal



Single Outside Mechanical Seal



of solids which might collect under the seal. The hydraulic pressure in an unbalance outside seal tends to open, rather than to close the seal faces. All outside seals are limited to applications having moderate pressures.

B. MULTIPLE SEAL :

Some fluids are not compatible with a single mechanical seal. Often these liquids carry abrasive material in suspension that would rapidly wear the seal faces or the liquid may be corrosive and hazardous. There are two solutions to this problem. One is the application of environmental controls and the other is the use of Multiple seals or double seals.

A multiple seal may be mounted as double - Back to back, double - face to face or tandem arrangement.

a) Double - Back to Back seal :

Figure 3 illustrates a typical double- back to back seal arrangement. A clean and non-corrosive liquid called barrier fluid is injected in the cavity between the inboard and outboard seals at a pressure higher than the product being pumped. In this design the buffer fluid prevents the product from contacting the inner portion of the seal and provides lubrication to both seal faces. The inboard seal prevents the buffer fluid from entering the pump where the outer seal prevents the buffer fluid from escaping to the atmosphere. The double seal is unaffected by the product being pumped.

The life of double back to back seal can be up to five times that of a single seal in certain severe environments. Both inboard and outboard seals can be either balanced or unbalance depending upon the pressure encountered. Back to back seal does not tolerate the pressure reversals. Pressure upsets can result in a seal failure. It can not be bench tested, hence seal performance cannot be verified until it is actually assembled in the pump.

b) Double - Face to Face Seal :

The double face to face seal is usually cartridge mounted with one seal inside the stuffing box and one seal on the outside. Both seals rotate against a common or separate stationary insert. **Figure 4** represents a double face to face cartridge seal. Face to face seal can be used as either a tandem seal or a double seal. If the liquid between the seals is at higher pressure than the product in the stuffing box, the inner seal is lubricated by a sealing liquid. If the liquid is circulated between the seals at a lower pressure than the stuffing box pressure, the purpose of the inner seal is same as that of any single seal and the outer seal simply serves as a back up or a tandem seal.

This seal is compact and can be bench tested using air as a buffer fluid before assembly. Pressure reversal will not cause it to blow up. The main limitation is in the exposure of inner seal to the product. Viscous, abrasive, thermosetting or corrosive products can damage the inner seal and cause leakage.

c) Tandem Seal :

The purpose of this seal is not to create an artificial environment as is the case with double seal, but to provide a back up seal in the event of inner seal failure. A typical tandem seal is illustrated in the **Figure. 5** . The inner seal functions similar to a conventional single seal. The cavity between inner and outer seal is flooded from a closed reservoir, which provide lubrication to outer seal. The inner seal is lubricated by the product. If the inner seal fails, the resulting pressure rise in the area between seals is sensed at the reservoir, where it can be either registered on gauge or activate an alarm. In any event, failure of the inner seal can be detected while the outer seal assumes the responsibility of sealing the shaft until pump is taken for seal repair. Hence reliability of tandem is high compared to other seals.

C. BALANCED :

Balancing seal involves a simple design change which reduces the hydraulic forces acting to close the seal faces. As seal faces rub together excessive heat is generated. This heat can be removed by increasing the lubrication between the faces. Lubrication can be increased by reducing the effect of seal cavity hydraulic pressure on the seal faces. This is done usually by building a step in the sleeve which allows the wear nose of stationary insert to be moved toward the centre of the seal. More of the seal face is thus exposed to the seal chamber pressure which in-turn reduces the forces acting to close the seal faces.

Because balanced seal enable seal face contact pressure to be kept low, a thicker film of stable liquid can exist between faces, reducing friction and the consequent heat generation. Normally a balanced seal is designed to operate with the lowest face pressure that will effectively prevent leakage between the faces.

D. UNBALANCED :

Unbalanced seals are often the design of choice for inside seals. In unbalanced arrangement, all of the seal face contact area lies outside of the shaft diameter. The amount of seal face leakage is inversely proportional to the amount of seal face loading. Higher the loading, the lower is the leakage. Unbalanced seals are having higher face loading than balanced seals, leak less and are more stable when subjected to vibration, misalignment or cavitation. They are often less expensive and more adaptable to standard stuffing boxes without need for modification of either the shaft sleeve or the stuffing box.

One of the disadvantage of an unbalanced seal is its relatively low pressure limit. If the closing force exerted on the seal face exceeds that limit, the lubricating film between the faces is squeezed out and soon the faces get destroyed. This problem is overcome by balancing seals.

E. SINGLE AND MULTIPLE SPRING DESIGN :

The single spring is less critical in its compression setting. This makes it a good choice for pumps which have a lot of thermal expansion, with the impeller between the bearings. The single spring is less prone to clogging in dirty service.

Multiple springs are small springs and are not susceptible to distortion at high speeds and exert even closing pressure on the seal ring at all times. The same size spring can be used in a range of seal sized just by varying quantity.

F. PUSHER AND NON-PUSHER TYPE :

Pusher seals have a dynamic secondary seal under the movable seal ring. The dynamic seal ring can take several forms like., 'O' ring, Teflon 'V' ring, wedge ring, 'U' cup etc.,. For high temperature (upto 500 deg.F) or aggressive chemicals a Teflon wedge ring may be used. Since Teflon is plastic and does not rebound like elastomer, it has to be pushed by spring force into the wedge shaped opening to maintain a seal on the shaft.

Non-Pusher type or Bellow seals have no dynamic secondary seal under the movable seal ring. This makes them more flexible and better able to tolerate mating ring misalignment.

The bellows can be made of rubber, Teflon and metal. Rubber bellows are used for less critical applications like car water pumps, circulating hot water pumps etc., Teflon bellows are used for low pressure, moderate temperature acid services. Metal bellow seal is its ability to run at a very high temperature (750 degF) if the elastomer 'o' rings are replaced with grafoil for the secondary seals. The use of bellow seal is limited to 400 PSI on OD.

G. CARTRIDGE SEALS :

Nearly all mechanical seals can be provided in a cartridge design. The seal is mounted usually with a gland ring on a sleeve which fits directly over the equipment shaft or shaft sleeve. Major benefit of cartridge seal is that they do not require the usual seal setting measurement for their installation. Cartridge seals are used to reduce installation errors and turn around time for repair. This optimum seal solves five common causes of component seal failure.

Sr. no	Component Seal failure Mode	Cartridge Seal solution
1	Improper axial positioning of rotary due to mis-measurement during installation	NO measurement is required for positioning seal parts.
2	Many stationary faces are not centred and therefore rub against the shaft	Centring device assures concentricity around the pump shaft.
3	Misaligned stationary faces cause excessive axial movement of rotary unit damaging seal and pump sleeve.	Stationary seal design virtually eliminates axial movement of faces, spring and O-ring
4	Most component seals are low cost commodity items using inexpensive materials subjected to high erosion, high corrosion and general breakdown.	Seals use high grade face materials and metallurgy's as standard.
5	Measuring and centring require excessive handling of parts which can distort, mis-position or damage individual parts	Factory pre-assembled cartridge eliminates handling of individual parts.

FACTORS AFFECTING THE SELECTION OF MECHANICAL SEALS

1. Media Handled :

- Corrosiveness of media decides the material of construction.
- Density of viscosity shows the lubricating properties of the media. This decides the seal arrangement.
- Abrasives in the media decides the type of flushing plan required.

2. Stuffing box pressure :

- When stuffing box pressure < 10 kg. / cm2, unbalanced seals are used.
- When stuffing box pressure . 10 Kg. / cm2 , balanced seals are used.

3. Shaft Speed :

- With increase in speed the chance of seal running dry increases. So proper flushing plan has to be decided which can give positive flush between the faces.

4. PV Factor :

- PV factor is defined as the product of the pressure drop across the seal and the average rubbing velocity. As a general guide, Seal capabilities can be classified as,

Low , if the PV value is 0.7 MPa m/s (about 20,000 psi ft/min)
Medium, if the PV value is between 0.7 and 10 MPa m/s (about 285,000 psi ft/min)
High , if the PV value ranges from 10 to 70 MPa m/s (about 2,000,000 psi ft/min).
Balanced seals reduce the pressure acting on the seal faces, therefore they have higher PV values than unbalanced seals.

5. Temperature :

- This decides the material of construction so that the seal does not fail at operating temperature.
- This will decides the seal flushing plan.

MECHANICAL SEAL CLASSIFICATION CODE (As per API 610 - 6th edition) :

Mechanical seal material and construction features may be coded by use of if the following five figure classification system :

1. First letter : Balanced or Unbalanced (B or U)
2. Second letter : Single, Double or Tandem (S, D or T)
3. Third letter : End plate (P =Plan , T= Throttle bushing, A= Auxiliary sealing device)
4. Fourth letter : Gasket Material.
5. Fifth letter : Face Material.

Fourth letter :

	Stationary Seal Ring gasket	Seal ring to Sleeve gasket
E	Fluoroelastomer (Viton)	TFE
F	Fluoroelastomer	Fluoroelastomer
G	TFE (Duraflon)	TFE
H	Nitrile (Buna N)	Nitrile
I	FFKM Elastomer (Kalrez)	FFKM Elastomer
R	Graphite foil (Durafite)	Graphite foil
X	As specified	As specified

Fifth Letter :

	Seal Ring	Mating Seal Ring
J	Carbon	Stellite
K	Carbon	Ni- Stellite
L	Carbon	Tungsten Carbide
M	Carbon	Tungsten Carbide
N	Carbon	Silicon Carbide
X	As specified	As Specified

As an example, a seal specified as code "**BSTEL"** would be a **B**alanced , **S**ingle seal with **T**hrottle Bushing end Plate and would have a **V**iton Stationary gasket, a Teflon seal ring to sleeve gasket and **C**arbon against **T**ungsten Carbide faces. Seal materials other than those listed above should be specified as code X and defined on the data sheet.

MECHANICAL SEAL FAILURE AT RIL. HAZIRA COMPLEX

The failure of a mechanical seal can be due to many reasons. The "mechanical seal failure modes" can be broadly summarised as given below. The failure can be due to any one or combination of these modes.

1. Improper Selection of Seals Design/Seal component/Flushing Plan
2. Implication of External Factors
   (like bearing failure, high vibration, Shaft eccentricity etc.,)
3. Improper start up and Improper Operation conditions / Procedures.
4. Fluid contamination / Seal flush oil degradation.
5. Cavitation.
6. Improper Installation / Assembly / Poor Workmanship
7. Ageing - Seal have completed a satisfactory life cycle

No. of Mech. Seal Failures Analysed

Sr.	Plant		No. of Mech. Seal Failure	
1.	VCM	=	30	
2.	AROMATICS	=	13	
3.	MEG 1 / 2 / 3	=	12	
4.	CRACKER	=	11	
5.	PE 1 / 2	=	09	
6.	PTA	=	04	
7.	PFF	=	03	
8.	PP	=	02	
9.	TERM	=	01	
10.	TFARM	=	01	
	TOTAL	**=**	**86**	**Failures**

MECHANICAL SEAL FAILURES MATRIX - (PLANT WISE)

Sr.No	PLANT	No. of Mech. Seal Failures on account of							TOTAL
		Improper Selection	External Factors	Improper Operation	Fluid Contamination	Cavitation	Improper Assembly	Ageing	
1	VCM	11	3	6	3	4	2	1	30
2	AROMATICS	4	1	1	5	0	2	0	13
3	MEG 1/2/3	3	6	1	1	0	1	0	12
4	CRACKER	5	1	2	2	1	0	0	11
5	PE 1/2	1	5	0	1	1	0	1	9
6	PTA	1	1	2	0	0	0	0	4
7	PFF	3	0	0	0	0	0	0	3
8	PP	1	0	1	0	0	0	0	2
9	TERM	0	0	1	0	0	0	0	1
10	TFARM	0	0	1	0	0	0	0	1
	TOTAL	29	17	15	12	6	5	2	86

MECHANICAL SEAL FAILURES INDEX - PLANT WISE

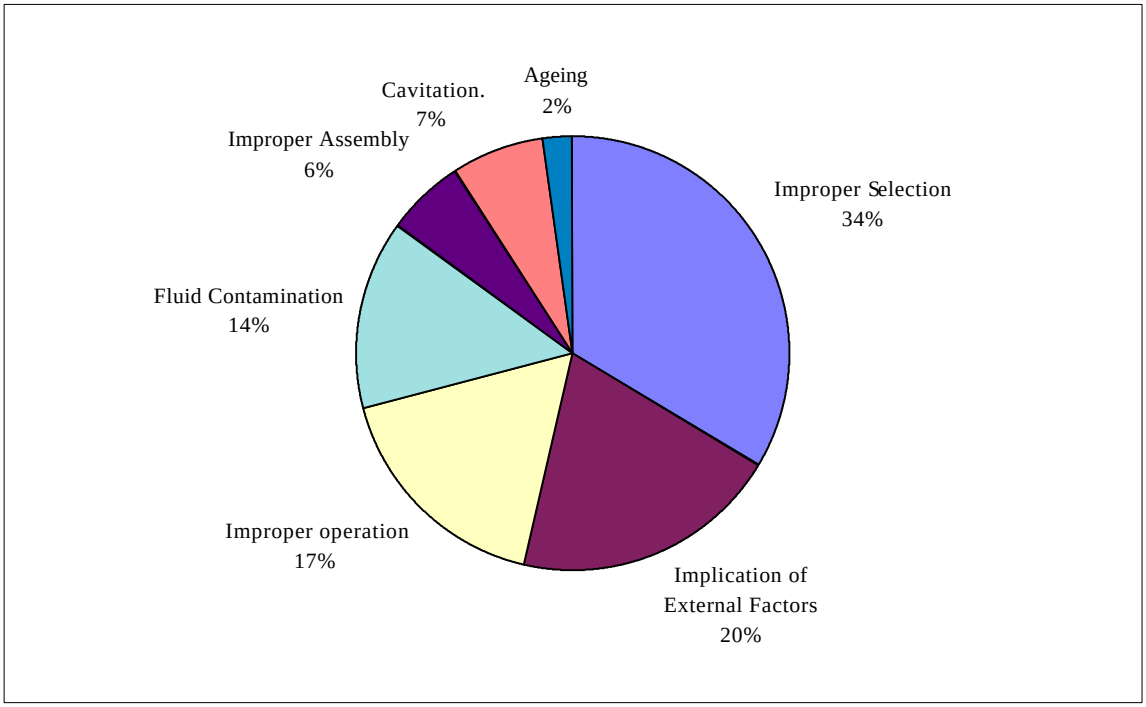
Sr.no	Plant	Tag No.	Description	FAR No.	Page No.
1	AROMA	P101A	EXTRACTOR FEED PUMP	FAR/M/98/13	16
2		P101B	EXTRACTOR FEED PUMP	FAR/M/98/15	48
3		P102B	STRIPPER BOTTOMS PUMP	FAR/M/98/18	88
4		P105A	LEAN SOLVENT PUMP	AROMA/M/97/4	13
5		P105A	LEAN SOLVENT PUMP	FAR/M/99/24	90
6		P105B	LEAN SOLVENT PUMP	FAR/M/97/10	15
7		P105B	LEAN SOLVENT PUMP	FAR/M/99/23	89
8		P113A	VACUUM PUMP	AROMA/M/97/2	67
9		P201A	EXTRACT DETOL TOWER OVERHEAD PUMP	FAR/M/98/17	86
10		P201B	EXTRACT DETOL TOWER OVERHEAD PUMP	FAR/M/98/12	108
11		P202B	EXTRACT DETOL TOWER BOTTOMS PUMP	FAR/M/99/29	91
12		P207A	MSTDP DETOL TOWER OVERHEAD PUMP	FAR/M/97/9	14
13		P401A	BENZENE TRANSFER PUMP	FAR/M/97/7	107
14	CKR	P210B	QUENCH OIL CIRCULATION PUMP	FAR/M/99/45	49
15		P210C	QUENCH OIL CIRCULATION PUMP	FAR/M/99/29	70
16		P211B	PAN OIL CIRCULATION PUMP	FAR/M/97/5	17
17		P342A	WEAK CAUSTIC CIRCULATION PUMP	FAR/M/98/25	21
18		P344A	STRONG CAUSTIC CIRCULATION PUMP	FAR/M/98/23	20
19		P347A	AEROMATIC GASOLINE CIRCULATION PUMP	FAR/M/98/20	19
20		P445A	DEETHANIZER REFLUX PUMP	FAR/M/99/49	93
21		P520A	C3 HYDROGENATION RECYCLE PUMP	FAR/M/98/16	18
22		P537B	TERT. DEETHANIZER REFLUX PUMP	FAR/M/98/13	92
23		P701A	1ST STAGE FEED PUMP	FAR/M/97/3	101
24		P701A	1ST STAGE FEED PUMP	FAR/M/97/4	68
25	MEG	P203	CONDENSATE CIRCULATION PUMP	MEG/M/96/9	50
26		P302A	CARBONATE PUMP	MEG/M/96/8	109
27		P302A	CARBONATE PUMP	MEG/M/97/18	22
28		P314	WP INJECTION PUMP	MEG/M/96/10	52
29		P405A	HIGH PURITY EO PUMP	MEG/M/97/16	53
30		P506A	GLYCOL FLASHER I BOTTOMS PUMP	MEG/M/95/1	55
31		P611A	TEG COLUMN BOTTOMS PUMP	MEG/M/97/17	95
32		P841B	SUMP PUMP FOR V841	MEG/M/95/2	56
33	MEG2	NP302AHT	HYDRAULIC TURBINE DRIVE FOR NP302A	MEG2/M/97/2	57
34		NP602A	MEG COLUMN BOTTOMS PUMP	FAR/M/97/4	72
35	MEG3	3P402A	LIGHT ENDS COLUMN FEED PUMP	FAR/M/99/5	25
36		3P509B	GLYCOL FLASHER II BOTTOMS PUMP	FAR/M/98/4	24
37	PE	GA3103S	REACTOR FEED BOOSTER PUMP	PE/M/95/25	61
38		GA3116	REG. WASTE TRANSFER PUMP	HDPE/M/94/16	27
39		GA3210A	RB REFLUX PUMP	HDPE/M/94/20	59
40		GA3218	FB-2 TRANSFER PUMP	PE/M/95/12	112
41		GA3401A	DTA TRANSFER PUMP	HDPE/M/94/6	97
42		GA3417A	HP DTA CONDENSATE PUMP	FAR/M/97/8	58
43		GA3417A	HP DTA CONDENSATE PUMP	HDPE/M/94/34	102
44		GA3417A	HP DTA CONDENSATE PUMP	PE/M/95/21	60
45	PE2	NGA3210A	RB REFLUX PUMP	FAR/M/97/4	62

MECHANICAL SEAL FAILURES INDEX - PLANT WISE

FINDINGS BASED ON ATTACHED FAR's :

The failure of a mechanical seal can be due to many reasons as it was observed in the failure analysis reports. Of the total 86 no. failures analysed the "mechanical seal failure modes" in the complex can be broadly summarised as given below. The failure can be due to any one or combination of these modes.

1. Improper Selection of Seals Design/Seal component/Flushing Plan = **29** Failures
2. Implication of External Factors = **17** Failures
   (like bearing failure, high vibration, Shaft eccentricity etc.,)
3. Improper start up and Improper Operation conditions / Procedures. = **15 F**ailures
4. Fluid contamination / Seal flush oil degradation. = **12** Failures
5. Cavitation. = **06** Failures
6. Improper Installation / Assembly / Poor Workmanship = **05** Failures
7. Ageing - Seal have completed a satisfactory life cycle. = **02** Failures.



SUB INDEX FOR SEAL FAILURE ANALYSIS REPORTS

MECHANICAL SEAL FAILURES

On account of

Improper Selection of Seals Design / Seal component / Flushing Plan

Plant : AROMA
Department : M
Tag No : P105A **Tag Description : LEAN SOLVENT PUMP**
FAR No : AROMA/M/97/4 **Sr. No: 2312** **Occurrence Date : 08/09/97**

Cause : DE
Description of Failure :
Inboard seal was found leaking

Observation :
Inboard seal was found leaking

Actons taken :
1. Pump was stopped and seal was dismantled. Carbon insert (seal face) was found damaged. Back up plate which holds and retains the carbon insert in position with the insert holder was also found in damaged condition.
2. The dimension of back up plate [part no m - drg no. 2h - 62892] was checked. The inner diameter of the back up plate should be 85.5 mm [please refer detail -" back up plate" in drg no 2h - 62892].
3. The actual dimension [back up plate inner diameter] was found to be 89 mm.
4. Due to this wrong dimension the carbon insert was found dislodged from its position .
5. New back up plate with correct inner diameter was machined and replaced.

Reasons :
Improper size of back up plate.

Analysis :
The back up plate inner diameter was found to be 89 mm .This was a wrong supply [error commited by vendor - m/s. Durametallic india ltd]. The back up plate dimension was found to be larger (89mm) than the required size of (85.5mm). Because of this the carbon insert (part no.2a ,drg no.- 2h - 62892) was slipping out of insert holder [part no. 1h] and got dislocated , which had resulted in failure of carbon insert .

Actions / recommendations :

1. Dimension of back up plate in pump P105b [which is having the same seal] is to be checked and back up plate is to be replaced if found necessary .

Plant : AROMA
Department : M
Tag no : P207A **Tag Description : MSTDP Detol tower overhead pump**
Far no : FAR/M/97/9 **Sr. No: 2324** **Occurrence date : 13/12/97**

Cause : DE
Description of failure :
Seal was found leaking

Observation :
1. On opening inboard seal, mating ring and seal ring were found in open condition.
2. The compression was also found to be inadequate. Sludge was found in the springs.

Actions taken :
Seal ring, mating ring and secondary seals were replaced and assembled and trial taken. Found o.k

Reasons :
Inadequate compression provided by the springs of the compression.

Analysis :
Due to inadequate compression of the springs, mixing of the pumping fluid and barrier fluid was taking place and sludge formation resulted. The sludge thus formed had affected the action of the spring further and seal started leaking

Actions / recommendations :

1. Seal design to be modified after raising FCO and in consultation with the vendor.

Plant : AROMA
Department : M
Tag No : P105B **Tag Description : LEAN SOLVENT PUMP**
FAR No : FAR/M/97/10 **Sr. No: 2325** **Occurrence Date : 27/12/97**

Cause : DE
Description of Failure :
Seal pot level was dropping.

Observation :
1. Seal faces were found in open condition.
2. Insert holder ring was found in damaged condition .

Actions taken :
1. New insert holder ring was machined and replaced.
2. Seal ring and all secondary packings were replaced and seal was assembled and trial taken. Found o.k.

This pump has a unique design of single set of springs retained by collar [part no.9 -drg no. Ms 5121303 r/1] providing compression to both inner and outer tungston carbide seal rings [parts no.3 and c - drg no. Ms 5121303 r/1]. Since the single set of springs are supplying compression to both the rings, the compression the compression force was found to be inadequate and there was mixing of pumping fluid and barrier fluid across the seal face.

Reasons :
Inadequate compression provided by the springs of the compression unit.

Analysis :
Due to inadeqaute compression force provided by the spring, there could have been mixing of the barrier fluid and pumping fluid across the seal face. This caused the formation of the sludge. Sludge further affects the free movement of the springs causing the seal to leak

Actions / recommendations :

1. Seal should be modified in consultaion with the vendor and after raising FCO.

Plant : AROMA
Department : M
Tag No : P101A **Tag Description : EXTRACTOR FEED PUMP**
FAR No : FAR/M/98/13 **Sr. No: 2328** **Occurrence Date : 04/05/98**

Cause : SU
Description of Failure :
Seal pot oil level was dropping.

