WET MECHANICAL SEAL RELIABILITY IMPROVEMENTS

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Abstract

Mechanical seal is a major component of the fluid transport system as an insulation to prevent fluid leakage in pump. Wet mechanical seal as components used working fluid passing through a shaft and serves to hold the fluid pressure and friction. PT. Wilmar Nabati Gresik Indonesia is one customer Johncrane that have data seal installation and components failure of the wet mechanical seal during 33 months (2012 – 2014). Analyses quantitatively by mathematical calculation reliability of components to reliability improvements. The greatest failure component of the mechanical seal are o - ring seals (77,13%) and bellows seal (20,63%). Reliability of mechanical sealswas in confidence limits range 97% - 99 %. The investment required to achieve higher reliability should be off set against the benefit when deciding on the most suitable plan of recommendation actions. Identifying the cause of failure, addressing the problems using defect elimination techniques, cost benefit analysis can be carried out to justify the time and costs associated with reliability improvement.

Keywords: *Wet mechanical seal, Reliability, Improvements*

INTRODUCTION

The existence of the pump today is one of the main parts as well as supporting the activities of industry, transport and households. As a means of transfer fluid, the pump has a type and size vary according to the needs, usability, capacity and ability. Mechanical seal is one of the important components in an industrial pump installation. The use of a mechanical seal is an important factor supporting the success of a production and therefore required a good mechanical seal to maximize the pump. In this case the mechanical seal is a component used insulate between the two fluids (liquids and gases) so that no leakage of the working fluid passing through a shaft. Wet mechanical seal is component used working fluid passing through a shaft. Mechanical dry seal system is an alternative to the traditional wet (oil) seal system. This seal system does not use any circulating seal oil. Dry seals operate mechanically under the opposing force created by hydrodynamic grooves and static pressure. Insulation ability (sealing performance) and seal life is very dependent on the selection of materials and construction, and installation of mechanical seals in the machine or plant. The performance of the mechanical seal pumps should be consistent in order to avoid leaks. Therefore, the required analysis and failure mode effects analysis of the mechanical seal performance degradation caused by the failure that occurred during the operation as well as the information systems that include failure events during the operation of mechanical seals and industrial pumping systems work.

The machine will decrease the level of reliability (reliability) when used continuously. Reliability is an opportunity of a unit or system to function normally if used according to the specific operating conditions for a specific time period (Dhillon, 2007). Nevertheless, the level of reliability can be maintained and can be extended engine life by doing good engine maintenance scheduling (Cahyono, 2005).

Maintenance activities are basically divided into two categories, namely preventive maintenance and corrective maintenance. Selection of maintenance activities are based on the nature of the damage to the equipment, whether predictable or unpredictable nature. Preventive maintenance is an activity of periodic inspection and observation of the performance of the system and has been planned in advance within a certain time period to extend the capabilities of the functioning of the equipment. Preventive maintenance is divided into four categories: time-directed maintenance, condition-based maintenance, failure finding and run to failure (no schedule maintenance). While corrective maintenance is activity maintenance performed after the occurrence of the damage or the system can not function properly. Actions that can be taken is in the form of replacement parts (corrective replacement), minor repair (repair), and major repairs (overhaul) (Priyanta, 2005).

John Crane is the largest subsidiary of Smiths Group plc. It has achieved many landmark successes through the years, including the design of the world's first automotive mechanical seal in 1949. John Crane is more than just one of the world's leading providers of engineered technology. They supply and service the products used by their customers in energy services and other process industries for their mission – critical operations- many of which involve extremely challenging conditions (Duncan Gillis, 2015). One customer of Johncrane is PT. Wilmar Nabati in Gresik, East Java that under the auspices of the Wilmar Group (Wilmar International) in Indonesia. Company owners of palm oil and palm oil biodiesel plants in the world's largest industrial complex Wilmar is located in an area of 54 acres. In this industrial complex will be made two additional business derived from the production of crude palm oil that seed crude palm kernel oil and seed palm oil. The results of the processing of both types of derivatives crude palm oil is used as raw material products, including cooking oil, creamer, product cosmetics, biodiesel production, and the production of oleochemicals. Because of that in this industrial complex used many wet mechanical seal for their production.The existence of failures in mechanical seal affect the performance of the pump in the production system. The failure of a component which affects the other components or the failure was caused by the failure of a component. Not enough information is available to support the activities of maintenance and repair of components. In this activity, there has not been a priority care to a component that has a major impact on the sustainability of the system pump.