Observation :
Seal Out board insert was having scoring marks. Seal was inspected and it was found that the stiffness of the Compression unit springs, was low.

Actions taken :
Pump was overhauled. Seal parts were replaced (New set of springs were used).

Reasons :
Inadequate spring stiffness.

Analysis :
Since compression unit was not exerting adequate pressure on seal faces, due to low stiffness of the compression unit springs, there was puffing of seal face causing chipping and scoring of seal faces, leadingto leakage. This is confirmed by the fact, that the seal is functioning satisfactorily after the new set of springs were assembled.The manufacturer might have used wrong springs which has has resulted in seal leakage.

Actions / Recommendations :

1. Since it is a mistake committed by vendor, there is no specific recommended corrective action. However the vendor may be communicated regarding this failure.

Plant : CKR
Department : M
Tag No : P211B **Tag Description : PAN OIL CIRCULATION PUMP**
FAR No : FAR/M/97/5 **Sr. No: 2246** **Occurrence Date : 03/12/97**

Cause : DE
Description of Failure :
Reported seal leak dropwise.

Observation :
1. Seal was found leaking. All operating parameters were found normal
2. On dismantling, uneven wearing out was observed on seal faces.

Action taken :
This failure was referred to the supplier M/s Sealol Hindustan ltd. M/s Sealol hindustan recommended to replace existing tc insert to carbon 52.(pt no.1) and GFT packing (pt no.c and 3) to viton " O " ring. The above change has been executed. A needle valve and pressure guage were installed in (the seal is having API 21 flushing plan) flushing line inlet. In additiona 4.5 mm dia hole has been drilled in the back plate in order to flush out accumulated muck from the seal housing. Pump boxed up and trial taken. Found o.k.

Reasons :
1. Improper contact on seal faces
2. Accumalation of muck inside seal housing

Analysis :
Analysis for reason no.1 :
Seal face was found to be having improper contact.this was confirmed by uneven contact. Since the dynamic seal (below the seal ring) was a teflon lip seal of ' V' shaped cross section , it was not responding to the minor axial movement of the seal ring spring during the running of the pump. So sealing of the faces was not proper and this resulted in seal leak.

Analysis for reason no 2:
When seal was dismantled, muck was found in seal housing.when seal face contact was not proper the muck had entered the seal face and affected the functioning of the seal.

Actions / recommendations :

1. Seal to be modified after raising FCO and in consultaiton with the vendor M/s sealol hindustan ltd.

Plant : CKR
Department : M
Tag No : P520A Tag Description : C3 HYDROGENATION RECYCLE PUMP
FAR No : FAR/M/98/16 Sr. No: 2257 Occurrence Date : 23/07/98

Cause : DE
Description of Failure :
P-520a seal leakage.

Observation :
1. Seal pot was getting pressurised.
2. On dismantling the seal green oil deposition was found on the inboard seal.
3. The thrust washer was found to be having ovality and it was not moving freely in the cup.
4. The seal was found to leak in static condition itself.
5. Shaft packing (Teflon) was found to be deformed.

Actions taken:
1. Shaft packing (Teflon packing partno p1- drg no 2h-58330) was replaced with viton "o" ring
2. Thrust washer was replaced.
3. Shaft sleeve was replaced with chrome-plated sleeve.
4. All secondary packings were replaced

Reasons :
1. Puffing at the seal faces .
2. Failure of shaft packing

Analysis :
Analysis for reason no 1:
This pump handles hydrocarbon with low vapour pressure. Heat generated at the seal faces may cause the vaporization of pumping fluid this is indicated by the deposition of green oil in seal parts. Vapour thus generated may cause puffing at seal faces leading to seal leakage.

Analysis for reason no 2 :
The teflon shaft packing was found deformed and it was replced with viton " o" ring.this indicates that the packing might have got deformed at the time of assembling on previous occasion leading to seal leak.

Actions / recommendations :

1. Seal is to be modified in consultation with the vendor to take care ofthe puffing effect and inadequate sealing by the secondary sealing elements.

Plant : CKR
Department : M
Tag No : P347A Tag Description : Aeromatic Gasoline Circulation Pump
FAR No : FAR/M/98/20 Sr. No: 2261 Occurrence Date : 26/10/98

Cause : DE
Description of Failure :
1. Seal pot found full totally during the operation.
2. Inboard mechanical seal leak noticed.

Observation :
1. After dismentling of mech seal caustic material found inside seal and packing area.
2. Also spring found clogged with caustic and due to that no spring tension noticed.
3. Carbon faces not found satisfactory.

Reasons :
1. Vibrations in the pump .
2. Improper assembly of the seal and not following the overhauling check list during assembly.
3. Improperdesign of the seal and its flushing plan.

Analysis :
After dismentling the seal caustic deposite observed around the seal spring.the same observation was also made during the previous failure.since face seperation had taken place due to spring clogging, the reason no 3 is supporting the cause of failure. Therefore the reasons no 1&2 of failure are ruled out.
After discussion with the process itis noticed that the pump handles fluid containing solid particals. These are due to presence of fine polymer particals and caustic crystels to some extent. Since the seal is supplied with api plan 11 the pumping fluid containing solids is getting circulated through seal. Since the pump has stand by it is possible that when the pump is ideal for a long time these particals get settled in the flushing line. Thus the flushing line will start chocking gradually. Refering to the past history and PM ESS it is observed that the seal flushing line is not inspected. Because of this circulation of barrier fluid through seal will not be sufficient resulting in seal failure.

Considering this analysis it is recommended that the vendor should be consulted for change in flushing plan so that deposition on seal springs can be avoided.

Actions / recommendations :

1. The seal vendore should be consulted for change of flushing plan to avoid deposition of the material on seal springs.

Plant : CKR
Department : M
Tag No : P344A Tag Description : STRONG CAUSTIC CIRCULATION PUMP
FAR No : FAR/M/98/23 Sr. No: 2264 Occurrence Date : 03/11/98

Cause : DE
Description of Failure :
Heavy seal leakage

Observation :
1. Heavy seal leakage was observed.
2. On dismantling the seal , mating ring was found in broken condition.
3. Slug was found all around the seal and springs were chocked.

Action taken:
1. New seal installed with all new elastomers.

Reasons : Failure of the seal can take place due to any of the following reasons:
1) Pump running with continuous vibrations.
2) Incorrect sealand seal flushing plan selection.
3) Incorrect seal assembly procedure.

Analysis :
Analysis for reason no 1 (pump running with continuous vibrations.)
The pump was running condition prior to failure. At the time of lastpm done on 10/10/98 nothing abnormal was noticed. The oil level in the bearing was also up to the mark. The coupling condition was also found to be ok. Hence any sign of vibration due to mechanical problem was not observed. Therefore this reason for seal failure is ruled out.

Analysis for reason no 2 (incorrect seal and seal flushing plan selection.)
The pump handles strong caustic solution. The caustic solution also contains impurities in the form of polymer particals. The seal vendore has suggested flushing plan 32 with compatible flushing liquid for the seal. However it was noticed that the flushing plan was changed to plan 11 at the time of the commissioning. Due to this the contaiminated caustic was getting circulated through the seal. This was resulting into gradual deposition on the springs resulting in loss of stiffness . Also at the time of PM the flushing line was also not checked. Therefore possibility of chocking in the flushing line also can not be ruled out. These two factors ie deposition on springs and chocking of flushing line are supporting the cause of the failure.

Analysis for reason no 3 (incorrect seal assembly procedure)
At thetime of seal assembly various check points were followed. The bearings were also checked and found ok. Therefore this reason for seal failure is ruled out.

Actions / recommendations :

1. The pump shall be installed with correct flushing plan as mentioned inthe drawing and flushing liquid flow as indicated in the drawing to be established.

Plant : CKR
Department : M
Tag No : P342A Tag Description : WEAK CAUSTIC CIRCULATION PUMP
FAR No : FAR/M/98/25 Sr. No: 2266 Occurrence Date : 16/11/98

Cause : DE
Description of Failure :
Seal Leakage.

Observation :
1. Seal leakage was observed.
2. On dismantling the pump slug was observed all around the seal and a clear indication that it came throughthe flushing line (plan-11) from pump dischrge.
3. Fretting corrosionand deep pitting marks were observed on the shaft sleeve at sealing area.
4. Mating ring and sealing ring were found in good condition.
Action taken:
1. Shaft sleeve was replaced by new sleeve.
2. All the seal parts including elastomers were replaced .

Reasons :
Reason No 1 :- Pump running with vibrations.
Reason No 2 :- Improper selection of the seal and seal flushing plan.
Reason No 3 :- Improper seal installation procedures.

Analysis :
Reason No 1 (Pump running with vibrations)
The pump was in operation prior to seal failure. The last PM of the pump was done on 03/10/98.At the time of the PM no abnormility with coupling, bearing etc was noticed. Any cause such as faulty bearing, misalignment, lack of lub oil etc that cause vibration was not present. This clearly indicate that the pump was operating smooth. Therefore this reason for seal failure is ruled out.

Reason No 02 (Improper selection of the seal and seal flushing plan)
It is observed that the pump handles caustic solution. Due to process conditions the caustic gets contaiminated and fine polymer particals are always present in the caustic. The vendor at the time of seal procurement suggested Plan 32 but as per the history records it was changed to Plan11. Due to this change over the contaiminated caustic is getting circulated through the seal. This has caused clogging of the seal springs. The seal was therefore leaking due to clogged springs.
Since there is always lateral movement of shaft due to axial play in the bearings, the fretting corrosion on shaft sleeve took place due to presence of solid particals in caustic. However this would have been easily avoided had clean liquid from external source being used for seal flushing. Therefore it is very clear that use of plan 11 in place of plan 32 resulted in seal failure.

ReasonNo 3 (Improper seal installation procedures.)
The check points for seal installation were followed and also the bearings were checked. Therefore this reason for seal failure is ruled out.

Actions / Recommendations :

1. The seal flushing plan to be changed from plan 11 to 32 as suggested by vendor in their drawing.

Plant : MEG
Department : M
Tag No : P302A **Tag Description : CARBONATE PUMP**
FAR No : MEG/M/97/18 **Sr. No: 2096** **Occurrence Date : 31/03/97**

Cause : SU
Description of Failure :
Mechanical seal leak

Observation :
On 20/3/97 abnormal sound was observed in the pump at intervals of 5-10 minutes during which time the motor was drawing approx.3-5 amps. More than the normal this was not continous after seal leakage started (26/03/97), the abnormal sound was not reported. Pump was opened for attending seal leakage the following observations were made.

1. Both the faces were found with rubbing marks and scratchesall around the circumference.
2. The whole seal unit, including sleeve and compression unitwas found with blackish deposits all over.
3. Suction strainer was found with iron particles.
4. Cooling water lines (supply and return) opened for clea-ning. Both lines contained lot of dirt and muddy particles

Actions taken:
Both faces and packings replaced . Pump assembled, trial taken and found ok.

Reasons :
1. Cavitation
2. Vapourization of sealing fluid.
3. Dirt entering into the seal

Analysis :
Analysis for reason no 1.
Abnormal sound was observed during the running of the pump but it has stopped after the seal leakage. If the cavitationis present the abnormal sound should not have been stopped even after the seal leakage. Hence this reason for failure canbe ruled out.

Analysis for reason no 2 & 3
This pump is having dura seal- single inside 'spt'cart., with flushing plan of 32. Flushing fluid is hot condensate about 120-135 degree centigrade at a pressure of 25 kg per sq cms. Through a cooler in which cooling fluid is cooling water. On opening the seal cooler for cleaning it was found that cooling water lines both supply and return contained a lot of dirt and muddy particles which caused the insufficient cooling of the seal flushing fluid. Thereby the seal flushing fluid is vaporized and causing flashing of the seal fluid. There was a clear indication of this problem i.e., abnormal sound coming from the pump and which was stopped after the seal leakage was started. During flashing of the fluid there will be a rapid change in the fluid from liquid to gaseous. In a dynamic seal this can occur when frictional energy is added to the fluid as the later passes between the primary sealing faces , when the fluid pressure is reduced below the fluids vapour pressure because of a pressure drop across the sealing faces. Flashing of the fluid lead to the seperation of the seal faces for an instance during which the dirt particles contained in the pumping fluid might have entered in between the seal faces there by causing the seal leakage. Both the seal faces found with rubbing and

scratches all around the circumference. The whole seal unit including sleeve and compression unit was found with blackish deposits all over which indicates the dirt entering into the system because of seal fluid flahing

Actions / recommendations :

1. Recommendations of far no MEG/M/96/8 dated 04/09/96 are still pending. The same recommendations still holds good. Possibility of using betteer design seal like multiple spring seal with shield or single spring compression unit to prevent clogging of springs. To be explored with vendor, flushing fluid pressure should be monitored requlary.
2. Seal cooler cleaning and seal flushing line dechocking should be rigorously followed.

Plant : MEG3
Department : M
Tag No : 3P509B Tag Description : GLYCOL FLASHER II BOTTOMS PUMP
FAR No : FAR/M/98/4 Sr. No: 4 Occurrence Date : 21/09/98

Cause : DE
Description of Failure :
3P509B inner seal leakage causing GR-1 was going to 3C504 causing product contamination.

Observation :
After plant startup on 21/09/98 at 12:30hrs. EG section was started at13:40hrs on 21/09/98. After stabilising the 3C601(MEG product column) and downstream MEG UV was reported very low.(@46,77,90). Sample wasanalysed again at 20:30 hrs. & UV was reported 57,87,94. Parallely DEG product UV was also reported very low. Purity wise MEG & DEG both products were on spec expect UV.
It was found that 3P509B seal (inner) was leaking causing GR-1 to go to 3C504 as NRV in that line also did not hold . MEG & DEG both products were already lined upto 3T601.
Action Taken:-
3C504, 3C601, 3C602, 3C603 shut down taken & columns were emptied out to 3T302 tank as colour was observed in the column bottom liquid. This was done two times. All the above columns were checked for any air ingress. But nothing was found. Colour was observed in 3C504 bottom also . So it was suspected that GR-1 is coming in the system through 3P509B seal. 3P509B seal pressure reduced to 0.5 kg/cm2 to avoid back flow of GR-1.

Reasons :
Pump inner seal leakge.

Analysis :
3P509A/B pump designed for 0.5-0.776 Kg/cm2 suction pressure and 2.5kg/cm2 discharge pressure.The pump is equiped with Sealol seal, Back-to-back arrangement with flushing plan API 54.The stuffing box pressure for the seal is 1.5-1.6Kg/cm2. The seal is flushed as per plan 54 with the external source of glycol coming from the 3P504A/B discharge linethro' 3S502A/B.The discharge pressure d/s of filter remains to be 1.2-1.5 kg/cm2 as the pump discharge pressure is 1.8-2.0kg/cm2. Considering the pressure drop in the line seal flushing pressure varies between 0.8-1.2kg/cm2 .
The stuffing box pressure being on higher side than flushing pressure, during inner seal leakge reversed flow will be there thro' seal flushing line and if the NRV in that line doesn't hold theliquid will went inside the C504. Intern causing product contamination.
This was confirmed during failure that GR-1 was coming to 3C504 through the line from 3P504 to 3P509B seal line and GR-1 was drained from the seal line of 3P509B pump.
Hence the reason for the product contamination is the 3P509B pump seal (inner) leak along with the NRV failure.
This is the mechanical aspect of looking at the failure and possible solution to avoid the product contamination in the future is modification in the seal flushing plan . However the other possible causes of product contamination can be studied and sorted out in consultation with CTS.

Actions / Recommendations :
1. The seal system to be reviewed and modified to plan 52 or 53 (seal pottype)
2. Other possible causes of product contamination to be studied and sorted out in consultation with CTS.

Plant : MEG3
Department : M
Tag No : 3P402A Tag Description : LIGHT ENDS COLUMN FEED PUMP
FAR No : FAR/M/99/5 Sr. No: 5 Occurrence Date : 19/07/99

Cause : DE
Description of Failure :
Pump Inboard seal leak was observed .

Observation :
1. Minor seal leakage with daily slight increase in pump seal pot level observed.
2. Pump was taken for maintenance along with PM .Pump removed and shifted to w/s.
3. On dismantling the seal ,it was observedthat inboard Kalrez 2035 packings were badly damaged but the seal faces were in good condition.
4. Slight scratches were seen on the outboard mating ring.
5. Seal assembled with new outboard mating ring ,old inboard seal faces and all new packings
6. Since Kalrez 2035 gradeinboard "O" ring was not available ,seal assembled with Kalrez1050LF grade "O" ring.
7. Stuffing box O ring and sleeve O ring changed.
8. Pump was boxed up , fixed in position aligned and coupled.

Reasons :
1.Incompatible "O" ring material.
2.Foreign particle entry.
3.Shaft vibration.

Analysis :
Analysis for the reason no.1:
Incompatible "O" ring material will lead to the seal leakage due to the failure of secondary sealing. During inspection, the "O" rings were found swollen, extruded and cracked. This is the indication of the chemical attack on the material. Hence the seal failure is attributed to the "O" ring failure on account of chemical attack.
Looking at the seal failure history it can be seen that, Mechanical seals were supplied with Kalrez 1050LF grade "O" rings for Ethylene Oxide service pumps. But later on it was found that Kalrez 1050LF grade is not suitable for the EO service. Hence the seal vendor had supplied the new "O" rings of Kalrez 2035 grade. The history of MEG2 & MEG3 pump seal failure with new grade of Kalrez reveals that it has failed in the period of 6-8 months in some of the pumps. The material for the "O" ring Kalrez 2035 is the most suitable for the Ethylene Oxide service. This is used all over the world and recommended by SHELL group. But the failure of the "O" ring is still unanswered .
Hence though this is the best material, its reliability couldnot be established, where as in MEG1 plant similar service pumps are running with "DURAFLON"(Teflon encapsulated viton) 'O' rings giving satisfactory service. Hence it can be concluded that the reliability of Kalrez 2035 is yet to be established and is the cause of seal leakage.

Analysis for the reason no.2&3:
Shaft vibration or the foreign particle entry can be other probable causes of the seal failure. But looking at the failure ,the seal leakage has developed progressively with minor inboard seal leakage which is the indication of the on set of secondary seal failure. On opening the seal, no foreign

particle was found inside also vibration readings were well within limits .Hence these reasons can be ruled out.

Actions / Recommendations :

1. Since the reliability of Kalrez 2035 is yet to established which is the main cause for seal leakage, it is recommended to take up the matter strongly with seal vendor. Also it is recommended to use Teflon "O" rings till the reliability of Kalrez 2035 gets established.

Plant : PE
Department : M
Tag No : GA3116 **Tag Description : REG. WASTE TRANSFER PUMP**
FAR No : HDPE/M/94/16 **Sr. No: 1137** **Occurrence Date : 06/11/93**

Cause : DE
Description of Failure :
Mechanical seal leakage

Observation :
1) Mechanical seal dismantalled & following observations were made:
a) Carbon seal ring packing (viton) found enlarged; deshaped, broken at places & has lost its proprtites
b) TC seal ring packing (PTFE) found loose
c) Seal sleeve (SS316) surface found having lot of pitting specially near 'O' ring area.
d) Carbon seal ring having minor scoring
e) Muck deposition found on sleeve & seal ring face

Action taken :
1) Sseal parts throughly cleaned and mechanical seal assembled using following items a) New carbon and TC seal faces b) New set of packing rings (Viton / PTFE) c) New seal sleeve

Reasons :
1) Failure of seal face due to entry of foreign particles.
2) Damage of elastomers
3) Wrong seal design or wrong material selection

Analysis :
1) Pitting of the SS316 sleeve may be due to
a) Entry of water during commission stage and that leads to chloride corrosion.
b) The waste product is different than waste considered at the stage of desiging the pump

2) Swelling of the elastomers may be due to deformation after releasing of the load.
a) Wear of seal faces is normal in due course of time.
b) Ingress of process muck might cause scoring on seal faces.

3) As the pump is handling waste hydrocarbon, including ketonether is likelihood of wrong material selection of seal and packing materials during seal design stage, which might be responsible for severe pitting on sleeve surface and premature deformation of packing material.

Actions / recommendations :

1. During next opening the parts are to be thoroughly inspected
2. The chemical composition of the sleeve material to be crosschecked.
3. The chemical composition of the waste generated to be examined at different time ie. during normal operation, during start up and just after failure.

Seal flushing plan for GA3116 should be changed from API 11 to API 32 i.e.,using clear flushing fluid.

Plant : PTA
Department : M
Tag No : G1-207B **Tag Description : REACTOR FEED PUMP**
FAR No : PTA/M/97/6 **Sr. No: 2199** **Occurrence Date : 07/04/97**

Cause : DE
Description of Failure :
Inboard mechanical seal leakage.

Observation :
On dismantling the pump,the following observations were made:
1. O-ring of the lower mechanical seal was found distended and deformed.
2. The inducer had pitting marks and material erosion at three places.

Actions taken:
The o-ring of the lower mechanical seal was replaced.

Reasons :
1) Improper assembly of the mechanical seal.
2) Mechanical seal o-ring of dubious quality.
3) The probable cause of pitting/erosion of inducer is cavitation.

Analysis :
Analysis for reason no.1:
The pump and mechanical seal assembly has been carried outunder careful supervision and as per the procedures spelt out by the vendor's manual. Also the swelling of the o-ring can never be due to improper assembly. Hence this reason is ruled out.

Analysis for reason no.2:
The 'MOC' of the o-ring as per the vendor's recommendationis kalrez. But even kalrez has got various grades. There is a possibility that the kalrez o-ring being used presently is not of the required grade. The swelling of the o-ring points towards that direction.the matter has been referred to the vendor and their reply is awaited. The pitting / erosion failure of the inducer was analysed by the inspection & corrosion department and the reason has been attributed to cavitation.

Actions / recommendations :

1. The matter of O-ring failure has to be taken up with the vendor again and the o-ring 'MOC' to be confirmed.
2. The pump has to be run as close to the duty point as possible so as to avoid cavitation and in turn avoid any pitting/erosion of the rotating components.

Plant : PP
Department : M
Tag No : G7012B **Tag Description : PELLETER WATER PUMP - V7040B**
FAR No : PP/M/97/14 **Sr. No: 2213** **Occurrence Date : 10/06/97**

Cause : PR
Description of Failure :
Pellet water pump mecanical seal leakage(single seal,api plan-11)

Observation :
After dismantling the seal unit the following wereobserved.
1. Rotary face was found completely worn out.
2. Stationary face(carbon) found to have chipped at one place
3. All other seal parts were found in good condition.
4. Seal flushing line was fully chocked with fine polymers.

Action taken :
1. Seal faces were replaced and pump was fixed in line.
2. Seal flushing line was dechocked and fixed back.

Reasons :
1. Seal flushing line chocked
2. Ingress of foriegn particals between the seal faces

Analysis :
Analysys for the reason no:1 :
The seal used in pellet water pump is single mechanical sealwith API Plan-11.for seal face cooling, pumping liquid was taken from its discharge and fed to the seal faces.while removing the pump to replace the seal, seal flushing line was found chocked with polymer fines which restrict the seal flushing liquid. Hence heat generated between the seal faces colud not be dissipated which results in over heating of seal faces and susequently seal got failed.

Analysis for the reason no:2 :
Ingress of polymer material between the seal faces might bethe other most probable cause of seal failure.since afteropening the seal housing, lot of polymer materials wasobserved in the seal cavity.it is concluded that the failure of seal was due toseal flushing line chocking with fine polymers and ingressof polymer material in to the seal cavity.

Actions / recommendations :

1. Prevent polymer fines going in to the pump suction with1.fine screen to be installed back on the pelleting tank toprovision to clean on line.
2. External seal flushing line with flow control valve may bearranged as alternative

Plant : PFF
Department : M
Tag No : 8003P03B **Tag Description : MONOMER FEED PUMP**
FAR No : FAR/M/97/1 **Sr. No: 1** **Occurrence Date : 23/12/97**

Cause : DE
Description of Failure :
Mono feed pump B seal leaked.

Observation :
Standby pump tried to take in line but it was not giving required flow. Hence same pump (8003P03B) was kept running & stand by pump was changed with ready spare back pull out assembly. This standby pump (8003P03A) was started. Running pump was taken under maintenance for attending its mechanical seal.

Reasons :
1. Undissolved polymer or dirt might have damaged the seal of running pump.
2. Shaft of standby pump was broken from threaded portion of impeller. Thus impeller removed from shaft and hence not giving any flow.

Analysis :
1. Solidification of monomer over bellow causes it to loose its spring action and jamming the bellow completely, which results in leakage of monomer between seal faces.
2. No API plan given in goulds pump drawing and manual for steam quenching of seal and jacket heating of pump.
3. There is a possibility of solid particle, coming along with monomer and getting stuck in bellow thus reduces the compressibility of bellow, as solid waste was also tried in glycolysis.

Actions / recommendations :

1. Jacket heating of pump to be implemented. This matter is under hold for getting the clarification from M/s. Goulds pumps. Drawing etc. has been made and kept ready. This matter was also discussed with M/s. John crane. He has recommended API plan 02 for jacket heating of pump.
2. Steam quenching of seal to be implemented. This matter was discussed with M/s. John crane and he has recommended API plan 62 for the same.
3. API plan to be implemented.
4. Sop made and direction of rotation to be marked on pump.

Plant : PFF
Department : M
Tag No : 8003P01B **Tag Description : MONOMER TRANSFER PUMP**
FAR No : FAR/M/98/2 **Sr. No: 2** **Occurrence Date : 27/01/98**

Cause : DE
Description of Failure :
Monomer transfer pump leakage observed at 9:00 hours from the seal. Gradually leakage increased. Leakage from casing also observed by 10.00hrs.

Observation :
Due to above mentioned problem stand by pump 8003- P01A taken in line and 8003- P01B pump isolated, drained and handed over to mechanical dept. for attending the pump.

Action taken :
1. Pump impller was found badly jammed with monomer and it was taken out after removing the monomer also mechanical seal was found flooded with monomer and taken out with very difficulty.

Reasons :
Damaging of bearing due to leakage of monomer from mechanical seal and entering in bearing housing.

Analysis :
1. Solidification of monomer over bellow causes it to loose its springaction and jamming the bellow completely with results in leakage of monomer between seal faces.
2. No API plan given in goulds pump drawing and manual for steam quenching of seal and jacket heating of pump.
3. Leakage of oil seal might have caused the monomer to enter in bearing housing and damaging the bearings.
4. Non-availability of throat bush might have caused the entrance ofmechanical seal leakage into bearing housing.
5. There is a possibility of solid particle, coming alongwith monomer and getting stuckin bellow thus reduces the compressibility of bellow, as solid waste was also tried in glycolysis.

Actions / recommendations :

1. Jacket heating of pump to be implemented. This matter is under hold for getting the clarification from m/s. Goulds pumps. Drawing etc. Has been made and kept ready. M/s. John crane has recommended api plan 02 for jacket heating of pump.
2. API plan for steam quenching to be implemented. M/s. John crane has recommended api plan 62 for steam quenching of mechanical seal.
3. Mechanical seal leakage to be arrested to avoid oil seal leakage.
4. Oil seal design with respect to monomer temp. To be reviewed.
5. Throat bush to be provided to avoid the entering of monomer into bearing housing. The matter to be discussed with M/s. Goulds pumps.

Plant : PFF
Department : M
Tag No : 8003P03A Tag Description : MONOMER FEED TRANSFER PUMP
FAR No : FAR/M/98/3 Sr. No: 3 Occurrence Date : 26/01/98

Cause : DE
Description of Failure :
1. Abnormal sound observed from monomer feed pump. Pump checked with mechanical engineer and found its bearing damaged due to mechanical seal failure and entering of monomer into bearing housing.
2. Pump impeller was found badly jammed with monomer and mechanical seal was found flooded with monomer. Mechanical seal was taken out with great difficulty.

Observation :
Due to above mentioned problem standby pump 8003 P03B taken in line and 8003 P03A pump isolated , drained and handed over to mechanical dept. for attending the pump.

Reasons :
Bearing damaged due to mechanical seal failure and entering of monomer into bearing housing.

Analysis :
1. Solidification of monomer over bellow causes it to looses its spring action and jamming the bellow completely, causing the leakage from seal faces.
2. No API plan recommended in goulds pump drawings and manual for steam quenching of mechanical seal and jacket heating of pump.
3. Leakage of oil seal might have caused the monomer to enter in bearing housing and damaging the bearings.
4. Non-availability of throatbush might have caused enterance of monomer into bearing housing.
5. There is a possibility of solid particle coming along with monomer and getting stuck in bellow thus reducing the compressibility of bellow.

Actions / recommendations :

1. Jacket heating of pump to be implemented. This matter is under hold for getting the clarification from m/s. Goulds pumps. Drawing etc. has been made and kept ready. M/s. John crane has recommended API plan 02 for jacket heating of pump.
2. Steam quenching of mechanical seal to be implemented and M/s. John crane has recommended API plan 62 for the same.
3. Mechanical seal leakage to be arrested to avoid oil seal leakage.
4. Oil seal design with respective monomer temp. To be reviewed.
5. Throat bush to be provided to avoid the enterance of monomer leakage into bearing housing.
Matter to be discussed with M/s. Goulds pumps.

Plant : VCM
Department : M
Tag No : GA2505 **Tag Description : OFF SPECIFICATION VCM PUMP**
FAR No : VCM/M/94/10 Sr. No : 1160 Occurrence Date : 14/11/93

Cause : DE
Description of Failure :
Inboard seal leakage.

Observation :
1. Thin layer of white deposits found in the pumping fluid side of the I/b seal upto I/b seal ring teflon wedge.
2. Slight scoring mark found on the I/b carbon seal ringface.

Actions taken :
Both the seal ring replaced by spare ones.
All the secondary packings replaced.

Reasons :

Accumulation of the deposits from the process fluid in the stuffing box had led to I/b seal leakage.

Analysis :

Seal design does not prevent pumping liquid from coming in contact with "O" ring. The solids in the pumping liquid get deposited resulting in jamming of shaft packing which restricted the forward motion of I/b seal ring for compensation of wear of the faces. These result in I/b seal leakage.

Actions / recommendations :

1. Study the reason for white deposition
Recommend modification in seal design.

Plant : VCM
Department : M
Tag No : GA2515S **Tag Description : 20% CAUSTIC TRANSFER PUMP**
FAR No : VCM/M/95/15 **Sr. No : 1706** **Occurrence Date : 18/08/95**

Cause : DE
Description of Failure :
seal leakage.

Observation :
1. Seal ring face found loose in the holder.
2. Mating ring found slightly wornout.
3. Secondary packings found ok.
4. Shaft runout=0.03mm, shaft radial play=0.02mm and shaft axial play=0.01mm.

Actions taken :
Both the faces (seal ring-Tungsten carbide face & mating ring- Sealide), secondary packings and throttle bush replaced.

Reasons :

1. High vibration.
2. Improper seal design.

Analysis :

1. As shaft runout, radial and axial play are within the limit, high vibration can be ruledout.
2. In the seal ring assembly, the tungesten carbide face is fixed to the holder (press fit). As the seal face got detached from the holder, leakage started from the gap between holder and face.

Actions / recommendations :

1. Seal manufacturer to install the seal and study subsequent failure.

Plant : VCM
Department : M
Tag No : GA6303S Tag Description : HIBOIL COLUMN BOTTOMS PUMP
FAR No : VCM/M/94/15 Sr. No : 1194 Occurrence Date : 17/03/94

Cause : DE
Description of Failure :
Inboard seal failure.

Observation :
1. Inboard insert mtg and shaft packing found badly swollen (both o'rings).
2. Inboard insert TC face OD found slightly chipped off.
3. Outboard insert carbon found slightly blistered.
4. Pump found to run with cavitation some time before failure.
5. Shaft runout radial play & axial play found within limit.

Action taken :
All seal faces and secondary packings replaced by new one. Inboard packing replaced by kalrez.

Reasons :

1. High vibration.
2. Cavitation & starvation.
3. Insert mounting & shaft packaging “O” ring material not compatible in chlorinate hydrocarbon services.

Analysis :

1. High vibration ruled out as shaft runout, radial & axial play within limit. No such report from plant CM schedule.
2. BFG & M/s.Dura-mettalic suggested kalrez “O” ring as insert mounting & shaft packing. Viton “O” rings used in place of kalrez ‘O' ring due to high cost. Viton O' ring swelled in chlorinated hydrocarbons which resulted into seal failure.
3. Cavitation & starvation lead to seal failure.

Actions / recommendations :

1. Pump to be taken under corrective maintenance every 3 months.
2. Cavitation to be avoided.

Plant : VCM
Department : M
Tag No : GA6402A **Tag Description : QUENCH SCRUBBER O.H. PUMP**
FAR No : VCM/M/94/25 **Sr. No : 1385** **Occurrence Date : 04/09/94**

Cause : DE
Description of Failure :
Outboard seal leakage.

Observation :
1. Shaft found badly corroded where sleeve portion ends towards atmospheric side.
2. Diameter of the shaft was reduced from 38 to 35.2 mm.
3. Sleeve packing area was having slight fretting effect.
4. Scoring marks found on sleeve area of the shaft.
5. Black sticky particles & rubbing marks found around i/b& o/b seal ring. I/b carbon face found o.k & of o/b having rubbing marks.
6. Black sticky material deposition found on I/b & O/b seal ring (carbon) O rings. Compression units found with black sticky material.
7. I/b compression unit spring action found uneven.
8. O/b seal face o rings found deshaped and were having black sticky material.
9. Seal pot oil found blackish. Shaft r/o - 0.05 mm, axial/radial play - 0.03/0.00 mm

Actions taken :
1. All faces & o rings replaced.
2. I/b compression unit replaced.
3. Shaft, bearings & shaft sleeve replaced.

Reasons :
Reasons for seal failure :
1. High vibration.
2. Contamination of buffer fluid.

Reason for shaft corrosion :
1. Condensation of dry HCL Vapour which leaks through the shaft packing.
2. Incompatible shaft packing material for required service.

Analysis :
Analysis for Seal leakage :
As shaft runout & axial / radial play found in limit & bearing condition was also found good. The possibility of high vibration can be ruled out.
From the observation no. 11, buffer fluid servosystem 32 was found contaminated & blackish in colour.some amount of HCL was also observed in oil. Blackish sticky material was also found in oil & seal cavity. This is a clear indication that HCL had leaked into the oil. Due to the ingress of HCL in oil, the oil got disintegrated. This can be attributed to seal failure. Stuffing box pr. is 21 kg/cm2 approx. & buffer fluid was maintained at 27 kg/cm2. So in normal condition, oil should leak in the pumping fluid & in any case pumping fluid containing HCL should not leak in oil. The exact cause of such an abnormal phenomenon of leaking HCL from low pr.zone to high pr. zone i.e. buffer fluid could not be established. Efforts are being made by RIL engineers & seal manufacturers to find out the exact cause of this leakage. One of the most probable causes suspected so far is explained.
Analysis for shaft corrosion :

Shaft packing prevents leakage along the shaft. But there was a fine leakage of dry HCL vapour which travelled along the shaft & condensed when exposed to atmosphere. This eventually corroded the shaft locally.

Actions / recommendations :

1. Modified seal with plan 32 & 53 (HPEFL) to be installed.
2. Shaft sleeve O ring be replaced every 6 months during corrective maintenance.

Plant : VCM
Department : M
Tag No : GA6402A Tag Description : QUENCH SCRUBBER O.H. PUMP
FAR No : VCM/M/96/4 Sr. No : 1929 Occurrence Date : 14/07/96

Cause : PR
Description of Failure :
Outboard seal failure.

Observation :
1. Plan-32 HPEFL (high pressure EDC flush line) 1"dia plug v/v as found in throttled condition. During which time, HPEFL prssure found to be 20kg/sq.cm instead of 22kg/sq.cm.
2. Seal pot oil was found contaminated.
3. Lot of coke type deposits found in the atmospheric side of outboard seal.
4. Outboard seal faces & o-rings found in good condition.
5. Inboard o-rings found swollen.

Actions taken:
1. Seal cartridge replaced. Modified sealol seal with plan-32 was installed for trial, but it failed. Old type seal reinstalled on 04/09/94. Outboard seal leakage & shaft corrosion where sleeve portion ends towards atmospheric side. All seal faces,O-rings,shaft,bearings replaced on.31/01/95. Plan-32 (HPEFL) installed as per the recommendation in FAR no. VCM/M/94/25. Plan-32 pressure set at 22 kg/sq.cm. Stuffing box pressure found to be 20 kg/sq.cm. Plan-53 pressure set at 24 kg/sq.cm.

Reasons :

1. Cavitation.
2. Reduction in HPEFL pressure.

Analysis :

1. The discharge of the pump is going to quench scrubber for spray. Also the suction pressure will always be maintaned at 19 kg/sq.cm. So, if the pump cavitates, standby pumpstart automatically. As this has not happened cavitation can be ruledout.
2. As the HPEFL pressure (22 kg/sq.cm) was not maintained for plan-32, the process fluid might have entered the seal oil resulting in the failure of outboard seal. The reason for reduction in HPEFL pressure is throttling of HPEFL plug valve. One of the reason for throttling is rotation of v/v handle after over a certain period (as the v/v handle is in vertical upward direction, when v/v is in fully open condition). "1. Hpefl pressure should be maintained at 22 kg/sqcm. Flow meter to be provided in the Hpefl of plan-32 to find out the quantity of EDC flow which facilitates further analysis. Position of Hpefl plug v/v handle to be changed from vertical upward direction to vertical downward direction (in fully open condition of v/v)."

Reasons :
Reasons for seal failure :
1. High vibration.
2. Contamination of buffer fluid.

Reason for shaft corrosion :

1. Condensation of dry hcl vapour which leaks through theshaft packing.
2. Incompatible shaft packing material for required service.

Analysis :

1. As shaft runout & axial / radial play found in limit & bearing condition was also found good, the possibility of high vibration can be ruled out.
2. From the observation no. 11,buffer fluid servosystem 32 was found contaminated & blackish in colour. some amountof HCL was also observed in oil. Blackish sticky material was also found in oil & seal cavity. This is a clear indication that HCL had leaked into the oil. Due to the ingress of HCL in oil, the oil got disintegrated. This can be attributed to seal failure. Stuffing box pr. is 21 kg/cm2 approx. & buffer fluid was maintained at 27 kg/cm2. So in normal condition, oil should leak in the pumping fluid & in any case pumping fluid containing HCL should not leak in oil.the exact cause of such an abnormal phenomenon of leaking HCL from low pr. zone to high pr. zone i.e buffer fluid could not be established.efforts are being made by RIL engineers & seal manufacturers to find out the exact cause of this leakage. One of the most probable causes suspected so far is explained.

Analysis for shaft corrosion :

Shaft packing prevents leakage along the shaft but there was a fine leakage of dry HCL vapour which travelled along the shaft & condensed when exposed to atmosphere. This eventually corroded the shaft locally.

Actions / recommendations :

1. Modified seal with plan 32 & 53 (hpefl) to be installed.
2. Shaft sleeve O ring be replaced every 6 months during corrective maintenance.

Plant : VCM
Department : M
Tag No : GA6502A **Tag Description : VCM COLUMN REFLUX PUMP**
FAR No : VCM/M/96/3 **Sr. No : 1915** **Occurrence Date : 11/06/96**

Cause : DE
Description of Failure :
Inboard seal failure.

Observation :
1. Outboard seal faces (TV/carbon) & O-rings (viton) found in good condition.
2. Inboard shaft packings & insert mounting (viton) found broken into pieces. Overheating marks found on the O-rings.
3. Inboard seal ring found coated with carbon like material from inside.

Actions taken :
Back plate replaced with overhauled one containing sealol make reversed balance type seal.

Reasons :

1. Use of defective O-rings.
2. Poor quality of O-rings.

Analysis :

1. If defective O-rings was used seal might not have passed in seal test just after assembly and could not have run since 25/04/96. Hence the reason that usage of defective O-rings is ruledout.
2. O-ring between seal ring & sleeve got extruded, which might have lead to leakage between seal ring and sleeve inturn draining of seal pot oil. Due to lack of oil in oil circuit the seal might have got overheated leading tooverheating of O-rings & breakage. The extrusion of O-ring alone in such a short duration, with all the seal faces in good condition indicates that the quality of O-ring was poor.

Actions / recommendations :

1. As viton O-rings which are used in other similar service pumps are giving good performance & this type of failure in this pump has occured for the first time (clear indication of poor O-ring quality) no recommendation can be suggested. However subsequent failures, if any, due to extrusion of O-rings should be studied.
2. Kalrez O-rings which are in stock should be used in Inboard until the stock lasts.

Plant : VCM
Department : M
Tag No : GA6803A **Tag Description : STRIPPER O/H PUMPS**
FAR No : VCM/M/95/2 **Sr. No : 1553** **Occurrence Date : 07/06/95**

Cause : DE
Description of Failure :
Inboard seal failure - seal pot level fall down immediately.

Observation :
1. Inboard face `O' ring found damaged.
2. Inboard `O' ring seat portion found eroded and coroded.
3. Wornout marking found on the outboard faces.

Actions taken :
1. Old casing cover machining done in stuffing box area to adjust throat bush.
2. New throat bush being prepared in CES w/s.
3. Old casing cover modified with throat bush arrangement to be installed.
4. All `O'rings and faces replaced with new.

Reasons :

1. Spurious `O' ring material.
2. `O' ring overheating.
3. Corrosive fluid handled by the pump.

Analysis :

1. As the `O'ring (viton) is being used in various pumps & as there is no frequent failure due to poor material quality, possibility of spurious `O' ring is ruledout.
2. As the `O' ring is in direct contact with the fluid and as neither the pump nor the seal were running dry, and also physical appearance of `O' ring doesnot reveal any mark of overheating, possibility of `o' ring overheating can alsobe ruledout.
3. Thus the most likely reason can be corrosive fluid. The sequence of failure can be as follows

a). Service of the pump containing EDC+water+dirt is corrosive and whenever there is upset in the plant, pH will become less.

b). Inboard `O'ring seat area, which is in direct contact with corrosive fluid got badly coroded and eroded.

c). The `O'ring got damaged, as it was seating on an uneven coroded surface.

d) As the `O' ring got damaged, seat face alignment got disturbed causing rubbing marks and hence inboard seal failure.

Actions / recommendations :

1. Casing cover (CS) with throat bush (SS-316) arrangement to be made.
2. Similar modification to be done for pumps with same MOC & service condition.

Plant : VCM
Department : M
Tag No : GA6803S **Tag Description : STRIPPER O/H PUMPS**
FAR No : VCM/M/95/1 **Sr. No : 1552** **Occurrence Date : 05/05/95**

Cause : DE
Description of Failure :
Inboard seal failure - seal pot level falldown immediately.

Observation :
1. Inboard face `O' ring found badly damaged (broken).
2. Inboard `O' ring seat portion eroded and coroded.
3. Found wornout markings on seat area of outboard faces.
4. Other items found ok.

Actions taken :
1. New casing cover installed with throat bush arrangement & pump boxed up.
2. All `O' rings and faces replaced with new one.

Reasons :

1. Spurious `O' ring material.
2. `O' ring overheating.
3. Corrosive fluid handled by the pump.

Analysis :

1. As the `O' ring (viton) is being used in various pumps & as there is no frequent failure due to poor material quality, possibility of spurious `O' ring is ruledout.
2. As the `O' ring is in direct contact with the fluid and as neither the pump nor the seal were running dry, and also physical appearance of `O' ring doesnot reveal any mark of overheating, possibility of `O' ring overheating can also be ruledout.
3. Thus the most likely reason can be corrosive fluid. The sequence of failure can be as follows

a). Service of the pump containing EDC+water+dirt is corrosive and whenever there is upset in the plant, pH will become less.

b). Inboard `O'ring seat area, which is in direct contact with corrosive fluid got badly coroded and eroded.

c). The `O'ring got damaged, as it was seating on an uneven coroded surface.

d) As the `O' ring got damaged, seat face alignment got disturbed causing rubbing marks and hence inboard seal failure.

Actions / recommendations :

1. Casing cover (CS) with throat bush (SS-316) arrangement to be made.
2. Similar modification to be done for pumps with same MOC & service condition.

Plant : VCM
Department : M
Tag No : GA6804A **Tag Description : CONTAMINATED WATER PUMP**
FAR No : VCM/M/95/11 **Sr. No : 1663** **Occurrence Date : 21/07/95**

Cause : DE
Description of Failure :
Inboard seal failure.

Observation :
1. Heat check marks found on inboard insert and seal ring (seal ring found to have cracks on face area in radial direction).
2. Impeller vanes found partially choked.
3. Outboard insert and seal ring found ok.
4. Scratches found on the gland ring,which may be due to rubbing of pumping ring.
5. All `O' rings found ok.

Actions taken :
1. All seal faces and `O' rings replaced by new.
2. Pumping ring replaced by new.
3. Seal tested at 9 kg/sq.cm and found ok. Pump trial taken and found ok.

Reasons :
1. Inadequate supply of buffer fluid.
2. Failure of nitorgen pressure.
3. Improper selection and/or combination of MOC of the I/b seal ring and insert.

Analysis :

1. As the buffer fluid supply was normal,inadequate supply of buffer fluid can be ruledout.
2. As the supply of nitrogen is from special header this reason can be ruledout.
3. I/b seal ring & insert are having MOC as tungsten carbide (TC) & silicon carbide(SC) respectively, which are very hard material. Hence heat check marks developed causing seal failure. As the service fluid contains abrasive particles, TC/SC combination is used. In TC/SC combination, which runs with very high skin temperature, this type of failure cannot be avoided. Only it can be reduced by smoothening the surface at regular intervals. The amount of heat generation is a factor of 1) Surface speed, 2) Area of contact, 3) Compression force, 4) Co-efficient of friction. The first three factors cannot be varied, but co-efficientof friction can be reduced by lapping, inturn reducing the skin temperature.

Actions / recommendations :

1. Lapping of the seal faces to be done after every one & half years of running.
2. MOC of the seal I/b insert to be reviewed after discussion with vendor.
3. Include recommendation in PM ESS.

Plant : VCM
Department : M
Tag No : GA6858AX Tag Description : QUENCH POT CIRCULATION PUMP
FAR No : VCM/M/94/12 Sr. No : 1179 Occurrence Date : 05/02/94

Cause : DE
Description of Failure :
Mechanical seal failures.

Observation : (05/02/94) : I/b seal leakage
1. Shaft-sleeve teflon lining found bulged at front portion.
2. A groove was formed below the back plate portion on the bulged portion.
3. Blackish mark found on the sleeve below the I/b peramic.
4. O/b insert mounting seat's (in polypropylene gland ring) surface found uneven.
5. Shaft runout = 0.04 mm6.seal ring & insert found ok.

Actions taken (05/02/94) :
1. All seal faces replaced.
2. Shaft sleeve replaced.
3. O/b insert mounting fixed by applying sealastic compound.

OBSERVATIONS (07/03/94) : O/b seal leakage
1. O/b peramic seal-ring found broken.
2. Polypropylene gland-ring found badly damaged from inside.
3. O/b insert had come out of gland-ring.
4. The collar (o/b insert mounting seat) in the gland-ring found molten.
5. Compression unit found fully clogged.
6. Shaft runout / radial-play / axial-play=0.04 / 0.04 / 0.02 mm.