In this study, the discussion will be limited to the the parameters of the data used come from John Crane with case studies PT. Wilmar Nabati Gresik Indonesia. The data used is data seal installation and components failure of the wet mechanical seal on the pump system that occurs in PT. Wilmar Nabati Gresik Indonesia during 33 months (2012 – 2014). The analysis is conducted quantitatively by mathematical calculation of reliability. Treatment components that should be prioritized according to the reliability of components.The input data destruction as well as the results of the analysis. Determining components – critical components and improve the reliability of components. Provide information to the user about the failure so as to prevent failure to the next. Determining critical components mean time between failure, and improve the reliability of components.

Reliability is defined as the probability that a device will perform its required function under stated conditions for a specific period of time. Predicting with some degree of confidence is very dependant on correctly defining a number of parameters. For instance, choosing the distribution that matches the data is of primary importance. If a correct distribution is not chosen, the results will not be reliable. The confidence, which depends on the sample size, must be adequate to make correct decisions. Individual component failure rates must be based on a large enough population and relevant to truly reflect present day normal usages. There are empirical considerations, such as determining the slope of the failure rate and calculating the activation. Reliability engineering can be somewhat abstract in that it involves much statistics ; yet it is engineering in its most practical form. Will the design perform its intended mission? Product reliability is seen as a testament to the robustness of the design as well as the integrity of the quality and manufacturing commitments of an organization. Mean Time Between Failure (MTBF) is a reliability term used to provide the amount of failures per million hours for a product (repairable product). This is the most common inquiry about a product's life span, and is important in the decision-making process of the end user. MTBF is more important for industries and integrators than for consumers. Most consumers are price driven and will not take MTBF into consideration, nor is the data often readily available. On the other hand, when equipment such as media converters or switches must be installed into mission critical applications, MTBF becomes very important. In addition, MTBF may be an expected line item in an RFQ (Request For Quote). Without the proper data, a manufacturer's piece of equipment would be immediately disqualified.

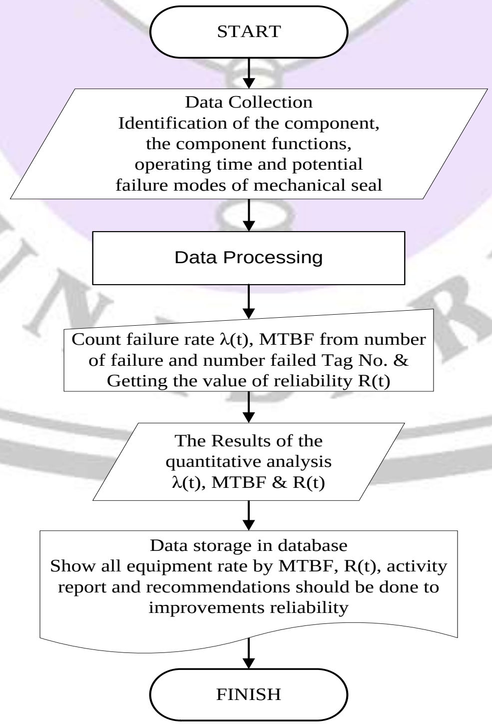

Figure 1.Flowchart Calculations

RESEARCH METHODS

In obtaining the results are accurate, then this chapter will describe the methods of research that explains the research stage, the determination of the parameters used, methods of analysis, and methods of making simulations used in the study . In this study used research methods to analyze the component failure mode - a critical component - in the wet mechanical seal to improvements the reliability of the component values . This research phase begins with data collection and data component failure, causes the failure analysis.