Actions taken (07/03/94) :
1. All seal faces & all pkgs. Changed.
2. Sleeve,gland ring & compression unit replaced.
3. Seal rings replaced by silicon carbide ones.
4. Tyre coupling replaced by flexible coupling. * Pumping ring was present (installed on 01/03/94)

OBSERVATIONS (18/03/94) : I/b seal leakage
1. O/b insert mounting squeezed out of the gland ring & found burnt.
2. O/b insert came out of the gland ring.
3. O/b insert seating area thinned.
4. O/b shaft pkg found cut.
5. Teflon lined sleeve bulged out at both ends.
6. Polpropylene gland ring inside surface found melted & de-shaped.

Actions taken (18/03/94) :
1. All seal faces & pkgs. Replaced.
2. New glass filled teflon gland ring installed in place ofpolypropylene gland ring.
3. New teflon lined sleeve installed.* Failed seal rings' MOC = Silicon Carbide* pumping ring was present.

OBSERVATIONS (30/03/94) : o/b seal leakage

1. All faces found ok.
2. O-rings found deshaped.
3. O/b insert mounting seat in gland ring found bulged.
4. O/b insert mounting found to have come out.
5. Sleeve teflon lining found bulged towards impeller side.
6. Shaft runout/radial play/axial play=0.05/0.02/0.00 mm.
7. Actions taken (30/03/94) :
8. Modified sealol make seal installed with face combinationof Carbon Vs Ceramic.* Failed seal rings' MOC. = Silicon Carbide* sleeve lining was virgin; (MOC= Teflon) made in workshop

OBSERVATIONS (31/03/94) : pump found jammed

1. Both mating rings found cracked.
2. Both mating ring packings found burnt.
3. Impeller found touching the back plate.
4. Sleeve found bulged toward impeller side & the bulged portion found sheared.
5. Shaft runout / radial play/ axial play=0.05/0.03/0.00 mm.

Actions taken (31/03/94) :

1. All seal faces & packings replaced.
2. Dura seal with incoloy 825 coated sleeve installed.
3. Peramic seal rings of durametallic make installed.* Face combination of failed Seal faces was peramic V/s car-bon (sealol make).

OBSERVATIONS (04/04/94) : O/B SEAL LEAKAGE

1. Slight scratch marks observed on the incoloy 825 lined sleeve below the seal ring.
2. O/b peramic found broken.
3. Sleeve/shaft run out = 0.12/0.07 mm.4.gland ring i/d found damaged.

Actions taken (04/04/94) :

1. All faces & packings replaced.
2. Sleeve & shaft replaced.
3. Seal plan changed to plan 54 with DM water.* Failed seal rings' m.o.c. was peramic.* Failed gland ring's MOC. was Teflon. Stand by pump -- GA6858SX

OBSERVATIONS (07/04/94) : O/B SEAL LEAKAGE

1. Blackish material found between impeller & back-plate.
2. I/b insert mounting found thinned.
3. I/b side sleeve teflon lining found cut.
4. No buldging of teflon sleeve observed.
5. O/b shaft packing found split to pieces.
6. Seal cavity found fullof blackish material.
7. All seal faces found o.k.
8. Gland ring's insert mounting seat found bulged.
9. O/b insert mounting found melted.

Actions taken (07/04/94) :

1. All seal faces,packings,sleeve and gland ring replaced.
2. Split washer type sleeve installed.* MOC of seal rings was silicon carbide.* MOC of gland ring was Teflon.

OBSERVATIONS (11/04/94) : O/B SEAL FAILURE

1. Compression unit found black in colour.
2. Half the total no. Of springs of compression unit foundbroken.
3. Drive pins of o/b compression ring found worned out. Wearmarks observed on the ring along its circumference.
4. A deep groove observed on the sleeve (o/b side, below theseal ring collar.
5. Gland ring i/d found damaged.
6. All seal faces and packings found o.k.
7. Shaft run-out 0.07 mm.

Actions taken (11/04/94) :
1. All seal faces,packings,sleeve & gland ring replaced.
2. Seal-flushing plan modified to API plan 54.* Seal rings' MOC was peramic.* Gland ring's m.o.c. was teflon.

Reasons :

1. Seal design not suitable for given duty.
2. Polypropylene & Teflon gland- ring material not suitable for higher seal cavity temperature.
3. Higher seal pot oil pressure.
4. Sleeve design not perfect.
5. Oil not suitable as flushing fluid.

Analysis :

M/s goulds pump suggested double cro seal with single coil spring, flushing plan-54 & flushing fluid as water. But in project stage it was changed to flushing plan-53 with flushing fluid as water. Then durametallic suggested cro seal in plan 53 with oil as flushing fluid. M/s Dura's suggestion was tried but with this change the heat generated was not getting removed by flushing oil.this was resulted in :

- High temperature of flushing fluid
- Polypropylene gland ring softened & lost its mechanical strength, which lead to seal failure.
- Teflon gland ring bulged out which lead to seal failure. At this stage, Dura suggested providing the pumping ring in the seal to achieve positive circulation of flushing oil. The pumping ring was provided but it did not improve performance, hence was removed.

Seal pot pressure should have been maintained at 4kg/cm2instead of 7 kg/cm2. Higher pressure caused the teflon gland ring to bulge. Hastelloy-B & Hastealloy-C sleeve tried as per M/s Bfg's recommendation. But it failed due to corrosion. PTFE enveloped S.S. sleeve was developed but due to impeller force & high temperature it got bulged. From the above analysis it can be concluded that heat was not carried away properly from the seal cavity & temp. of flushing oil increasing resulting in failure of polypropylene & teflon gland rings.& Ultimately resulting into mechanical seal failure.

Actions / Recommendations :

1. Flushing plan-54 with water to be used.
2. Frp gland-ring to be developed
3. Polpropylene gland should not be used.
4. Titanium GR-7 sleeve to be developed.

Plant : VCM
Department : M
Tag No : GA6858AX Tag Description : QUENCH POT CIRCULATION PUMP
FAR No : VCM/M/94/20 Sr. No : 1264 Occurrence Date : 16/05/94

Cause : DE
Description of Failure :
Outboard seal failure.

Observation : GA6858AX - 16/05/94
1. O/b peramic face found in pieces.
2. O/b peramic face found to have deep groove.
3. O/b insert sil-car found to have chipped on both ID & OD of mating faces. Rubber like substance found sticking to the seal faces.
4. O/b o ring found deshaped.
5. I/b o rings & faces found o.k..

Actions taken :
1. All seal faces & o rings replaced.

Observations : GA6858SX - 17/05/94
1. Crack found in o/b peramic.
2. O/b insert silicon found to have chipping on both ID & OD of mating face.
3. O/b 'O' rings found deshaped.
4. I/b 'O' rings & faces found o.k.
5. Gland ring insert mounting seat found slightly buldge.

Actions taken :
1. All seal faces replaced.
2. All secondary packing O rings replaced.

Observations : GA6858AX - 25/05/94
1. Gland ring face where the o/b insert fits found buldged.
2. O/b insert found chipped throughout the OD & ID of the face.
3. Compression unit springs found loose.

Actions taken :
1. Spare gland ring & compression unit installed.
2. All seal faces & O rings replaced.

Reasons :
Seal design not suitable for given duty.

Analysis :
Because of the heat generation between the faces i.e.peramic V/s silcaon, peramic seal face observed a thermal shock. This resulted in a breaking of O/b peramic face as peramic being brittle material then silcaon. Morever the rubber like substances which was found on seal faces may have come from rubber hose provided for plan 54 draining caused the seal leakage.

Actions / recommendations :
1. For flushing fluid as water, silicon carbide v/s silicon carbide seal faces to be used instead of peramic V/s silicon carbide as recommended by M/s Durametallic & M/s Jhon zink.
2. FCO to be raised for permanant piping for plan 54.

MECHANICAL SEAL FAILURES

On account of

Implication of External Factors

(like bearing failure, high vibration, Shaft eccentricity etc.,)

Plant : AROMA
Department : M
Tag No : P101B **Tag Description : EXTRACTOR FEED PUMP**
FAR No : FAR/M/98/15 **Sr. No: 2330** **Occurrence Date : 24/10/98**

Cause : DE
Description of Failure :
Pump in-board seal was leaking, oil level in seal pot was coming down @ 3 ltr/hour.

Observation :
The seal leakage started on 21/10/98. Initially the rate of leakage was small, i.e. One litre oil per three hours. Gradually the primary seal leak increased to 3 ltr/hr. The pump was stopped and no seal pot oil leakage was observed in static condition. The pump was restarted after two hours and there was no seal leak for three hours, but then it developed and started increasing gradually. It was decided to dismantle the pump for attending mechanical seal leak. Following observations were made:

1. There was a hole (40 mm x 15 mm size) in impeller backshroud, 75 mm away from the vane tip. It arrears to be a manufacturing defect.
2. Faces of Inboard mechanical seal were found o.k. there was no muck in packings also.
3. Wear ring clearance were with in the limit.
4. There were no marks of rubbing / contact at impeller/casing.
5. After installing new impeller, the current drawn by the pump is increased by 10 amperes.

Reasons :
1. Vibrations in the pump.
2. Improper assembly of the pump.
3. operation of the pump at or near to the shut off head condition.

Analysis :
As per the observation made during seal repairing, the seal faces were found in good condition. Also no muck was found on seal spring. Therefore it is clear that the seal was not leaking due to failure of any of the seal part. Moreover the seal gave a typical leak pattern where in the seal was not found leaking when the pump was stopped and the leakage rate found to be gradually increasing within a span of 3 hrs.
When the pump was opened impeller was observed to be having a hole of 40mmx15mm at a distance of 75mm from vane tip on back shroud. Due to this big sized hole the a recirculation of the pumping fluid may be getting established from high pressure to low pressure area. Since the hole is rotating at the pump rpm, the unbalanced pressure zone is also changing the position with in the casing. This may cause vibrations in the pump which will lead to leakage through seal. Since the problem was solved after replacement of the impeller it is very clear that hole in the impeller is the only reason for seal leakage.
Considering this analysis other probable reasons for seal failure are overruled..

Actions / recommendations :

1. The vendor to be contacted regarding the manufacturing defect in impeller and a free replacement of the same to be asked.
2. The impeller of the stand-by pump to be checked at the available oppotunity.

Plant : CKR
Department : M
Tag No : P210B Tag Description : QUENCH OIL CIRCULATION PUMP
FAR No : FAR/M/99/45 Sr. No: 2286 Occurrence Date : 14/11/99

Cause : PR
Description of Failure :
P210B seal/bearing failure/ fire at pump seal.

Observation :
Fire observed around seal of P210B at 18:05 hrs.pump stopped and fire put off with foam. Earlier GD364 had acctuated. Leakage of hydrocarbon from seal /seal flushing observed. Pump Amps had gone up from 39 to47.

Reasons :
On dismantling the pump the bearing housing was found empty. Hence clearly this is the lubrication failure only.

Analysis :
The problem of improper lubrication of the bearing is attributed to following factors :

1) The PM of the pump was due on in 46th week and was planned on 10/11/99. Due to process requirement the pump was not released for PM. Had the pump was released for PM, the low oil level would have been detected in time and failure could have been avoided.

2) As per the present practice, the area operator is supposed to check the oil level in bearing housing and should report the related problem for necessary correction. However since the area operators are not recording such check points in there log book, the consistency in regular checking could not be ensured and and area operator failed to notice the low oil level in bearing housing. This had resulted into the failure of bearings.

3) The loss of oil can also take place possibly through threaded joints of constant oil leveler, bearing cover etc. But this reason can not be established since no evidence can be obtained.

Therefore analysis at point 1 and 2 seems to support the reason for failure. Due to failure of the bearing the shaft rubbed against bearing cover and generated the shaft. This might had caused spark which had resulted into the fire. On dismantling the seal the faces were found in good condition. However since the shaft had moved axially the leakage of quench oil took place through seal wedges.

Actions / recommendations :
1. The log book of area operators should be modified to include oil level indications of there area.
2. A RI (Reliability Improvement) schedule checking and recording parameters like oil leak checking, vibrations level recording at a set frequency is already in existance in plant. It is to be incorprated in IPMS for planning and proper follow up.
3. Pump high Amperage alarm to raise alarm at 45amp (normal current 41amp, FLC 49amp) to be provided in DCS for timely action of pannel operator. Process to raise instrument change order.

Plant : MEG
Department : M
Tag No : P203 Tag Description : CONDENSATE CIRCULATION PUMP
FAR No : MEG/M/96/9 Sr. No: 1956 Occurrence Date : 23/07/96

Cause : DE
Description of Failure :
Leakage through shaft sleeve.

Observation :
Heavy seal leakage was observed from seal / sleeve. Pump was dismantled and seal was opened. On opening the pump following observations were recorded.
1) Rubbish (brownish) & wear marks on shaft and sleeve ID.
2) Impeller nut found with deep groove (2-3 mm) at the gasket seating area.
3) Impeller nut gasket found damaged.
4) Seal faces were found in good condition.
5) Iimpeller vanes were found eroded at the hub area.:

Actions taken :
1) As new impeller nut was not available, old impeller nut was machined after filling the groove by welding wither 304 filler wire.
2) Old impeller, shaft and old wear ring were reused as new spares were not available.
3) Impeller nut gasket, sleeve gasket and all packings were replaced.
4) Seal cooler was opened for inspection and found normal.
5) Pump was boxed up,charged the system with steam and hot alignment was carried out.
6) Pump trial was taken and zero seal leakage was observed.

Reasons :
1) Failure or damage of seal internals.
2) Damage of impeller nut / impeller nut gasket.
3) Improper tightening of impeller nut gasket in previous overhaul.
4) Improper cooling of the flushing fluid in seal cooler.
5) High axial and radial play in bearings.

Analysis :
Analysis for reason no 1:
On opening the pump, seal faces, compression unit and all elastomers were found in good condition. Hence, this reason can be eliminated.

Analysis for reason no.2:
From the history it is clear that, this pump was overhauled several times for seal repair. In,the previous repair, impeller nut which developed grooves were filled and machined. As this nut was machined for more than once, hardness of gasket seating area must have reduced & soft interior got exposed, resulting in frequent failure of impeller nut and there by gasket failure.

Analysis for reason no 3:
If the impeller nut was not properly tightened, in the previous overhaul, it could result in erosion of gasket seating area and formation of grooves on it.this could result in damage of gasket seating area and subsequent seal failure. Also due to repeated repair of this pump, the thread insert inside the impeller nut must have lost its positive locking property resulting in loosening of the impeller nut.

Moreover this pump handles hot condensate of max.240 degree celsius, which could result in loosening of the impeller nut. Once, the impeller nut gets loosened, its gasket seating area gets damaged resulting in seal leakage. However on opening the pump impeller nut gasket was found tight. Hence, this reason can be eliminated.

Analysis for reason no 4:
Improper cooling of flushing fluid can result in vapori-zation, resulting in vapor lock. This in turn will break the film between seal faces, resulting in rubbing marks and heat marks on seal faces and subsequrntly seal leakage. However on opening the seal, seal faces were found in good condition. Hence, this reason can be eliminated.

Analysis for reason no 5:
As this pump handles condensate of 240 degree celsius temp. and this pump is in charged condition continuously, there is a slim possibility of expansion of bearing housing resulting in increased bearing clearances and clearance between bearing housing and bearings. This could lead to vibration at seal area and subsequent deterioration in seal performance. Hence, reason nos, 2 & 5 can be attributed to seal failure.

Actions / recommendations :

1. Provision of viton o-ring between shaft & sleeve to prevent leakage from the sleeve.
2. Provision of cooling media to bearing housing / pedestal (asper api plan 'G' or plan 'E' to be studied to prevent increased bearings / bearing housing temparatures and clearances.
3. Thread insert to be replaced after every opening of the impeller nut.

Plant : MEG
Department : M
Tag No : P314 **Tag Description : WP INJECTION PUMP**
FAR No : MEG/M/96/10 **Sr. No: 1957** **Occurrence Date : 11/09/96**

Cause : SU
Description of Failure :
Leakage from shaft sleeve.

Observation :
Moderate seal leakage was observed from sleeve. Pump was opened and following observations were recorded.
1) Impeller nut was loose.
2) Thread insert in the impeller nut was found missing.
3) Impeller nut gasket was found damaged.
4) Seal faces were found in good condition.

Actions taken:
1) Pump was boxed up with new packings and old impeller nutas new impeller nut was not available. Impeller nut was tightened with loctite and lead wire.
2) Impeller nut gasket was renewed.
3) Pump trial was taken and found zero leakage.

Reasons :
1) Damage of seal internals.
2) Failure of impeller nut gasket and sleeve gasket
3) High vibrations.

Analysis :
Analysis for reason no.1
After opening the pump and seal assembly, seal internals were found in good condition. Hence,this reason can be eliminated.

Analysis for reason no.2:
On opening the pump,impeller nut was found loose.also,thread insert was found missing.impeller nut could become loose,for two reasons. (a) Improper assembly of pump (b) Missing thread insert. Of these two above reasons, missing thread insert could be the most possible reason for impeller nut becoming loose. Once, the impeller nut is loose, impeller nut gasket, impeller and sleeve gasket becomes loose resulting in leakage path through sleeve. Hence, this is the reason for leakage through shaft sleeve.

Analysis for reason no 3:
The condition monitoring reports carried out by plant maintenance reveal no abnormal vibrations in the pump or from it's prime mover. Hence, this reason can be eliminated. Hence, reason no 2 can be attribured to leakage from seal/sleeve.

Actions / recommendations :

1. Ensure that new thread insert is fixed every time after opening the pump.
2. Better MOC of impeller nut gasket and sleeve gasket should be explored with vendor

Plant : MEG
Department : M
Tag No : P405A **Tag Description : HIGH PURITY EO PUMP**
FAR No : MEG/M/97/16 **Sr. No: 2048** **Occurrence Date : 03/02/97**

Cause : DE
Description of Failure :
Heavy outer seal leakage.

Observation :
Heavy outer seal leakage was observed. On opening the pump following observations were recorded.
Outer seal carbon face was found badly chipped. slight chipping marks were observed on the carbon face of inner seal also. Minor groove was observed on the sealing area of the sleeve

Actions taken: Sealing area of the sleeve was lapped. Seal was assembled with new faces [outer & inner],packings,o-rings, and compression unit. Pump trial was taken. No seal leakage was observed.

Reasons :
1. Aging of the seal
2. Entry of foreign matter inside the seal.
3. Reusing of damaged sleeve.
4. Incorrect flushing fluid pressure.
5. Misalignment

Analysis :
Analysis for reason no 1:
As the seal has failed within two months, the seal failure due to aging is ruled out.

Analysis for reason no 2 :
On opening the seal no foreign material is found inside the seal. Hence, this reason is also ruled out.

Analysis for reason no 3:
In the previous failure of seal (31/12/96), no mention was made regarding the condition of sleeve. On opening the pump on 03/02/97, a groove was observed on the sleeve. Reason for leakage from seal can be attributed to the formation of groove on the sleeve. Groove on the sleeve can be formed due to following reason. Fretting of sleeve/ elastomer. Since the wedge packing is a dynamic packing,frequent rubbing against sleeve must have caused pitting/galling of sleeve in packing area, which led to leakage. (moreover,sleeve is not supplied as a mechanical sealspare and is also not covered under inventory control. Hence,old sleeves are being reused).

Analysis for reason no 4:
From the observations it was found that the outer seal carbon face was found chipped, and slight chipping marks were found on the carbon face of the inner seal also. This chipping of the seal places could take place due to following reasons.
1) Seal faces not flat.
2) Excess / inadequate flusing fluid pressure.
3) Excessive compression of the compression unit. From the overhauling report it is clear that new sealfaces are used. Hence, this reason can be eliminated. Excess /over pressurization of flushing fluid does result in chipping at the edge of faces. As the flushing fluid pressure is maintained through pressure controlling mechanism, chances of excess or inadequate flushing fluid pressure

is remote. Hence, this reason can be eliminated. Excess compression of the compression unit can result in chipping of the seal edges. However on opening the seal, compression unit was found to be free. Hence, this reason can also be eliminated.:

4) Analysis for reason no 5:

Misalignmnet of the pump can result in high vibrations of the pump and result in seal failure. The standard practice of carrying out alignment with dial gauges is pracised. Hence, there is no possibility of misalignment. Thus this reason is eliminated. However, considering the frequent cleaning of suction strainer (once in every 10 days) and to eliminate the possibility of pump alignment getting disturbed, it issuggested to do alignment during every PM check. Hence, reason no 3 can be attributed to seal failure.

Actions / recommendations :

1. For P405 A&B alignment should be carried out with every PM check. To be included in equipment service sheet.
2. As sleeves are not covered under mechanical seal spares, these should be covered under inventory control.
3. The regular condition monitoring check (for semi critical equipments) should be carried out relegiously.

Plant : MEG
Department : M
Tag No : P506A Tag Description : GLYCOL FLASHER I BOTTOMS PUMP
FAR No : MEG/M/95/1 Sr. No: 1478 Occurrence Date : 19/01/95

Cause : DE
Description of Failure :
Mechanical seal leak (between sleeve and shaft).

Observation :
Pump casing was pressurized to locate seal leak. Seal leak observed from between sleeve and shaft. Pump opened. No abnormality observed in impeller nut or impeller to sleeve gasket. Pump casing pressurized again. This exercise was carried out for a few times. Finally, CES carried out a DP test of the impeller. One pin hole was observed. Pin hole area was ground and welded.

Reasons :
1. Impeller to sleeve gasket failure.
2. Impeller nut gasket failure.

Analysis :
The seal leaked as mentioned earlier because the pin hole by-passed the gasket sealing between impeller and impeller nut.the casing defect in the impeller, (though) must have been present since its manufacture; but it opened up only after pump operated for over 3 years under service conditions fluid attack, cavitation, vibration, temperature variations,etc.

Actions / recommendations :

1. Inform pump vendor regarding the defect.

Plant : MEG
Department : M
Tag No : P841B **Tag Description : SUMP PUMP FOR V841**
FAR No : MEG/M/95/2 **Sr. No: 1480** **Occurrence Date : 01/02/95**

Cause : DE
Description of Failure :
Motor tripped on overload. Pump was found jammed.

Observation :
Pump shaft found jammed. Luboil quality found satisfactory. All bearings found completely damaged. Circlip of DE side bearing found twisted. Mechanical seal leakage.

Reasons :
Pump bearings have operated without adequate lubrication and hence the bearings have failed. Shaft has jammed after bearing failure. Mechanical seal might have also been damaged during the process of bearing deterioration and seizure.the circlip might have been twisted as a result of being subjected to abnormally high axial forces during bearing deterioration and seizure.

Analysis :
The position of the constant oil leveller is such that the oil level remains below the outer races of the bearings. The bearings thus operated under inadequate or no lubrication bearings were thus damaged. The bearings might have survived so long without adequate lubrication because the pump doesnot run continuously.shaft seizure, mechanical seal failure and twisting of circlip were as a consequence of bearing failure.

Actions / recommendations :

1. Raise oil level in the bearing bracket to a level as recommended for antifriction bearing operation.

Plant : MEG2
Department : M
Tag No : NP302AHT Tag Description : Hydraulic Turbine Drive For NP302A
FAR No : MEG2/M/97/2 Sr. No: 2 Occurrence Date : 04/08/97

Cause : DE
Description of Failure :
Seal and bearing failure.

Observation :
On opening the pump the following observations were recorded. Lot of ferrous particles were found adhered to impeller and casing. Impeller wear rings found touching. Seal faces damaged. Bearing damaged. A thick layer of iron carbonate found on impellers and casing.

Actions taken :
1. Impeller was sand blasted and casing was thoroughly cleaned.
2. Seal assembly, bearings and impeller wear rings were renewed.
3. All packings were replaced with new packings. Pump trial was taken and found to be running satisfactorily.

Reasons :
1) Imbalance of rotor assembly.
2) Improper lubrication

Analysis :
Analysis for raeson no 1:
From the observations it is clear thst lot of iron carbonate deposits were found adhered to impeller and casing. These ferrous particles were the result of erosion of top dome of NE304 which is in the up stream of this pump.this deposition of ferrous particles has resulted in the imbalance of the rotor assembly, high vibrations and bearings failure. Bearing failure caused the seal damage. Hence, this is the reason for bearing and seal failure.

Analysis for reason no 2:
Improper lubrication can also result in bearing damage and seal failure. But on opening the pump oil quantity and quality were found to be satisfactory. Hence, this reason can be eliminated.

Actions / recommendations :

1. As such type of failures are remote no corrective actions were recommended.

Plant : PE
Department : M
Tag No : GA3417A **Tag Description : HP DTA CONDENSATE PUMP**
FAR No : FAR/M/97/8 **Sr. No: 2386** **Occurrence Date : 25/12/97**

Cause : PU
Description of Failure :
Seal leak observed.

Observation : -Drop wise DTA leakage observed from seal.
-Seal flush cooling water outlet temperature was high.

Action taken :
-Pump was removed fromsite for seal replacement.
-On dismantaling it was found Rotary face(carbon) slightly damaged. Complete set of seal was replaced.
-Seal flush cooler found choked with cooling water slush. Cooler was cleaned and boxed up.

Reasons :
Chocking of Seal Flush cooler.

Analysis :
Due to hot services (DTA temp~300 deg .cent) liquid loses its lubricity resulting in high seal face wear. As the operating temp is very highit is necessary for the cooler to work efficciently.Also the seal has been found working without any problem last year (1996-1997). In the above scenario it appers that the cooler / lines are getting restricted due to formation of scales. As the cooler was choked and the flushing liquid from the discharge was not sufficiently cooled, the seal faces could not get required quenching. This as resulted in seal failure.

Actions / Recommendations :

1. Seal flush cooler to be cleaned thoroughly during PM as included in ESS.
2. Outlet temperature of CW at the out let of seal flush cooler to be monitored.
3. Vendors to be contacted for change in seal design for frequent failure.

Plant : PE
Department : M
Tag No : GA3210A **Tag Description : RB REFLUX PUMP**
FAR No : HDPE/M/94/20 **Sr. No: 1159** **Occurrence Date : 23/02/94**

Cause : DE
Description of Failure :
Mechanical seal leak.

Observation :
1) Heavy seal leakage observed.
2) Suction strainer found clean. Impeller vane found cracked.
3) Wearing marks found on sleeve (impeller side)
4) Spring found chocked with traces of polymer/grease.
5) Rotary head assembly found jammed.
6) Shaft run out at step = 0.05 mm. Shaft run out at impeller end = 0.03mm Sleeve run out = 0.05 mm. Shaft axial float = 0.06 mm. Shaft radial play = 0.20 mm. Throttle bushing clearance = 0.8 mm. All elostomers found in good condition. Seal faces found in fairly good condition.

Action taken :
1) All bearing replaced.
2) Pump impeller replaced.
3) Seal faces replaced with new one. (predictively- as oneyear has passed)
4) Shaft sleeve rplaced.

Reasons :
1) Clogging of spring of rotary head assembly by polymer /grease might have restricated the axial movement of seal faces leading to seal leakage.
2) Radial play in the bearing might have caused the faces to run eccentric leading to seal leakage.

Analysis :
1) Hydraulic forces in a pump impeller can not be so high to break the impeller except in the case of severe cavitation, sustained for a very long time, so it is almost sure that the impeller had a hair crack at the time of manufacturing and it remained unnoticed by the vendor which enlarged slowly in last 1 year and eventually failed.
2) Casting defect at manufacturing stage might have developed a crack in impeller.
3) Ingress of grease/polymer in the pump might have led to overloading of impeller & its cracking. Henceforth.this might have led to unbalanced forces on shaft & increased radial play of the pump.

Actions / recommendations :

1. Use of additional conical strainer in pump's suction after shut down & polymer carry over.
2. Explore the possibility of using semi open/open impeller in lieu of present closed one.

Plant : PE
Department : M
Tag No : GA3417A **Tag Description : HP DTA CONDENSATE PUMP**
FAR No : PE/M/95/21 **Sr. No: 1723** **Occurrence Date : 11/08/95**

Cause : PR
Description of Failure :
Mechanical seal was found to be leaking.

Observation :
The mechanical seal was found to be leaking. There was no other abnormality.

Actions taken :
The pump was immediately taken under maintenance. The mechanical seal was dismantled. The graphite packing beneath the TC was found in a damaged condition. Impeller nut was found loose. No other abnormality was found in the seal. The packing was replaced along with all other elastomers. The seal was boxed up.

Reasons :
The probable reason of failure is looseness of impeller nut in its position.

Analysis :
The probable reason of failure was due to the looseness on the impeller, due to which the compression force of the seal is reduced resulting in seal leakage. The looseness of the impeller may be due to worn out impeller thread, worn out shaft thread, prematurely deformed thread insert or improper nut tightening.

Actions / recommendations :

1. Shaft, impeller nut & key to be replaced during next overhauling
2. Threaded insert to be replaced if found defective during overhauling.

Plant : PE
Department : M
Tag No : GA3103S **Tag Description : REACTOR FEED BOOSTER PUMP**
FAR No : PE/M/95/25 **Sr. No: 1791** **Occurrence Date : 18/10/95**

Cause : PR
Description of Failure :
Puffing of process fluid from mechanical seal assembly.

Observation :
No other abnormality observed other than puffing. Initially puffing was 5 to 6 times per minute, which later on increased to 10 to 12 times per minute. Pump was dismantled and parts were inspected. Carbon face was found chipped from inside. End play was found to be 0.32mm. Bearings were found to be ok.

Actions taken :
Replaced with new faces and 'o' rings. End play was arrested to 0.02 mm by inserting shims.

Reasons :
The reason of failure is puffing and blowing of vapours at the seal faces which is known as vaporization. This results in excessive leakage and damage to them. If vaporization does not cause catastrophic failure, it usually shortens seal life and impairs seal performance. The reasons of vaporization are :
1. Excessive seal face deflection.
2. Excessive pressure for a given seal.
3. Inadequate cooling and lubrication of the seal.

Analysis :
Vaporization occurs when heat generated at the seal faces cannot be adequately removed and the liquid between them flashes. Vaporization can also be caused by operating the seal too near the flash temperature and flash pressure of product in the seal cavity. As the pump is handling ethylene slight heat generation at the seal faces will lead to vaporization.
1. Excessive pressure for the given seal can be ruled out as the other auxillary pump is running without any such problems.
2. Excessive seal face deflection can be the most probable cause of failure. This can be due to overloading of seal. On opening the pump, the end play was found to be 0.32 mm which is a bit high (maximum value = 0.1mm). The bearings were found to be ok. The end play was arrested by adding shims to 0.02 mm.
3. Inadequate seal cooling and lubrication of the seal can be ruled out as same cooling system is used for the auxillary pump. But the puffing can be reduced by improving cooling. The seal & sleeve dimensions were checked as per drawing and seal compression was checked. All dimensions were found to be correct.

Hence the probable reason of failure can be excessive seal face deflection which can be due to high end play.

Actions / recommendations :

1. Whenever there is an opportunity for maintenance, the pump end play has to be checked.
2. Improve cooling of seal faces.

Plant : PE2
Department : M
Tag No : NGA3210A **Tag Description : RB REFLUX PUMP**
FAR No : FAR/M/97/4 **Sr. No: 4** **Occurrence Date : 09/07/97**

Cause : SU
Description of Failure :
Mechanical Seal leak.

Observation :
Mechanical Seal was found to be leaking. On dismantaling the pump, the bearing housing oil was found mixed with water, all the bearings were found damaged, seall faces were damaged. Air breather cap was found broken at the bottom .

Action taken :
Pump was assmbeled with new set of bearings, new seal faces, new breather cap boxed up and handad over.

Reasons : Oil contamination with water can be due to
1. Leakage of bearing jacket water cooler.
2. Deflector failure.
3. Air breather capfailure.

Analysis :
1. On opening the pump bearing jacket was checked and there was no leakage of cooling water into the bearing housing. First reason is ruled out.
2. Deflector was in good condition there is no possiblity of water entry into the bearing housing. Second reason is ruled out.
3. Air breather cap was found broken at the bottom , due to heavy rains the water has entered the bearing housing and contaminated the oil and damaged the bearings. They in turn damaged the seal. This is the probable reason for the failure
.

Actions / Recommendations :

1. During PM as included in ESS healthiness of the air breather should be poistively checked.

Plant : PTA
Department : M
Tag No : G1-703A Tag Description : CATALYST SOLUTION FEED PUMP
FAR No : FAR/M/98/28 Sr. No: 2401 Occurrence Date : 10/09/98

Cause : PR
Description of Failure :
Inboard seal leak in G1-703A pump

Observation :
Pump was dismantled for inboard seal leak and following observations were taken.
1. Minor rubbing marks observed on sleeve
2. Inboard carbon bellow assy. Found deformed (approx. 2mm) relative to new carbon bellow assy.
3. The bellow was found compressed,

Actions taken
Pump was assembled with new carbon bellow assy./new sleeve and all o-rings

Reasons :
1. Problem with the pump bearing.
2. Improper selection / Design of the seal

Analysis :
Analysis For Reason No 1 :
Refering to the history it is found that brgs have failed during previous two occasions. Failure of the bearing also lead to the seal failure. The bearing can fail due to misalignment, improper lubrication,wrong assembly procedures, spurious bearings etc. Presently the pump is not coverd in PM list. The vendor has recommonded replacement of oil after every 1000 hrs. This works out to 42 days. Therefore use of oil for the time more than specified will reduce the life of bearing. Also by doing the PM regular checks like oil leakage through oil seals, oil level checks in the brg housings, oil leveler conditions etc are done. However presently since the pump is not covered in PM list these checks are not performed. All these factors together reduce the life of the bearing and inturn cause the failure ofthe seal.
So, the bearing failure is one of the contributing factors in mechanical seal failure.

Analysis for reason No. 2
Refering to the history it appears that in the seal assembly, mainly the bellowis getting damaged repeatedly. Therefore there may be some problem with the bellow itself. It was observed that the bellow got permanently compressed and did not come to its original shape(Observation) The seal vendor therefore required to be consulted for the analysis of bellow failure.

So, the improper design of mechinical seal bellow alongwith the bearing failure is the main cause of seal failure.

Actions / recommendations :

1. The pump to be included in the PM list.
2. The vendor to consulted for checking the suitability of the seal.

Plant : VCM
Department : M
Tag No : GA2515A **Tag Description : 20% CAUSTIC TRANSFER PUMP**
FAR No : VCM/M/96/2 **Sr. No : 1855** **Occurrence Date : 21/02/96**

Cause : DE
Description of Failure :
Seal leakage.

Observation :
1. Seal mating ring found to have a groove at the ID of mating surface.
2. Seal ring found to have shining surface at the ID of the mating surface.
3. Plan-62 circulation (water) area found heavily choked with caustic.
4. Plan-62 inlet port found clean, outlet port found choked.
5. Eccentricity of shaft to stuffing box found to be 0.46 mm.

Actions taken :
Seal parts replaced. Choking cleared.

Reasons :

1. High vibration.
2. Improper flushing of the seal.

Analysis :

1. As the shaft runout, radial play and axial play are within the limit, high vibration can be ruled out.
2. Due to eccentricity of shaft with stuffing box, water which is used as flushing media (plan-62) was leaking out through the clearance between throttle bush and sleeve. Due to this leakge caustic was not getting flushed and was accumulating in the circulation area. This has lead to seal leakage. The reason for shaft eccentricity can be due to the following reasons. Defective shaft, defective sleeve,sleeve loose on the shaft, defective pump stuffing box (housing) or defective gland plate.

Actions / recommendations :

1. To establish the exact cause of shaft eccentricity by dimensional checking.

Plant : VCM
Department : M
Tag No : GA2515A Tag Description : 20% CAUSTIC TRANSFER PUMP
FAR No :VCM/M/95/18 Sr. No :1758 Occurrence Date : 21/09/95

Cause : DE
Description of Failure :
Seal leakage.

Observation :
1. Seal ring face found loose in the holder. Mating ring found slightly wornout. Secondary packings found ok.
2. Seal gland ring area found clogged with caustic.
3. Drive end angular contact bearing (7309 BECBP) found damaged.
4. Water found inside the bearing housing.
5. Shaft found eccentric with respect to gland.
6. Shaft runout=0.05mm, shaft radial play=0.04mm & shaft axialplay=0.02mm.

Actions taken :
1. Seal faces (Seal ring- Tungesten carbide and Mating ring-Sealide) and secondary packings replaced.
2. All bearings replaced.

Reasons :

A. Mechnical seal failure
1. High vibration.
2. Improper seal design.
B.bearing damage
1. High vibration.
2. Water entry.

Analysis :
A. Mechanical seal failure :
1. As shaft runout, radial and axial play are within the limit high vibration can be ruledout.
2. In the seal ring assembly, the tungsten carbide face is fixed to the holder (press fit). As the seal face got detached from the holder, leakage started from the gap between holder and face.

B. Bearing damage :
1. As shaft runout, radial and axial play are within the limit. High vibration can be ruledout.
2. Water which is used as seal flushing fluid (API-Plan 62) entered the bearing housing contaminating the oil & hence causing bearing damage. The reason for water entry is increase in clearance between throttle bush and sleeve. This increase in clearance might be due to shaft eccentricity, which can be due to the following reasons. Defective shaft, defective sleeve, sleeve loose on the shaft, defective pump stuffing box (housing) or defective gland plate.

Actions / recommendations :
1. Similar seal failure occured in the standby pump. Hence the same recommendation (FAR no.VCM/M/95/15) to be implemented which is as follows - Seal manufacturer to install the seal and study subsequent failure.
2. To establish the exact causeof shaft eccentricity by dimensional checking and replace the defective parts.

Plant : VCM
Department : M
Tag No : GA2537S Tag Description : IMPORTED EDC FEED TRANSFER PUMP
FAR No : VCM/M/94/3 Sr. No : 1145 Occurrence Date : 07/11/93

Cause : PR
Description of Failure :
1. Slight rubbing sound in the de bearing area.
2. Inboard seal leakage.

Observation :
1. Both bearings found damaged because of excessive clearance & oil found blackish in colour.
2. Shaft runout - 0.04 mm
3. Inboard sealring found jammed on sleeve due to ingress of solids between sleeve & sealring.

Actions taken :
1. All bearings replaced by new ones.
2. All seal faces & "O" rings replaced by spare ones.

Reasons :

1. Seal leakage because of bearing damage.
2. Ingress of solids in seal chamber and seal ring jammed onsleeve.
3. Lubricant got fouled because of bearings which got damaged.

Analysis :

1. Seal failed because of bearing failure & ingress of solid in seal chamber seal ring being jammed on the sleeve.
2. The bearings gave a life of about 2 years.
3. The pump being semi critical, its CM is not covered by CES. Vibration readings taken by plant did not indicate high vibration before failure.

Actions / Recommendations :

1. Examine the solids found in seal chamber.
2. Vibration readings taken by plant to be recorded & to be taken on condition monitoring by CES.

MECHANICAL SEAL FAILURES

On account of

Improper start up and Improper Operation conditions / Procedures.

Plant : AROMA
Department : M
Tag No : P113A **Tag Description : VACUUM PUMP**
FAR No : AROMA/M/97/2 **Sr. No: 2309** **Occurrence Date : 18/09/97**

Cause : SU
Description of Failure :
Inboard seal (drive end) failure

Observation :
1. While carrying out PM jobs for the pump,seal pot oil was checked and tried to increase the level (by pumping with hand pump)
2. But level was not getting increased, the seal pot drain was opened and seal pot was found to be dry. The level gauge bottom isolation valve was found to be in closed condition.
3. The level gauge was indicating level, due to isolation of level gauge bottom isolation valve, even though the seal pot was empty.
4. Pump seal was dismantled, seal faces were having scoring marks due to dry running.

Actions taken:
The worn out parts (seal faces-carbon & durachrome) and the 'O' rings were replaced.

Reasons :
The isolation valves of the level gauge of the seal pot were kept closed when the pump was operating.

Analysis :
Since the isolation valves of the level gauge of seal pot were kept in closed condition while the pump was running, the loss in seal oil level due to consumption over a long period of time went unnoticed. The level gauge was wrongly indicating level since the level gauge isolation valve was in closed condition. Seal pot level dropped gradually and the pump seal was running dry. This resulted in wearing out the seal faces and failure of seal.

Actions / recommendations :

1. The isolation valves of the seal pot level gauge are to be kept in open condition and regular check list should be in place.

Plant : CKR
Department : M
Tag No : P701A **Tag Description : 1ST STAGE FEED PUMP**
FAR No : FAR/M/97/4 **Sr. No: 2245** **Occurrence Date : 29/10/97**

Cause : DE
Description of Failure :
1. P701a mechanical seal failure : 29/10/97.
2. Bearing and shaft sleevedamage during trial on 30/10/97.
3. Bearing and sleeve damage during trial on 02/11/97.
Pump in breakdown condition till date due to want of critical spares.

Observation :
1. 29/10/97 : Pump seal pot was getting drained. Pump pwas dismantled, O rings were found to have deformed. Pump was reassembled and trial taken on 30/10/97.
2. On startup [30/10/97], the rotating parts rubbed. Pump was stopped immediately and dismantled, bearings and shaft sleeve were found damaged.
3. Pump was rassembled and trial taken on 02/11/97.
4. On 02/11/97- similar rubbing of rotating parts was observed immediately after start up. Pump was stopped. On dismantling, bearings and sleeve found damaged.

Reasons :
1. Wrong assembly .
2. Wrong piping configuration / Partial choke of suction line portion leading to P701A.
3. Improper operation procedure.

Analysis :
Pump has a history of similar failures and four times it had failed soon after overhauling, during trial run after overhauling.
Pump vendor's service engineer inspected pump on 15/10/97 and reported that no mechanical problem exists [all clearances, assembling procedures and condition of parts were checked by vendor's representative and confirmed that everything is o.k.]. Recommended start up and change over procedures. Also advised not to run both pump simultaneously. All recommendations implemented, still failure could not beprevented.

Both the start up procedures [for (1) sop when boththe pumps are healthy and (2) sop when one pump is unhealthy afer maintenance.- Both provided by vendor m/s. Sunstrand], were tried during the trial run of the pump P701A on 29, 30/10/97 and 02/11/97 and the pump failed under both the procedures.

Pump history of failures sent to M/s sundstrand for analysis and recommendations. Pump suction and discharge line lay outs also sent to sundstrand for study. Report awaited

Analysis for reason no. 1 :
Wrong assembly - This reason is ruled out since all the aspects involved in assembling werechecked and confirmed in presence of vendor's field engineer.

Analysis for reason no.2 :
Wrong piping configuration - This is to be checked and confirmed by piping expert.
Partial choke of suction line portion leading to P701A - This reason could not be confirmed since the pumping fluid is a clean fluid and during all previous occasions, when the strainer was opened

for cleaning, no particle was found from the strainer. However during the next available shutdown opportunity, the suction line portion leading to P701A may be opened and checked.

Analysis for reason no.3 :
Improper operation procedure - This reason can not be ruled out since the pump has falied even after adapting the modified operation procedure suggested by the vendor's field engineer.

Actions / recommendations :

1. Pump's suction line / discharge line lay out may be modified after getting reply from vendor M/s.Sunstrand and study by piping expert.
2. During next shutdown opportunity the suction line portion leading to P701A from the branch from common suction header may be opened and checked for any obstruction to flow.
3. Operation procedure may be modified to take care of: (1) minimum time on recirculation and minimum overall simultaneous running of both the pumps,during change over. (2) ergonomics of operator involved in change over of pumps [location of ammeters & pressure guages, distance and movement between valves etc., Finally facilitating smooth pump change over].

Plant : CKR
Department : M
Tag No : P210C Tag Description : QUENCH OIL CIRCULATION PUMP
FAR No : FAR/M/99/29 Sr. No: 2270 Occurrence Date : 13/02/99

Cause : PR
Description of Failure :
1. Heavy mechanical seal leak noticed.
2. Quench oil coming out of seal with smoke.

Observation :
1. After disassembly of mechanical seal , mating ring found completely damaged.
2. Mating ring seating area of gland plate found damaged.
3. Bearing found badly damaged and both the bearing covers also damaged.
4. Strainer in seal flushing line (plan-32) was chocked onthe down stream side with coke lumps.

Action taken :
1. Sealfaces and packings were replaced.
2. Glandplate and bearing covers repaired and assembled.
3. Bearings were replaced.

Reasons :
After discussions with process and plant maintenance and also after referring to the observations made at the time of attending the seal it was concluded that the failure of the seal took place due to reduction of flushing fluid pressure in the stuffing box. The reduction of the pressure can take place due to
1) choking of the strainer in seal flushing line.
2) closed valves in seal flushing line.

Because of the failure of the seal the quench oil leaked through stuffing box and entered in to bearing housing resulting in bearing failure.

Analysis :
Reason no 01 (chocking of the strainer in seal flushing line.)

The pump seal is provided with flushing plan 32. For flushing of the seal pan oil is used as the flushing fluid. For this purpose a tapping from delivery of the pan oil pump P-211 A/B has been provided. A filter is also provided to filter the pan oil before it enters the pump seal.since lots of quench oil deposites were observed on seal components it is quite cleare that circulation of flushing oil to seal had reduced due to chocking of the filter. Due to lesser pressure of flushing oil the pumping fluid entered into stuffing box causing damage to seal components. Therefore this reason seems to support the cause of seal failure. After refering to ESS it was also observed that cleaning of filter in flushing line at the time of PM is not mentioned. Due to this the filter in the flushing line remained unattended for a long time causing the chocking and hence the seal failure. Therefore modification of ESS is required to prevent the occurance of similar failure in future.

It was also noted that a pressure gauge is provided downstream of seal flushing line to check the pressure of flushing fluid going to stuffing box. However this pressure was not monitored on a regular basis. Therefore reduction in the flushing fluid pressure could not be detected in time. The timely detection of reduced pressure would have helped in preventing seal failure.

Reason no 02 (closed valves in seal flushing line.)

Since the pump was in running condition before failure, it is clear that the valve was kept in open condition, otherwise the seal might have failed immediately. Therefore this reason for seal failure is ruled out.

Actions / recommendations :

1. The filter in the seal flushing line should be cleaned in every pm.
2. The ESS should be modified to cover the job of strainer cleaning during PM.
3. The flushing fluid pressure to be monitored regularly and should be recorded in the operator's log book.
4. Explore possibility and cast implication of installing flow meter in flushing line which will ensure adequate flushing

Plant : MEG2
Department : M
Tag No : NP602A **Tag Description : MEG COLUMN BOTTOMS PUMP**
FAR No : FAR/M/97/4 **Sr. No: 4** **Occurrence Date : 26/07/97**

Cause : DE
Description of Failure :
Mechanical seal leakage.

Observation :
Temperature of seal flushing fluid is found to be very high. Carbon faces of both in board and outboard were found in damaged condition. Packings were replaced. Only carbon rings of both in board and outboard were renewed. Cooling water lines were flushed.

Reasons :
1) Entry of foreign particles
2) Insufficient seal flushing fluid.

Analysis :
Analysis for reason no 1:
Entry of foreign particles between seal faces can lead to the failure of mechanical seal. But upon opening the seal, no foreign particles were observed. Hence this reason can be elimineted.

Aanalysis for reason no 2 :
Insuffficient cooling water flow to the seal will damage the seal faces. The seal fluid tends to get vaporised when there is inadequate lubricatoin to seal faces. The vaporisation of the seal fluid at seal faces causes breakage of the thin lubricating film between the faces. This wil eventually lead to the mechanical seal failure. In this case, thecooling water flow when measured was found to be 15 lit/min against30lit/min as recommended by the vendor M/s khimline pumps limited. Hence, it is obvious that low cooling water flow is the reason for seal failure.

Actions / recommendations :

1. Cooling water line size to be suitably increased to get the reqd. Flow of 30 lit/min.

Plant : PTA
Department : M
Tag No : G1-1602B **Tag Description : PTA M/L COOLER FEED PUMP**
FAR No : PTA/M/97/13 **Sr. No: 2328** **Occurrence Date : 11/08/97**

Cause : PR
Description of Failure :
Mechanical seal leakage was observed from the pump.

Observation :
On dismantling the pump, the following observations were made
1) The ingress of the operating fluid in the seal chamber.
2) Excessive wear on the seal faces.
3) Crack in the throat bush.
4) Wear marks on the sleeve at the throat bush locating region.
5) Looseness of the throat bush inside the seal chamber.

Actions taken :
A new throat bush was fabricated in the CES workshop and the pump was reassembled with a new seal.

Reasons :
1) Intermittent unstable operation of the pump.

Analysis :
The paratolic acid level in the mother liquor of pressure centrifuge is high (800 to 1500 ppm), which sometimes results in the scaling of the wall of F1-1601 vessel. These scales might block the level indication sensor, and thus give rise to erroneous level indication of liquid in the vessel. This can lead to temporary cavitation in the pump. Sometimes the scales are found to clog the suction strainer of the pump as well. This reason, too will lead to cavitation. The cavitation effect is bound to cause the failure of the mechanical seal.

Actions / recommendations :
1. The F1-1601 vessel should be caustic washed on a daily basis. Also if the situation demands for more frequent cleaning, then it should be done as and when required.

Plant : PTA
Department : M
Tag No : G1-1606B **Tag Description : PTA M/L FILTER SLURRY PUMP**
FAR No : PTA/M/97/1 **Sr. No: 2067** **Occurrence Date : 24/02/97**

Cause : DE
Description of Failure :
Inboard seal leakage.

Observation :
1. The leak occurred during the caustic wash operation.
2. The pump was removed from site and dismantled. The following observations were made:
- The seal chamber was found to be filled with PTA slurry.
- The inboard seal faces were found to be cracked.
- The in-board side seal holder springs[2nos] and stationary ring locating pin were found damaged.
3. Out board seal parts were found ok.
4. Seal water flow gauges were not functioning.

Actions taken:
The pump was assembled with a new seal assembly and installed at site.

Reasons :
1) Damaged bearings.
2) Misalignment.
3) Low pressure differential between caustic and seal water.
4) Low seal water flushing pressure.

Analysis :
Analysis for the reason no: 1.
On dismantling the pump ,the bearings were found to be alright. Hence ruled out.

Analysis for reason no 2:
Misalignment would have caused distress to the bearings as well as the outboard seal. Hence ruled out.

Analysis for reason no 3:
The caustic solution used for cleaning is at a pressure of 4.5 bar (max).the seal chamber pressure in this event would be in the range of 6 bar and the seal water pressure is maintained at 6 bar. The differential pr.is practically nil, for restricting the ingress of product into the seal chamber. Thus this is a distinct possibility for the failure of the seal. The solution lies in increasing the seal water pressure to the range of 8 to 9 bars at the seal inlet. This could be done only if the "PRV" setting at the down stream of the LP seal water pumps is suitably elevated. This matter should be studied in depth by "TLS/Project" group and relevant recommendations given. However, till such time, during the caustic washing operation, the caustic inlet into the pump may be taken in a controlled manner, so as to keep the seal chamber pressure within 4 bars.

Analysis for reason no 4:
The seal water pressure can come down only if the seal water pumps are not pumping properly or in the event of any choking in the seal water lines. The integrity of the seal water pumps have been verified. The flow gauges for monitoring the seal water flow were malfunctioning at the time of the failure, but as the seal water does not contain any solid particles, the possibility of hindrance in the seal water flow due to any choking is remote. However theflow gauges should be rectified /

replaced immediately. In addition to this, the possibility of installing a pressure gauge on the seal water line near the inlet to the seal should be thought of. This will enhance the reliability of the pump and dispel any apprehensions regarding the lowering of seal water pressure.

Actions / recommendations :

1. The seal water should be always in line.
2. Supervision during caustic wash should be mandatory.
3. Seal water flow gauges should be rectified / replaced.
4. The possibility of installing a pressure gauge at the seal inlet should be discussed and action taken accordingly.
5. A study for increasing the seal water pressure should be carried out and recommendation given

Plant : PP
Department : M
Tag No : G5269BS **Tag Description : RECOVERED PROPYLENE PUMP**
FAR No : FAR/M/98/23 **Sr. No: 2389** **Occurrence Date : 26/04/98**

Cause : DE
Description of Failure :
1. Gearbox mech seal failed.
2. Gearbox bearing failed.

Observation :
1. High speed shaft got damaged in thrust washer area.
2. Gearbox top cover thrust washer areagot damaged.

Action taken :
The identical gearbox of a similir model pump from non critical service was installed on G5269BS and pump boxed back.

Reasons :
The gearbox bearings got damaged due to failure of the mech seal. The seal failure caused draining of the oil because of which gearbox ran dry causing damage to the shaft bearings. The seal failure took place due to following reasons :
1. Malfunctioning of the lub oil pump causing reduction in the oil pressure.
2. Prolonged use of oil filter without adhering to specified change schedules. This will lead tohigher pressure drop.
3. There is no safety device used for oil circuite. Therefore reduction in oil pressure was not detected in time and the failure of seal took place.

Analysis :
Reason 1 :
The operators log book does not have any records of lub oil pressure and temp. Therefore the problem of these parameters could not be detected in time and failure took place.

Reason 2 :
The oil filter changing decision to be taken based on reduction in oil pressure. Since presently it is not recorded, the problem with oil pressure could not be identified in time and failure took place.

Reason 3 :
The pump oil circuit does not have any safety switch . Therefore the pump was not tripped at low oil pressure and the failure took place. Therefore the seal failure is cumulative effect of all the reasons listed herewith.

Actions / recommendations :
1. The lube oil pressure and temp to be recorded regularly. As per the pump manual these values shall be at 3.2 to 4.2 kg/sq.cm and 60 to 95 degc. Any deviation from these values shall be reported for timely corrective action.
2. Lube oil filter changing decision to be taken depending upon the pressure of lub oil. If the oil pressure reaches to 3.6 kg/sq.cm then it isto changed.
3. Oil pressure switch to be incorporated in oil line to trip the pump atloe oil pressure. The trip setting can be kept at 3.4 kg/sq.cm.

Plant : TERM
Department : M
Tag No : GA2603S **Tag Description : ETHYLENE TRANSFER PUMP**
FAR No : FAR/M/98/7 **Sr. No: 2393** **Occurrence Date : 17/09/98**

Cause : DE
Description of Failure :
Pump mechanical seal leakage & Pump was tripped due to jamming.

Observation :
Seal pot pressure was high.Gear box (GB) oil got completely drained out.Ethylene was found to be coming through seal detection port. Seal fluid (i.e. Ethonal was mixed with oil). On opening the pump and gear box we found following failures.
1) Pump seal faces(of tandem seal) &sleeve were severely worn out.
GEAR BOX
1) Stationery face was found be broken. Sleeve was worn out.
2) High speed shaft upper bearing got detached and bonded to the shaft due to heat. Upper thrust washer got melted. Bottom thrust washer was severly worn out. Lower thrust cum radial bearing was worn out(radially).Upper thrust bearing housing was got slightly damaged (due to hitting).
3) Idler shaft bottom ball bearing was completely damaged (balls & cage came out).Upper bearing slightly wornout.
4) Dents were found on two nos teeth of input shaft gear.
5) Oil seal (top side, lip type) was damaged.
6) Rubbing marks(up to 1mm depth,15 mm long radially) were found on the impeller vanes

Reasons :
The reasons for the seal failure are listed as per following :
1) Vibrations in the high speed shaft of the gear box.
2) Chocking ofPump Seal flushing line.
3) Completion of expected life of the seal componebts.

Since the pump seal got failed, this resulted in thefailure of Gear box seal failure. This had caused draining of the oil from the gear box resulting in the failure of High Speed Shaft Bearing. Failure and jamming of the gear box.

Analysis :
Analysis for Reason No 1:
The pump was running smooth at the time of the failure. Prior to the pump failure increase in the vibration level of low speed shaft was noticed but high speed shaft vibrations werewithin the limit. Therefore possibility of failure due to Vibration in the gear box is ruled out.

Analysis for Reason No 2 :
Thepump is handling Ethylene which is a clean fluid. Therefore possibility of chocking of seal flushing line due to process fluid is ruled out. Therefore this reason for seal failure is ruled out.

Analysis for Reason No 3:
The pump was running without any seal failure since its commissioning in 1991 ie since last 7 years. After so much service period the life expectancy of seal components might be over. Therefore failure of the seal might have occured due to natural failure of seal components. Since the seal components could not be inspected after dismentling, the exact reason for seal failure could not be

established. However considering the past history of the pump, this reason seems to be supporting the cause for the seal failure.

At the time of the seal failure it was noted that seal pot high pressure alarm was by-passed and also the seal pot pressure gauge valve was closed. Due to this the failure of the inboard seal could not be noticed in time and gearbox failure took place. Also when the gear box oil got drained due to seal failure, the pump should have tripped on low lube oil pressure. Since this did not happen at the time of failure, it appears that the either the pressure switch was by-passed or it was not in working condition.
Since the seal components failed due completion of expected life no specific recommondation for preventing seal failure is given. However to prevent further failure of gearbox the safety systems of the pump should be always kept in line.

Actions / Recommendations :

1. The safety system of the pump should be always kept in line and should be checked regularly as per SOP and records included in operators log book.

Plant : TFARM
Department : M
Tag No : GA7204S **Tag Description : ACETIC ACID UNLOADING PUMP**
FAR No : FAR/M/99/7 **Sr. No: 2389** **Occurrence Date : 08/01/99**

Cause : PR
Description of Failure :
Found Mechanical seal leak

Observation :
1. Found Mechanical seal leak and no discharge.
2. Pump opened and found acitic acid was in freezed condition in both suction pipe line and also in casing.
3. Mechanical seal faces were found with slight rubbing marks.
4. Freezed Acitic acid was removed by flushing it with water.

Action taken :
Pump boxed up with New mechanical seal, trial taken and found OK.

Reasons :
1. Dry run

Analysis :
Analysis for reason No1: Dry run

When the pump was opened its casing and suction spool piece was filled with freezed acetic acid. The pump has single mechanical seal with API plan 11 and plan 62. Because of acitic acid freezing the pump has run dry and hence mechanical seal has failed because of no circulation fluid between the seal faces.

100% pure Acetic acid freezing point is 16.635 deg. centigrade. Water significantly lowers the freezing point of Acetic acid. Minimum temperature on 07/01/1999 was 13.1 deg.Centigrade and on 08/01/1999 was 11.06 deg.Centigrade. Hence the failure is due to pump operated below the freezing point of the operating fluid and hence mechanical seal has failed due to no circulation fluid.

Actions / Recommendations :

1. Pump to be operated well above the freezing point of the pumping liquid. Hence during winter pumping liquid temperature to be maintained 4-5deg. centrigrade above freezing point of Acitic acid i.e., 16.63 deg.Cent. either heating the line by electrical coil (similar to EhtyleneTerminal-Acetic acid transfer pumps GA7203A/S and GA7205A/S) or by steam heating.
2. Discharge line insulation to be done.

Plant : VCM
Department : M
Tag No : GA2501S **Tag Description : WET CRUDE EDC TRANSFER PUMP**
FAR No : VCM/M/94/17 **Sr. No : 1219** **Occurrence Date : 11/04/94**

Cause : PR
Description of Failure :
Inboard seal leakage.

Observation :
1. Pump discharge line was being flushed with the help of fire water. Fire water injected through discharge pressure gauge drain point. Pump was in stopped condition. Its suction valve was closed. No isolation of casing from the discharge pipe was done.
2. Inboard carbon found jammed on the sleeve due to dirt.
3. Impeller & sleeve found badly jammed on the shaft.
4. Corrosion marks observed on the wetted parts of the pump.
5. All seal faces found ok. O/b seal ring broken during dismantling.
6. Impeller found slightly corroded.

Actions taken :
1. All seal faces & packings replaced.
2. Sleeve & throat bush replaced.

Reasons :

1. Ingress of dirt restricting the movement of seal ring.
2. Dislocation of I/b seal.

Analysis :

1. Seal pot pressure was only 6 kg/cm2, while stuffing box pressure was 10 kg/cm2 (because of fire hose connection). Due to more stuffing box pressure, I/b seal opened & got stuck up because of ingress of dirt & could not take its position. This lead to seal failure.

Actions / recommendations :

1. Blind to be provided at pump discharge flange while flushing.
2. To study the source of dirt.

Plant : VCM
Department : M
Tag No : GA2515A **Tag Description : 20% CAUSTIC TRANSFER PUMP**
FAR No : VCM/M/94/11 **Sr. No : 1177** **Occurrence Date : 03/03/94**

Cause : SU
Description of Failure :
Mechanical seal leakage.

Observation :
1. Sleeve gasket found deformed.
2. Seal ring face found pitted. Whitish deposite found at ID of seal ring.
3. Deep groove found on inner side of insert. Similar groove found on the mating area of seal ring which found pitted.
4. Insert mounting found cut.
5. Shaft & secondary packings found ok. At the time of checking, valve of water flushing line to seal (plan 62) found closed.
6. Caustic crystals deposition found on the backside ofinsert.
7. Shaft runout - 0.04 mm. Radial/axial play - 0.05/0.02 mm

Actions taken :
All seal faces & secondary packings replaced by new one.

Reasons :

1. High vibration.
2. Starvation & cavitation.
3. Formation of caustic crystals on seal faces.

Analysis :

1. Possibility of high vibration ruled out as shaft run out, radial & axial play were within limit.
2. There is no history of starvation & cavitation.
3. Seal was modified to plan 62 to remove salt crystals on seal faces. Water line used for this purpose was found closed. Therefore probably crystals formed & caused the seal failure.

Actions / recommendations :

1. Plan 62 valve should always be kept open.
2. SOP to be revalidated.

Plant : VCM
Department : M
Tag No : GA6306A Tag Description : VACCUM COLUMN BOTTOMS PUMP
FAR No : VCM/M/95/21 Sr. No : 1796 Occurrence Date : 01/11/95

Cause : DE
Description of Failure :
Inboard seal failure.

Observation :
1. Severe pitting due to corrosion and erosion found on the casing and backplate (MOC- SS 316).
2. Impeller and tab washer (MOC- SS 316) found slightly corroded
3. Dirt particles found near inboard seal ring area.
4. Seal faces (stationary-carbon,rotary-tungsten carbide) found in good condition.
5. Radial play=0.07 mm and runout of shaft=0.01 mm.

Actions taken :
1. All seal faces and O-rings replaced.
2. Both top (22311 CC) and bottom (6308) bearings replaced.

Reasons :

1. High vibration.
2. Ingress of dirt in inboard seal.

Analysis :

1. As the shaft runout and radial play were within the limitand also no abnormality found during routine conditionmonitoring, seal failure due to high vibration can be ruledout.
2. Sundyne pump seal design is such that any solid particlesin the process fluid will get accumulated in the bottom seal housing (inboard). Solid particles at very high percentage was observed during plant upset or process startup / shutdown. And also in number of instances the seal housing was packed with blackish solid particles. Thus ingress of dirt lead to jamming of inboard seal ring causing seal failure.

Actions / recommendations :

1. As the this type of process upset cannot be eliminated and also average seal failure frequency is about 5 months, it is recommended to clean the seal during every PM (3 months).
2. Cleaning of seal to be done during every PM for all the pumps with similar service sheet. The above activity to be included in the equipment service.

Plant : VCM
Department : M
Tag No : GA6314A Tag Description : Heads Col. Decanted Water Pump
FAR No : VCM/M/94/23 Sr. No : 1272 Occurrence Date : 18/04/94

Cause : SU

Description of Failure :

1. Inboard seal failure.
2. Hole formed in the impeller.

Observation :

1. Corrosion observed on all C.S parts which come incontact with process fluid.
2. Hole (size-20x12 mm approx.) observed in the impeller back shroud. No corrosion mark or rubbing marks observed on the impeller. Thickness near hole - 2.4mm, other areas - 3.9mm. Thickness of shroud was also uneven due to major casting defect.
3. I/b seal ring found jammed on the sleeve due to presence of dirt.
4. I/b insert found cracked.
5. All other faces & o rings found o.k.
6. Impeller wear ring found broken.
7. Casing wear ring found worn out. Lock screw found missing.
8. Shaft runout - 0.04 mm radial play - 0.03 mm

Actions taken :

1. Rotor replaced by spare rotor. Impeller replaced.
2. Casing replaced by a spare one.

Reasons :

Probable reasons for seal failure :

1. Presence of dirt lead to seal failure.
2. High radial & axial play as well as shaft runout.

Probable reasons for hole formation :

1. Original fabricational / casting defect.
2. Corrosion/ Erosion.

Analysis :

Analysis for inboard seal failure

1. As shaft r/o & plays are within limit, that possibility of seal failure can be ruled out.
2. As the service of the pump is slightly dirty the dirt may have got deposited between I/b seal ring & sleeve. This restricted the forward movement of I/b seal ring for compensation of wear caused the I/b seal leakage.

Analysis for hole formation

1. No appreciable effect of corrosion / uniform thickness observed on the shroud / vanes of the impeller. Original fabricational /casting defect with locallized thin section of the shroud. This finally resulting into locallized puncture, after eroding further by process fluid / hard foreign particles probably by way of impingement.

Actions / recommendations :

1. Pump be taken on corrective maintenance every 1.5 years.
2. Proper Q.A. plan & stage-wise inspection be adopted.

.

Plant : VCM
Department : M
Tag No : GA6314S Tag Description : Heads Col. Decanted Water Pump
FAR No : VCM/M/94/8 Sr. No : 1155 Occurrence Date : 10/02/94

Cause : DE
Description of Failure :
Inboard seal leakage.
Outboard seal leakage (dropwise).
Pump casing becoming hot during running.

Observation :
1. Stuffing box inside collar including I/b insert mounting seat found badly chipped.
2. O/b carbon found badly chipped.
3. I/b shaft packing found deshaped & hard.
4. Wear ring clearance found increased.(1.56 mm).
5. Corrosion marks observed on casing.
6. Discharge line found hot during running upto control valve & minimum circulation line.
7. Min. Circulation line found cold.
8. EDC was found in the pumping fluid.
9. pH of heads column overhead system is always maintained alkaline by injection of NH3 in wet crude tank.

Actions taken :
1. Rotor unit with assembled seal installed.
2. Spare impeller with new wear ring (OD - 74.86 mm) and casing with new wear ring (ID - 75.4 mm) installed making clearnace 0.54 mm.

Reasons :

1. Inboard seal leakage due to a) corrosion of i/b insert mounting seat. b) deformation of i/b shaft packing & it becoming hard due to high temperature of casing.
2. Outboard dropwise leakage due to chipping of o/b insert.
3. The presence of EDC in pumping fluid (water) is due to limitation of reflux line.

Analysis :

Failure of the seal is because of corrosion of I/b insert seat resulting in misalignment of insert & seal ring. Corrosion resulted in increased clearance & internal circulation causing heat generation. Reason for corrosion to be investigated by TLS.

Actions / recommendations :

1. Reason of corrosion to be found out.
2. Pump to be taken on corrective maintenance every 6 months.

Plant : VCM
Department : M
Tag No : GA6502A **Tag Description : VCM COLUMN REFLUX PUMP**
FAR No : VCM/M/96/1 **Sr. No : 1854** **Occurrence Date : 10/02/96**

Cause : DE
Description of Failure :
Inboard seal failure on 10/02/96 & 11/02/96.

Observation :
Observations of failure on 10/02/96
1. Dirt found inside the seal buffer fluid area.
2. Chipping found on the inboard insert face (carbon).
3. Inboard seal ring found jammed on the sleeve.
4. Sleeve & impeller were found jammed on the shaft.
5. Casing, impeller and all other wetted parts found heavily coated with hard layer of dirt.
6. Bearing radial play found to be 0.08 mm. Shaft runout and axial play were found ok.

Actions taken for the failure of 10/02/96 :
Rotor and backplate replaced with overhauled one.

Observations of failure on 11/02/96
1. Seal inboard insert face (carbon) found to have pittingmarks.
2. All other seal parts found in good condition.

Actions taken for the failure of 11/02/96 :
Seal faces and O-rings replaced.

Reasons :
1. High vibration.
2. Cavitation.
3. Ingress of dirt.
4. Vapourization effect near the seal face area.

Analysis :
1. As the vibration were found normal (inspite of high radial play during first failure), failure due to high vibration can be ruledout.
2. As there is no findings of cavitation during both the failures, this reason can also be ruledout.
3. During first failure, there was heavy ingress of dirt between inboard seal ring & sleeve causing restriction of seal ring movement.this lead to inboard seal leakge. But for the second failure this was not the cause as there was no such ingress of dirt.
4. There are instances of seal pot pressure going down due to leakage in the nitrogen line. Due to reduction in seal pot pressure below the stuffing box pressure, the oil film between the face will be replaced by VCM film. Heat generated between the face vapourises VCM leading to pitting of inboard carbon face. As the inboard carbon face found with pitting marks, this could be the reason of second failure.

Actions / recommendations :

1. On trial base reduce the seal pot pressure to 16 kg/sq.cm & judge the seal performance.
2. PCV to be installed in the nitrogen line for regulating seal pot pressure.
3. Reversed balanced seal to be used to take care of vapourization

MECHANICAL SEAL FAILURES

On account of

Fluid contamination / Seal flush oil degradation.

Plant : AROMA
Department : M
Tag No : P201A Tag Description : Extract Detol Tower Overhead Pump
FAR No : FAR/M/98/17 Sr. No: 2332 Occurrence Date : 19/11/98

Cause : DE
Description of Failure :
Seal pot oil level was dropping gradually. The pump could not be taken for maintenance because of process constraints. Hence the seal leak was attended during planned plant shut-down.

Observation :
The barrier fluid (seal oil) was dropping and had to be made-up approx8 liter per day. This was hapening from quite some time (approx 20 days) the out- board seal was leaking 13 to 15 drops per minute corresponding to one liter oil per day. Hance it was concluded that both in-board and out board seals were leaking. After dismantling the seal, following observations were made:
1) Sludge was found under primary and secondary seal rings.
2) Shaft sleeve was having scoring marks under primary seal ring packing. Packings and seal ring were jammed on shaft sleeve.
3) Primary carbon was found chipped off from corners. Scoringmarks were observed on faces.
4) Scouring marks werealso observed onsecondary seal faces.

Reasons :
The seal leak can be caused due to any of the following reasons :
1) Due to vibrations in the pump.
2) Due to operational problems.
3) Due to contaimination of the flushing fluid.

Analysis :

Analysis for reason no 1 (due to vibrations in the pump.)
The pumpwas in operation since commossioning without any problem. Also at thetime of pm lub oil level, coupling condition etc found ok. This clearly indicate that pump was not having any mech problem. Hence this reason for failure is ruled out.

Analysis for reason no 2 (due to operational problems.)
During operation the pump was not operated with cavitation, too much throttled delivery etc.the pump therefore was notsubjected to vibrations due to improper operation. Hence this reason for seal failure is also ruled out.

Analysis for reason no 3 (dueto contaimination of the flushing fluid)
As per the observation made at the time of seal replacement, sludge was observed under primaryand secondary seal rings. Presently the pump is working with flushingplan 53. M/s duramettalic has specified dura oil as the flushing liquid. Since dura oil was very costly, the plant maint started using servosystem 32 as flushing fluid. This was done in consultation with m/s duramettalic.
In plan 53 flushing oil is getting circulated through the seal and in this process it is removing heat from the mating faces.this is obvious from the fact that flushing liquid outlet line is always hot. The temp of the oil is kept normal by cooling it in seal pot.this means that flushing oil is subjected to variable temperature during pump running. Since the oil is used continuously it is possible that oil properties may get changed under variable temperature conditions. This can cause build up of the deposition on seal parts. Hence this reason seems to support the cause of failure.

Actions / recommendations :

1. The seal vendor/ oil supplier should be consulted for selection of appropriate grade of oil.
2. The flushing oil to be checked and changed if required at the time ofpm till proper grade of oil is finalised.

Plant : AROMA
Department : M
Tag No : P102B **Tag Description : STRIPPER BOTTOMS PUMP**
FAR No : FAR/M/98/18 **Sr. No: 2333** **Occurrence Date : 26/11/98**

Cause : DE
Description of Failure :
Heavy leak observed from mechanical seal, after plant start-up after ashut -down of one week.

Observation :
Following observations were made on dismantling:
1) Lot of particles were observed in stuffing box
2) Both carbons were jammed with tcseal ring. Carbon were also found in broken condition.
3) Particles were also found around ptfe packings.

Reasons :
1) Vibrations in the pump due to mechanical problems.
2) Operational problems causing cavitation, dry running etc.
3) Presence of foreign particals in stuffing box.

Analysis :
Reason no 1 (vibrations in the pump due to mechanical problems)
The pump is running satisfactorily since commissioning. The pm is alsodone regularly. As such the pump did not show anu sign of abnormalitydue to mechanical problems. Hence this reason for seal failure is ruled out.

Reason no 2 (operational problems causing cavitation, dry running etc.)
The suction to the pump is given from column bottom. Also the pump is handling clear liquid. Therefore possibility of cavitation due to suction filter chocking and dry running due to loss of suction is not there. Therefore this reason for seal failure is ruled out.

Reason no 3 (presence of foreign particals in stuffing box)
Asper the observation made at the time of seal replacement, foreign particals observed in the stuffing box and also around the seal packings.the foreign particals can enter into the stuffing box by following ways :
1) Along with the flushing oil at the time of top up or replacement. This possibility is remote since proper care is taken at the time of top up and also filter is provided at the seal pot bottom.
2) Along with pumping fluid. It is to be noted that the seal failed whenthe plant was started after shutdown of one week. During shutdown exchanger E-103 was opened to attend tube leakage. In E-103 lot of scaling / rust was found in process side. Since the pumping fluid passes through E-103 before entering to pump suction, it is possible that some of the scale / rust may go to piping going towards pump suction though E-103 was cleaned. Subsequently when the pump was started after shutdown the scale entered into stuffing box resulting into the scratching of the inboard seal mating faces. Thus the seal got leaked. Therefore presence of foreign particals is the main cause of seal failure.

Actions / recommendations :
1. Mesh size of the suction strainer to be reviewed in order to prevent entry of foreign particals into the pump.
2. The pump suction line to be flushed before starting the pump after plant shutdown.

Plant : AROMA
Department : M
Tag No : P105B **Tag Description : LEAN SOLVENT PUMP**
FAR No : FAR/M/99/23 **Sr. No: 2338** **Occurrence Date : 16/02/99**

Cause : PR
Description of Failure :
Seal pot level was coming down at a fast rate.

Observation :
1) Grey sludge in promary seal dynamic packing, carbon insert
2) Absence of locking pin in primary carbon
3) Chipped of corners of carbon
4) Grooving in primary & secondary TC faces
5) Black sludge in secondary seal ring

Reasons :
After referring to the observations made at the time of attending the seal it can be concluded that the failure of the seal took place due topresence of foreign particals in flushing oil. This is quite evidentsince grooving observed on tc faces and also deposits were observed onseal internals.
The reason for deposites and presence of foreign particals are as per following :
1) Degradation of flushing oil.
2) Use of higher viscosity oil.
Analysis :
Reason no 01: (degradation of flushing oil.)
The pump seal works with plan 53. Under this plan the flushing oil is circulated through seal housing to take the heat and also to provide lubrication at the seal faces. Due to this temperature of the oil increases as it comes out of seal housing. This oil is again cooled before it enters the seal housing. Therefore it can be concluded that the oil undergoes alternating temperature during the working. This will cause degradation of the oil after due course of time. Due to this degradation ash content of the oil will increase and deposites will start developing on seal internals. Therefore it is required that the oil should be analysed for ash content atleast once in two months and the replacement of oil should be planned according to the lab results. Therefore this reason seems to support the cause of failure.
The seal vendor was consulted for analysing above problems and they had also given their recommendations on similar lines. In addition the vender had also suggested to provide flushing liquid outlet from flushing pot to be raised by 20 to 25 mm above seal pot bottom. This will allow the foreign particals to sattle at the bottom and therefore cleaner oil will go to seal. This has been already implemented.
Reason no 02 (use of higher viscosity oil.)
As per plant maintenence presently oil servosystem 32 is used as flushing liquid. The seal vendore M/s Duramettalic has recommended to use Dura oil as the flushing liquid. The dura oil has viscosity equivalent to SAE # 20. Therefore it is quite clear that higher viscosity oil is being used presently. As per the vendor higher viscosity oil will cause increase in viscouse shear and hence increase in generation of heat. Also the output from pumping ring will come down leading to again increase in heat generation. Therefore this reason also seems to support the cause of failure.
Actions / recommendations :
1. The flushing oil should be analysed for ash content once in a month and replacement of flushing oil should be planned accordingly.
2. The oil equivalent to SAE # 20 should be used as flushing liquid as per vendor recommendations.
3. The recommendations given in our previous far no FAR/M/98/31 should be followed up for all other pumps having flushing plan 53 and not using correct oil till correct oil is used.

Plant : AROMA
Department : M
Tag No : P105A **Tag Description : LEAN SOLVENT PUMP**
FAR No : FAR/M/99/24 **Sr. No: 2339** **Occurrence Date : 29/03/99**

Cause : PR
Description of Failure :
Leakage of oil from secondary seal. The leakage was there from some time, the seal was attended during plant shut down

Observation :
Scouring of seal faces and presence of sludge in secondary packings.

Reasons :
The pump seal was leaking from quite some time. The pump was run as it is since the plant shutdown was due and it was decided to replace the seal in shutdown only.
Since the sludge was found to be present on seal faces and scouring marks were observed on seal faces, it is quite clear that seal failure took place due to presence of foreign particals in flushing liquid. The reason for presence of foreign particals influshing oil are as per following
1) Degradation of flushing oil.
2) Use of higher viscosity oil.

Analysis :
Reason no 01: (degradation of flushing oil.)
The pump seal works with plan 53. Under this plan the flushing oil is circulated through seal housing to take the heat and also to provide lubrication at the seal faces. Due to this temperature of the oil increases as it comes outof seal housing. This oil is again cooled before it enters the seal housing. Therefore it can be concluded that the oil undergoes alternating temperature during the working. This will cause degradation of the oil after due course of time. Due to this degradation ash content of the oil will increase and deposites will start developing on seal internals. Therefore it is required that the iol should be analysed for ash content atleast once in two months and the replacement of oil shouldbe planned according to the lab results. Therefore this reason seems to support the cause of failure.
The seal vendor was consulted for analysing above problems and they had also given their recommendations on similar lines. In addition the vendore had also suggested to provide flushing liquid outlet from flushing pot to be raised by 20 to 25 mm above seal pot bottom. This will allow the foreign particals to sattle at the bottom and therefore cleaner oil will go to seal. This has been already implimented.
Reason no 02 (use of higher viscosity oil.)
As per plant maintenence presently oil Servosystem 32 is used as flushing liquid. The seal vendore M/s durametallic has recommended to use dura oil as the flushing liquid. The dura oil has viscosity equivalent to SAE # 20. Therefore it is quite clear that higher viscosity oil is being used presently. As per the vendore higher viscosity oil will cause increase in viscouse shear and hence increase ingeneration of heat. Also the output from pumping ring will come down leading to again increase in heat generation. Therefore this reason also seems to support the cause of failure.
Actions / recommendations :
1. The flushing oil should be analysed for ash content once in a month and the replacement of oil should be planned accordingly.
2. The oil equivalent to SAE # 20 should be used as per recommendations of the vendor.
3. The recommendations given in our previous FAR/M/98/31 should be followed up for all other pumps having flushing plan 53 using oil not recommended by vendor till correct oil is used.

Plant : AROMA
Department : M
Tag No : P202B Tag Description : Extract Detol Tower Bottoms Pump
FAR No : FAR/M/99/29 Sr. No: 2344 Occurrence Date : 05/10/99

Cause : PR
Description of Failure :
P202B is having heavy outboard seal leak.

Observation :
P202B seal pot level had decreased drastically as it had heavy outboard seal leak. The pump was changed over and kept isolated for attending the same.

Reasons :
As per the observation the seal faces were having the scoring marks aswell as sludge deposition on rotary assembly. Since the seal runs with API plan 53 using Servoprime 32 as flushing oil, it is quite clear that the scoring on seal faces was caused by contamination of flush liquid. The contamination of flushing liquid can be caused by any of the following reason :
1) Prolonged use of flushing oil .
2) Use of incorrect grade of oil.

Analysis :
Reason no 01(prolonged use of flushing oil)
The pump was under taken for pm last on 08/09/99. As per the PM ESS the flushing liquid quality to be checked. At the time of PM the technicians are doing only qualitative checks ie oil colour, oil thickness etc. These checks areonly subjective and the observation can vary from person to person. Moreover no specific oil change schedule is being followed presently. The last pump seal failure was reported on 20/12/97. Since then the flush oil might not have been changed but only topped up as and when required. Therefore it is quite clear that oil quality might have deteriorated because of prolonged use. Since flushing oil is under going cyclic temperature changes while in working, its use for a prolonged period will certainly cause detoriation in its lubricating properties.
Considering this analysis this reason seems to support the cause of failure.

Reason no 02 (use of incorrect grade of oil.)
The pump is installed with dura seal and the vendor has recommended to use dura oil which is equivalent to SAE 20. Since the dura oil was very costly, the plant maintenance started using Servosystem 32 after consulting M/s indian oil. The Servosystem 32 was again causing precipitation of zinc based compounds at high temp. Therefore then vendor had recommended for servoprime 32 which is free from zinc based compounds. Apparently therefore the problem with oil quality is ruled out. This reason therefore is not supporting the cause of failure.

Actions / recommendations :

1. The oil should be changed on every alternate PM. Ess should be modified accordingly.

Plant : CKR
Department : M
Tag No : P537B Tag Description : TERT. DEETHANIZER REFLUX PUMP
FAR No : FAR/M/98/13 Sr. No: 2254 Occurrence Date : 22/06/98

Cause : SU
Description of Failure :
Mechanical Seal Failure

Observation :
Pumping ring was found loose. Dirt was found insideseal cavity. Outboard carbon ring was found worn out and damaged. Elastomers were found intact without any damage.
Actions taken:
Pumping ring was tightened , all elastomers and seal faces were replaced. Flushing fluid system including the seal pot was thoroughly cleaned and flushing fluid was replaced to ensure removal of dirt particles from the system

Reasons :
1. Dent on seal cup
2. Bend on the shaft.
3. Damaged elastomers
4. Presence of dirt [foreign particles] in seal

Analysis :
Analysis for reason no 1: dent on seal cup
After dismantling a dentwas observed on the body of the seal cup. Dent prevents the free movement and action of the springs and hence the seal would have leaked ifdent had been present initially. The seal could not have served for along period without leak. This indicates that the dent had occured while the dismantling of the seal and hence the reason of dent on seal cup causing the seal leak is ruled out.
Analysis for reason no 2: bend on the shaft.
After dismantling the shaft was checked for bend / runout and it was found to be o.k. So this reason is ruled out.
Analysis for reason no 3 : damage of elastomers
The elastomers were inspected and found to be o.k. However the elastomers were replaced during seal replacement after failure, since they have been removed for checking and also since they were in service for about 10 months.
Analysis for reason no 4 : presence of dirt [foreign particles] in seal
During seal replacement after failure, dirt was found in seal cavity. This may have come from flushing fluid. Inadequate cleaning of seal pot might have caused intrusion of foreign particles, the foreign particles have come in between seal faces and caused leakage.

Actions / recommendations :

1. Since the failure has taken place due to presence of dirt particles inseal pot, the seal pot is to be flushed thoroughly and cleaned and the seal pot fluid is to be replaced to ensure the elimination of dirtparticles - once in a year or based on condition.

Plant : CKR
Department : M
Tag No : P445A **Tag Description : DEETHANIZER REFLUX PUMP**
FAR No : FAR/M/99/49 **Sr. No: 2290** **Occurrence Date : 31/12/99**

Cause : PR
Description of Failure :
P445A outboard seal leak

Observation :
1. P445A seal pot level drop observed and make up frequently increased. On opening pump seal sludge found on out board seal rotating face.
2. On opening the seal the mating faces at the outboard seal found in good condition. Scratch marks were observed on shaft sleeve at the seating surface of wedges. Therefore it is likely that the leakage was taking place through the secondary seal and not through the sealing faces. The primary and secondary seals were replaced and removed seal faces are kept as an emergency spares.

Reasons :
As per the observation the leakage through the seal was mainly due to failure of the secondary seals. The secondary seal failed due to development of the deposit around the seal component. The sludge around theseal faces can develop due to any of the following reason :

1) Degradation of the barrier fluid.
2) Entry of the foreign material while make up of the barrier fluid.

Analysis :
Reason no 01 : (Degradation of the barrier fluid.)
As per the pump manual the vendor has recommended to use light mineral oil as a barrier fluid. But at the time of commissioning the barrier fluid was changed to methanol since the pumping fluid temp is -17 degc. Since methanol is hazardous liquid it was letter on changed to MEG which was further changed to Toluene. The vendor ingersoll dresser had given their consent for use of toluene as barrier fluid. The toluene which is obtained from aromatics plant has the purity of 99.96% minimum. As per the laboratory the remaining 0.04% of Aromatics do not have any tendency of polymerization since they are not in unsaturated state. Also since the pumping fluid temp is -17 deg.C, the barrier fluid temperature fluctuations are not wide, therefore possibility of degradation of barrier fluid due to temperature fluctuations and continuous use for a long time is ruled out. Therefore this reason for failure is ruled out.

Reason no 02 (entry of the foreign material while make up of the barrier fluid.)
The barrier fluid make up is done with the help of a hand pump. This is the responsibility of field operator who does this job with the help of rigger. Also the Toluene is brought from aromatics in cans or drums. It is possible that if proper cleanliness is not maintained in both of these activities then possibility of entry of foreign material can not be ruled out.
It was also noted that the make up pump has the provision of strainer to filter out foreign material present in make up fluid. But the availability of strainer and also the mesh size could not be confirmed by the maintenance engineers. Therefore all of these reasons are supporting the fact that foreign materials arenot getting prevented from entering into the system.
Therefore this may be a cause of the failure of the seal.

Actions / recommendations :

1. Proper care should be taken while filling the barrier fluid in make uphand pump. This can be done by the use of clean jerry cans and plastic/glass beakers and also by properly supervising the job by field operator.
2. The availability of the filter should be ensured in hand pump in all locations where ever applicable
3. The finer filter mesh of the size 50 mesh or above to be used to effectively filter out the foreign material.
4. Plan 62 to be made operational as indicated in the seal drawing to improve the seal life.

Plant : MEG
Department : M
Tag No : P611A **Tag Description : TEG COLUMN BOTTOMS PUMP**
FAR No : MEG/M/97/17 **Sr. No: 2062** **Occurrence Date : 30/01/97**

Cause : DE
Description of Failure :
Heavy inner seal leakage was observed

Observation :
Heavy inner seal leakage was observed and TEG was continuously getting drained from the seal pot. Pump was opened for attending seal leakage. Both faces found with rubbing marks. Compression unit found with dirt particles. Inboard stationary face and sleeve had deep pitting marks all around the circumference.

Actions taken :
All faces, packing & sleeve replaced. Pump boxed up & trial taken and found ok.

Reasons :
1. High vibration
2. Seal pot pressure variation
3. Excess provision of quenching media
4. Dirt entering into the seal

Analysis :
Analysis for reason no 1 :

High vibrations can lead to seal failure. High vibrations can be caused due to either misalignment or damaged bearings. However on 20/11/96, during PM with alignment check, axial float of shaft was found to be high. On opening the pump, bearings were found damaged. Bearings were renewed and pump was properly aligned. As the bearings were new and alignment was carried out two months back, possibility of seal failing because of high vibrations can be eliminated.

Analysis for reason no 2 :

Low seal flushing pressure can lead to seal failure.the flushing pressure fluid is maintained at 1.5kg/sq.cm more than the discharge pressure of the pump. With this condition existing, there is no possibility of seal failing for the given reason.:

Analysis for reason no 3:

Quenching media suggested for this seal system is steam with 1 cubic meter/hr. and 0.3 kg/sq.cm. Excess steam when given to the system as quenching media can result in seal damage. In this case, there is no proper control on steam supply or pressure as a manual valve is kept continuously open. There is slim possibility of seal faces getting opened if steam flow and pressure goes up excessively. Hence, excess, uncontrolled steam can also be one of the reasons for seal failure. Though the PCPO does not mention any thing about steam quenching it is worth consulting the vendor for possibility of providing instrumentation for measuring steam flow and pressure.

Analysis for reason no 4:

Dirt entering in to the seal componenets will definitely result in the seal failure. Dirt can enter in to the sealsystem through the following passages. [1] through the damaged seal parts [2] seal flushing fluid. Before going in to the actual analysis for the failure it is worth reviewing the nature of the product this pump handles, modifications carried out in the discharge system and seal system. The

suction of the pump is from the C603 column bottom and the pump discharge is connected back to column through a filter of sintered mesh. Pump handles TEG with heavy glycols and foreign particles. As the filter S604 was continuously getting choked the filter element was taken out few months back. With filter in line there was the provision of removing some heavy glycols and the residue from the system.removal of filter element has deprived to clean the system and regular removal of some amount of heavy glycols and residue This is inturn putting lot of strain on the seal, especially on seal elastomers. Initially the seal was a single coil with seal plan as 11and 62. Frequent failure of seal has necessitated to change the seal design from plan 11,62 to plan 53,62 and single coil to double coil. Seal design modification was carriedout initially in P611A. It was decided to change the design of the seal in the standby pump P611B after success is ensured in P611A. Though the failure rate has come down minutely in P611A, after change in the seal design, these changes were not incorporated in P611B. This is forcing the process department to put P611A continuously in operation. Hence, it should be noted that seal failing frequently in this case may be attributed to overusage of this pump. However, the analysis for seal failure is herewith put forth as under. 1] if the viton o-ring (p.no 3) fails, the pumping fluid TEG will enter in to the seal system & deposit generally either on seal faces or the compression unit. Deposition on seal faces or clogging of the compression unit lead to seal failure. As explained above, due to absence of filtering element in S604, the pump is constantly subjected to ingress of heavy glycol and the viton O-ring is getting damaged, resulting in seal failure. 2] the second avenue for the dirt entering in to seal system is while replenishing the seal pot. It is understood that the seal pot is filled from product TEG tank through a plastic bucket. Though the product TEG is clean, there is the possibility of fine dirt/dust getting mixed with the sealing fluid because of usage of plastic bucket. Also,the seal plan of this pump is API 53 with 62. In plan 53 there is no provision of strainer in the flushing system. Hence, there is the possibility of dirt entering in to the seal system and resulting in seal leakage. Hence, the reason for seal failure is dirt (foreign particles, heavy glycols and residue) entering the system.

Actions / recommendations :

1. Possibility of reproviding the filter elements in the filters 604 should be studied.
2. Fill teg pot using clean glassjars instead of plastic bucket
3. Possibility of installing a strainer in the seal plan 53 should be explored in consultation with vendor.
4. Seal design should be changed in standby pump P611B andsubject both the pumps to equal load (duration wise)
5. Check the alignment of pump during each PM as a reliability measure and change should be incorporated in customised ESS.
6. Install the total instrumentation of seal system as per PCPO.
7. Steam quenching should be provided as per the recommended values and possibility of providing instrumentation for controlled steam flow and pressure should be explored in consultation with vendor.

Plant : PE
Department : M
Tag No : GA3401A **Tag Description : DTA TRANSFER PUMP**
FAR No : HDPE/M/94/6 **Sr. No: 1120** **Occurrence Date : 22/12/93**

Cause : DE
Description of Failure :
Mechanical seal leak

Observation :
Stationary face found damaged on contact face

Action taken : Stationary face changed with reconditioned one.

Reasons :
Ingress of foreign particles between faces.

Analysis :
1) Incase if the level in dta storage vessel comes down, the accumulated sludge may come into the suction line and damage the seal.
2) There are chances of carbon particles along with regenerated stream which might have come in between the faces, causing scoring on faces.

Actions / recommendations :

1. DTA tank should be cleaned thoroughly as and when there is an opportunity.
2. Suitable strainer should be provided in the pump suction.
3. Side stream filter should be opened and checked on opportunity.

Plant : VCM
Department : M
Tag No : GA6403S **Tag Description : FLASH VAPOUR CONDENSATE PUMP**
FAR No : VCM/M/94/18 **Sr. No : 1221** **Occurrence Date : 29/03/94**

Cause : DE
Description of Failure :
Inboard seal leakage.

Observation :
1. I/b seal ring found jammed due to ingress of blackish material in shaft packing area.
2. I/b side of compression unit found clogged.
3. I/b insert found chipped at face OD.
4. I/b seal ring found scored.
5. Blackish material found in seal chamber.
6. Seal oil found blackish in colour.
7. Shaft runout - 0.02 mm radial/axial play - 0.03/0.03 mm

Actions taken :
1. All seal faces & secondary packings replaced.

Reasons :

1. High vibration & cavitation.
2. Seal design not suitable.
3. Ingress of foreign particles.

Analysis :

1. Vibration taken - found normal.cavitation not reported.
2. Lube oil gets contaminated due to HCL vapours coming in contact with seal oil. Although liquid does not leak, a vapour leakage from seals results into oil contamination.
3. Due to ingress of blackish material between i/b seal ring & sleeve, the forward motion of the seal ring got restricted resulting in I/b seal leakage.

Actions / recommendations :

1. Seal pot flushing should be done with steam in every PM.

Explore the possibility of better seal design in consultation with vendor.

Plant : VCM
Department : M
Tag No : GA6801A Tag Description : STRIPPER FEED PUMP
FAR No : VCM/M/94/19 Sr. No : 1245 Occurrence Date : 07/05/94

Cause : DE
Description of Failure :
Inboard seal failure.

Observation :
1. Slight cavitation observed in the pump.
2. I/b seal ring found jammed on the sleeve due to dirt between seal ring & sleeve.
3. Fretting marks found on sleeve.
4. All other faces & o rings found o.k.
5. Shaft r/o - 0.02 mm radial/axial play - 0.07/0.20 mm

Actions taken :
1. All seal faces & secondary packings replaced.
2. Sleeve replaced by spare ones. Bearings replaced.

Reasons :

1. Ingress of foreign particles.
2. High radial & axial play.

Analysis :

1. Presence of dirt between sleeve & seal ring restricted the forward motion of seal ring for compensation of wear which it lead to seal leakage.
2. Fretting corrosion of sleeve took place because of high radial & axial play.

Actions / recommendations :

1. Source of the dirt in the process fluid to be found out.
2. Radial & axial play to be measured during PM.

Plant : VCM
Department : M
Tag No : GA6804A **Tag Description : CONTAMINATED WATER PUMP**
FAR No : VCM/M/94/9 **Sr. No : 1156** **Occurrence Date : 27/02/94**

Cause : DE
Description of Failure :
Inboard seal leakage.

Observation :
1. I/b shaft packing found worn & broken and covered with black coloured solid particles.
2. Heavy deposition at i/b shaft packing area.
3. I/b carbon found scored along seal face & chipped on OD of seal face.
4. I/b insert mounting found deformed.
5. Pitting marks found on sleeve at I/b shaft packing area.
6. O/b insert mounting seal face OD have black deposits & scoring marks found along circumference as well as on face.
7. O/b shaft packing deformed & deposition found at shaft packing area.
8. O/b seal ring found jammed on its position.
9. Radial play - 0.04 mm shaft run out - 0.02 mm, axial play - 0.08 mm corrected to 0.02 mm after providing shims.

Actions taken :
All seal faces & O rings replaced.

Reasons :
1. Shaft run out.
2. Damage of viton packing
3. Foreign material.

Analysis :

1. Shaft runout, axial & radial play were within limits hence were not responsible for seal failure.
2. The viton packings were found damaged resulting in seal leakage. Failure of viton O rings allowed particulate matter between seal faces. This resulted in damage to the seal inserts and then the seal leakage.
1. The foreign particles in seal chamber resulted in chipping & scoring of seal inserts.

Actions / recommendations :

1. Pump to be taken on corrective maintenance on yearly basis.

MECHANICAL SEAL FAILURES

On account of

Cavitation

Plant : CKR
Department : M
Tag No : P701A **Tag Description : 1ST STAGE FEED PUMP**
FAR No : FAR/M/97/3 **Sr. No: 2244** **Occurrence Date : 22/08/97**

Cause : DE
Description of Failure :
Pump and gearbox mechanical seal failure

Observation :
1. Pump was started from stand by condition and was alright on minimum flow.
2. P701B was already in operation at full load.
3. P701A was cavitaiting soon after it was taken on line.
4. After some time gear box oil got drained
5. Seal pot fluid { methanol } was also found drained.
6. Thrust bearing, runner, journal bearing,gear box side mechanical seal,pump side mechanical seal, high speed shaft and inducer were found badly damaged.
7. Impeller was found damaged on front side.
8. All damaged parts were replaced.

Reasons :
Insufficient suction flow - Cavitaion

Analysis :
This faiure occurs when both the pumps are taken on line. When P701B was runnig and P701A was taken on line, P701A was found cavitating immediately after starting. Insufficient flow in suction line has caused the pump to cavitate. Cavitaion caused damage of both mechanical seals (pump side and gearbox side) resulting in draining of gear box oil and seal pot fluid. Thrust bearing and journal bearing failure which followed the drainig of oil has caused failure of other parts (high speed shaft, inducer and impeller) also.
Since these pumps [sundyne model LMV 313] are of very high flow type, operating the pump on minimum circulation at the time of pump change over should be restricted to minimum possible time. During any pump changeover, the time overlap between start up of one pump and stoppage of the other should be reduced to minimum possible time.

Actions / Recommendations :

1. The SOP of pump operation and change over is to be modified to ensure
a) Minimum time overlap during change over from one pump to another.
b) Pump running minimum circulation is to be reduced to minimum possible time.
2. Since frequent start up and stoppage is not desirable in case of these pumps as these are high flow and high speed pumps, the PM frequency may be reduced (The present frequency of once in 13 weeks may be changed to once in 26 weeks).

Auxiliary lube oil pump is to be maintained in Auto start mode and it should cut in when lube oil pressure goes below 10 PSI. Instrumentation to check the interlock and ensure the above condition.

Plant : PE
Department : M
Tag No : GA3417A **Tag Description : HP DTA CONDENSATE PUMP**
FAR No : HDPE/M/94/34 **Sr. No: 1294** **Occurrence Date : 31/05/94**

Cause :
Description of Failure :
Mechanical seal leak.

Observation :
1. DTA fumes observed from the seal.
2. On dismantling, seal sleeve found jammed on shaft.
3. All seal 'o' rings found damaged. Seal face (TC) was found to have wear marks.
4. Jacket 'o' ring found damaged.
5. Casing gasket found damaged.
6. Both radial & axial play found high (axial play = 0.25mmradial play = 0.28mm). Shaft run out found ok (0.02mm).
7. Angular contact bearing cage found broken.

Actions taken :
1. Mechanical seal changed. Bearings replaced (both DE & NDE).
2. Sleeve removed by heating. Cleaned the shaft & sleeve. Jacket 'O' ring & casing gasket replaced.

Reasons :
Pump run under sudden cavitation.

Analysis :
Pump gets suction from HP DTA condensate tank (FA 3408). Both the pumps (GA3417 A/S) were running in parallel. Both DTA vapourizers (BN 3401 AX/SX) tripped due to which there was sudden dip in preheater load. Due to this HP DTA condenser pressure dropped causing vapour locking & NPSH requirement of the pump was not fulfilled causing cavitation. The other pump was not affected.

Actions / recommendations :

1. No specific corrective is recommended.

Plant : VCM
Department : M
Tag No : EGA6501A Tag Description : HCL Column Reflux Pump
FAR No : VCM/M/97/1 Sr. No : 2116 Occurrence Date : 23/02/97

Cause : DE
Description of Failure :
Inboard seal failure. Pump suction line isolation valve passing.

Observation :
1. Seal pot oil level dropped drastically at the rate of 60% in two minutes.
2. Inboard stationary face (carbon) found cracked at one place.
3. Black sticky material found near the Inboard mating face.
4. Outboard stationary face (carbon). Found in good condition.

Actions taken :
Seal parts replaced. Suction valve replaced.

Reasons :

1. High vibration.
2. Flashing phenomenon.
3. Improper seal design.
4. Cavitaion.

Analysis :

1. As the vibrations were found normal & also as outboard seal face was found in good condition, high vibration can be ruled out.
2. As the pump service is of low temperature HCL (-25 deg.c), there is possibility of flashing.
3. As the Inboard carbon seal face which is stationary has a thorugh & through crack at one place & also the same type of failure occured in the standby `S' pump (both are new pumps installed on 18/12/96). There can be a possibility that the seal design may be improper (Seal vendor of this pump is M/s John Crane).
4. While changing over the pump, it was reported that the other pump will cavitate (on few instances). As the cavitation induces impact force on the seal faces, there is possibility of seal getting cracked. Hence combination of points no.2,3 & 4 might have lead to Inboard seal face damage.

Actions / Recommendations :

1. Explore the possibility of avoiding cavitation during pump change over.
2. Matter to be referred to the seal vendor (M/s John Crane) regarding both `A' & `S' pump.

Plant : VCM
Department : M
Tag No : GA6303A **Tag Description : HIBOIL COLUMN BOTTOMS PUMP**
FAR No : VCM/M/95/14 **Sr. No : 1704** **Occurrence Date : 06/08/95**

Cause : DE
Description of Failure :
Inboard seal leakage.

Observation :
1. Dirt found between inboard seal ring and sleeve.
2. Stuffing box surface found to have corrosion at few places
3. All faces (i/b-silicon carbide / tungsten carbide, o/b-carbon/tungsten carbide) and`o'rings(i/b-kalrez,o/b-viton) found ok.
4. Shaft r/o=0.025mm,radial play=0.02mm & axial play=0.06mm.

Actions taken :
Rotating assembly replaced with spare one.

Reasons :

1. Cavitation.
2. Ingress of dirt.

Analysis :

1. Cavitation reported three times since 08/06/95. During hiboil column reboiler shutdown, suction line of both `A' and `S' pump were flushed (lot of CS packing found). Even after flushing, pump `A' used to cavitate. This might have caused seal failure.
2. The ingress of dirt between seal ring and sleeve in inboard seal restricted the movement of seal ring leading to seal leakage.

Actions / Recommendations :

1. Cavitation to be avoided.
2. The problem of ingress of dirt between seal ring and sleeve to be discussed with the seal manufacturer and suitable corrective actions to be taken.

Plant : VCM
Department : M
Tag No : GA6502S **Tag Description : VCM COLUMN REFLUX PUMP**
FAR No : VCM/M/95/12 **Sr. No : 1664** **Occurrence Date : 24/07/95**

Cause : SU
Description of Failure :
Outboard seal failure.

Observation :
1. O/b insert face found to have chipping on atmospheric side.
2. Seal faces of both the seal rings found ok.
3. I/b insert face found ok.
4. Found extrustion of i/b insert mounting.
5. All other `O' rings found ok.
6. Shaft runout=0.07mm, axial play=0.02mm, radial play=0.03mm.

Actions taken :
Pump rotating assembly (bearing block and backplate) replaced with overhauled one.

Reasons :

1. Misalignment.
2. High shaft play.
3. Seal running dry due to cavitation in the pump.

Analysis :

1. As the condition of seal faces and I/b insert were good, possibility of seal failure due to misalignment can be ruledout.
2. As the radial and axial play are within the limit, this reason can also be ruledout.
3. Discussion with service manager of M/s durametalic lead to the following analysis - From the condition of the O/b seal carbon face (chipping on the inner diameter & pitting marks on the faces), it is clear that seal has run without any lubrication.the oil in the seal cavity & pot must have got drained out and then affected the O/b seal. The rason for draining of the oil from the pot can be due to cavitation inturn heavy vibration. In this condition the I/b seal is unstable & the oil in the pot which is at higher pressure, has leaked into the pump leading to dry running of o/b seal.

Actions / recommendations :

1. Cavitation to be avoided.

Plant : VCM
Department : M
Tag No : GA6804A **Tag Description : CONTAMINATED WATER PUMP**
FAR No : FAR/M/99/18 **Sr. No : 2399** **Occurrence Date : 11/02/99**

Cause : PR
Description of Failure :
Seal Leakage Observed

Observation :
1. Inboard seal ring TC found broken in pieces.
2. Inboard seal ring O-ring found badly damaged
3. Inboard composite insert TC found to have detached and broken.
4. Inboard side compression ring and compression collar found distorted. All drive pins and springs were damaged.
5. Deep groove found in the ID of the Insert Holder and Stuffing Box.
6. Shaft runout found to be around 0.12mm.
7. Radial play and Axial play were also high.
8. Wear-ring clearance found high and the wear-rings found to have rubbed against each other.
9. Shaft sleeve found worn out at the impeller side.
10. Casing and back platefound badly corroded.
11. Pump is being run with 2" suction line in place of 4" line.

Action taken:
1. All seal parts including sleeve and compression unit replaced.
2. Shaft and Bearings replaced.
3. Backplate i.e. Gland Cover replaced with the spare one.

Reasons :

1. Cavitation

Analysis :

1. GA6804 A/S pumps have suction from FB6802-Contaminated water storage tank. Tank is filled with sludge and water, which is agitated by two agitators (GD6803A/S). But these agitators are not run since from commissioning because of suction strainer getting choked imeediately as soon as the agitators started. The feed to the tank comes from various pits located in the plant. The tank seems to be filled with mud at bottom up to a certain height. Therefore main suction line is not used for the pump suction as this line is getting choked immediately . Hence a 2" line about 2-3 meters above the main suction line is connected to the suction header of the pump. Even this line is also getting choked frequently, thereby pump cavitates frequently because of low flow.
Pump cavitation has lead to the opening of the seal faces, thereby draining the secondary fluid which finally led to the dry running of the seal. Hence burning and breaking of the seal faces.
Pump cavitation also results in high unsteady vibrations which led to premature bearing failure.

Actions / Recommendations :

1. The tank should be cleaned before rainy season starts.

MECHANICAL SEAL FAILURES

On account of

Improper Installation / Assembly / Poor Workmanship

Plant : AROMA
Department : M
Tag No : P401A **Tag Description : BENZENE TRANSFER PUMP**
FAR No : FAR/M/97/7 **Sr. No: 2322** **Occurrence Date : 22/10/97**

Cause : SK
Description of Failure :
Out board seal leak and leakage from sleeve packing

Observation :
After opening the seal out board carbon was found chipped at three locations. Throat bush was found in pieces, big groove and heavy scoring marks and blakening of the surface of the sleeve were observed. The pieces of broken throat bush had caused extensive damage to the sleeve and also chipping of the carbon faces of the seal.

Reasons :
Defective throat bush.

Analysis :
Throat bush must have had crack at the time of supply itself. This crack had propogated in due course of time during running and finally resulted in breaking of throat bush into pieces. Once the throat bush broke, it had caused all damage to sleeve and carbon faces. This is due to the supply of defective throat by pump vendor.

Actions / recommendations :

1. Since this is due to supply of defective throat bush by pump vendor , no specific corrective action is being recommended.

Plant : AROMA
Department : M
Tag No : P201B Tag Description : Extract Detol Tower Overhead Pump
FAR No : FAR/M/98/12 Sr. No: 2327 Occurrence Date : 29/03/98

Cause : SU
Description of Failure :
Heavy hydrocarbon leakage through seal.

Observation :
1) Shaft sleeve set screw [Part no S1 in Drgno. 2H- 61223 R2] one no. [out of total two] was found in loose condition.
2) Throat bush found in broken condition.
3) Primary insert was having slight scoring marks.
4) Scoring marks observed on shaft sleeve in throat bush area.
5) Shaft sleeve got stuck up in shaft.

Actions Taken :

1) Seal faces were replaced .All secondary seal elements were replaced
2) Throat bush was also replaced.
3) Seal assembled and trial taken and found O K

Reasons :
Inadequate tightening of the Set screw [Part no S1 in Drg no. 2H- 61223 R2] of shaft sleeve .

Analysis :
The failure of the throat bush indicates that the throat bush has come into contact with the shaft sleeve. If the shaft sleeve is held secure in place by Set screw [Part no S1 in Drg no. 2H- 61223 R2], the thraot bush can not come in contact with the shaft.
The Set screw [Part no S1 in Drg no. 2H- 61223 R2] may have got loosened due to some transient vibration if it had not been tightened proerly during assemling of the pump by Vendor. This has lead to the loosening of the screw during running of the pump and misalignment of the sleeve with respect to the shaft , which has resulted in opening of seal faces and seal leak.
The looseining of Set screw [Part no S1 in Drg no. 2H- 61223 R2] and subsequent misalignment of seal faces is also confirmed by the fact that the the Throat bush was found damaged when the pump was opened for seal leak

Actions / Recommendations :

1. Since it was a mistake committed by Vendor during supply of the pump, there is no seperate recommended corrective action.

Plant : MEG
Department : M
Tag No : P302A **Tag Description : CARBONATE PUMP**
FAR No : MEG/M/96/8 **Sr. No: 1952** **Occurrence Date : 12/08/96**

Cause : DE
Description of Failure :
Seal failure

Observation :
Lean carbonate solution leakage was found from the seal in a jet form.carbonate deposit was found on the gland plate seal and stuffing box. Seal was opened and found both faces with slight wear marks and carbonate deposits were found between the faces. Packings were found slightly distorted. Compression unit springs were found clogged.throat bush clearances were found on higher side.bearing Clearances were found high by 0.30 mm axially and 0.25 mm radially.
Actions taken :
All packings, both faces, compression unit, throat bushand bearings were replaced.

Reasons :
1) Clogging of compression unit springs.
2) Aging of seal faces and packings.
3) High clearance in (a) bearings. (b) throttle bush.
4) Low seal flushing pressure.

Analysis :
Analysis for reason nos 1 & 2:
This pump is in operation since 01/03/94 with out any seal problem. On opening of the pump it was observed that comp-ression unit springs were found clogged. Because of continuos operation of the pump, aging of seal faces took place and the lubricating film between seal faces broke down. This resulted in wearing of seal faces and both seal faces got separated. As compression unit springs were found clogged seal faces could not come together. This in turn led to heavy seal leakage.
Analysis for reason no 3:
Due to continuous operation of pump, the clearances of bearings and throttle bush were found on higher side. Becauseof high axial and radial play, coupled with clogging of compression unit springs, seal failure has taken place.Also, it was observed that during the alignment check in second quarter, axial play and radial play readings were not filled in equipment service sheet. Because of this, the deteriorating trend of bearings could not be established. Ultimately, it resulted in seal failure.
Analysis for reason no.4:
Low seal flushing pressure can create a major problem inseal as cooling of seal faces and lubrication between seal faces do not take place. Due to low or insufficient flushing liquid, puffing takes between seal faces resulting in momentary opening and tilting of seal faces. Frequent puffing, opening and tilting of seal faces result in chipping offaces and subsequent seal failure. However as sufficient flushing fluid was available, This reason can be eliminated. Hence, reason nos 1,2 & 3 can be attributed to seal failure.

Actions / recommendations :
1. Possibility of using better design seal like multiple spring seal with shield or single spring compression unit toprevent clogging of springs to be explored with vendor.
2. Flushing fluid pressure shouldbe monitored regularly.

Plant : VCM
Department : M
Tag No : GA6858AX **Tag Description : QUENCH POT CIRCULATION PUMP**
FAR No : VCM/M/94/6 **Sr. No : 1150** **Occurrence Date : 14/11/93**

Cause : DE
Description of Failure :
Outboard seal failure.

Observation :
1. Seal oil outlet line from the seal came out from glandring.the threads of polypropylene gland ring were damaged.
2. O/b seal ring found broken & found fixed in innerperiphery of gland ring.
3. Gland ring inner surface found badly scored & melted due to heat.

Actions taken :
1. Gland ring replaced.
2. Seal faces & compression unit replaced.
3. Secondary packings replaced.

Reasons :

1. Dry running of seal.
.

Analysis :

Seal oil outlet line came out of gland ring as the threads of gland ring were found damaged due to repeated screwing / unscrewing Because of the outlet line disengagement seal oil got drained. Pump ran without seal oil resulting in damage to o/b seal ring which resulted in O/b seal leakage. The threaded joints are in tension as there is no flexible joint in the oil line. Due to repeated screwing / unscrewing actions threads have a tendency to wear out. Due to this outlet line came out.so seal oil got drained resulted in running of pump without seal oil lead to damage of O/b sealring causing O/b seal leakage.

Actions / recommendations :

1. Flexible hose to be used at screwed joints.
Suitable material for gland ring to be looked.

Plant : VCM
Department : M
Tag No : GA6858SX Tag Description : QUENCH POT CIRCULATION PUMP
FAR No : VCM/M/94/14 Sr. No : 1184 Occurrence Date : 07/03/94

Cause : DE
Description of Failure :
Inboard seal failure

Observation :
1. Teflon lining on the sleeve found bulged from impeller side.
2. Groove formed on the Teflon lining of sleeve below insert.
3. Both the seal ring (Peramic) faces found broken.
4. Lot of blackish dirt found in inboard seal area.
5. Teflon lining (Gasket) on the sleeve face found missing from its position. It was found compressed between teflon lining & sleeve of the sleeve itself.
6. Grooves found on inboard area.
7. Impeller O ring found cut & found embedded in the sleeve.
8. Shaft run out - 0.05 mm9. Radial / axial play - 0.02/0.00 mm

Actions taken :
1. All seal faces & secondary packings replaced.
2. Seal rings replaced by silicon carbide.
3. PTFE lined sleeve replaced.
4. Metaflex coupling installed in the place of tyre coupling

Reasons :

1. High vibration.
2. Poor quality of teflon material.
3. Poor quality of workmanship.

Analysis :

1. Possibility of high vibration ruled out as shaft run out, radial & axial play found within limit.
2. Teflon quality was not poor as per visual inspection.
3. As per the modification designed, the teflon lining on the S.S. sleeve should be in one part but the Teflon lining was found made up in two parts, ie.a) Teflon lining on the sleeve b) Teflon face gasket bonded to lining by some material. Now Teflon is such a material that no material can adhereto teflon effectively. So, the bondage of gasket & sleeve failed. On account of this, Teflon gasket was compressed between the S.S sleeve & Teflon lining which resulted in Teflon bulging. This bulged portion of lining restricted the movement of seal ring resulted into the brekage of peramic seal ring. This broken peramic piece acted as a turning tool & made the groove on Teflon sleeve leading to inboard seal leakage.

Actions / recommendations :

1. Sleeve should be made by casting glass filled Teflon around S.S. 304 sleeve.

MECHANICAL SEAL FAILURES

On account of

Ageing - Seal have completed a satisfactory life cycle

Plant : PE
Department : M
Tag No : GA3218 **Tag Description : FB-2 TRANSFER PUMP**
FAR No : PE/M/95/12 **Sr. No: 1578** **Occurrence Date : 21/06/95**

Cause :
Description of Failure :
Mechanical seal failure.

Observation :
The seal pot was found to be filled with butene.

Actions taken : The pump was immediately taken under maintenance. On dismantling, the tandem mechanical seal was found to be slightly scratched.- All 'o' rings were found slightly deformed. The seal was replaced with new one.

Reasons :
Normal wear of mechanical seals and aging of 'o' rings.

Analysis :
The pump was being taken under overhauling for the first time after installation (after 3.1/4 years). So it is concluded that the failure has occured due to normal wear of mechanical seal and aging of 'o' rings.

Actions / recommendations :

1. No specific action may be recommended.

Plant : VCM
Department : M
Tag No : GA6802S Tag Description : STRIPPER BOTTOMS PUMP
FAR No : VCM/M/95/17 Sr. No : 1741 Occurrence Date : 08/09/95

Cause : DE
Description of Failure :
Mechanical seal leakage.

Observation :
1. Seal compression unit found badly jammed on sleeve.
2. Seal ring (Tungsten carbide) face fully wornout -convex shape.
3. Seal insert (Sealide) face found to have groove.
4. Pump casing (carbon steel) and back plate (carbon steel) found badly corroded and eroded.
5. Impeller (SS-316) found in satisfactory condition.

Actions taken :
Pump replaced with new one. Wetted parts (carbon steel) coated with ceramic (brushed) compound.

Reasons :

Mechanical seal failure
1. Spurious seal face moc.
2. Inadequate supply of flushing fluid.
3. More compression force between seal faces.

Back plate and casing corrosion/erosion
Low withstandibility of carbon steel to corrossive service

Analysis :

Mechanical seal failure :
1. As the seal was in service for more than two years, spurious seal face MOC can be ruledout.
2. Supply of flushing fluid was normal. Hence this reason also can be ruledout.
3. Seeing the condition of the seal faces and the compression unit, it appears that the seal leakage is due to more comrpression force between seal faces.

Back plate and casing corrosion/erosion :
The pump service containing EDC, accumulated solids etc..are corrosive / erosive in nature. Hence the cause ofthe damage appears to be due to corrosion attack on carbon steel followed by erosion due to the presence of accumulated solids in service.

Actions / recommendations :

1. As the normal average life of the seal is 24 months, seal to be replaced after every 2 years and to be included in PM schedule.
1. As per inspection note no. I&c/vcm/42/95 dated 18/09/95, pump casing and back plate MOC to be upgraded to SS-316.

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