Starting from the collected data then identification of the component, the component function, operating time and potential failure modes of the mechanical seal. Data that has been identified is then performed data processing by analysis. In quantitative analysis was also performed by counting failure rate $\lambda(t)$, MTBF from number of failure and number failed Tag No. information appliances and getting the value of reliability $R(t)$ which is subsequently used as a maintenance activity reports and recommendations. After donethe quantitative analysis the result save by data storage in database. The final the information system show all equipment rate byMTBF, $R(t)$, activity report and recommendations should be done to improvements reliability.

RESULT AND DISCUSSION

PT. Wilmar Nabati in Gresik, East Java is one customer of John Crane Company that under the auspices of the Wilmar Group (Wilmar International) in Indonesia. Company owners of palm oil and palm oil biodiesel plants in the world's largest industrial complex Wilmar. In this industrial complex will be made two additional business derived from the production of crude palm oil, crude palm kernel oil and palm kernel oil. The results of the processing of both types are production of oleo chemicals, because of that in this industrial complex used many wet mechanical seal for their production and further in this thesis mechanical seal will be discussed in question is wet mechanical seal.The data used is data seal installation and components failure of the mechanical seal on the pump system that occurs in PT. Wilmar Nabati Gresik Indonesia during 33 months (April 2012 – December 2014). There are 446 number of failures components of mechanical seal in 46 area plant that have 1596 pump that exists in this industrial. The analysis is conducted quantitatively by mathematical calculation of reliability. Recommendation action components that should be prioritized according to the reliability of components.

Market pressures are demanding cost reductions in the process industries. Most operators are seeking to achieve substantial savings through reductions in the maintenance and “real” operating costs of mechanical seals of which o-ring seal, bellows seal, metal bellows, and other are critical components. This thesis reports on the variable lifetimes being currently achieved, the improvements that are being made analysis quantitatively by mathematical calculation of reliability. Data are often difficult to get and interpret because of that in this discusses how detailed critical component and get result analyzed to make good corrective maintenance. In Table1. displayed data mechanical seal failure distribution that will be used as a data analysis reliability of the mechanical seal.

Table 1. Mechanical Seal Failure Distribution

Component Name	Number of Failures	2012	2013	2014	Percentage Number of Failures
O-Ring Seal	344	55	149	140	77.13%
Belllows Seal	92	20	54	18	20.63%
Part : Bellows & O-Ring	7	1	4	2	1.57%
Metal Bellows	1	0	1	0	0.22%
Catridge	1	0	1	0	0.22%
Abutmen Ring	1	0	1	0	0.22%
TOTAL	446	76	210	160	100.00%

To put mechanical seal failure distribution into perspective Figure 2, it is use some failure data supplied by PT. Wilmar Nabati Gresik to John Crane Company (446 failures from 1596 pumps during 2012 – 2014). In this figure shows clearly that the greatest failure of the mechanical seal due to failure of the component o - ring seals (77,13%), bellows seal (20,63%) and others (2,24%). This figures do serve illustrate two things. First, o – ring seal and bellow seal are all important target areas for reductions in mechanical seal failure and secondly, correcting the problems involves much more that just looking the components.

A programme to assure the proper reliability improvements of rotating component failure frequency, initiated 2012 until 2014 at PT. Wilmar Nabati Gresik, Indonesia, need significantly reduced mechanical seal failures. These failures were frequently need a corrective and preventive maintenance. The reliability improvement programme addressed all these issues, so that failures of all types of rotating component were reduce by about 2013 to 2014 (Figure 3.). Component downtime now occurs much less frequently, and maintenance costs are substantially lower.

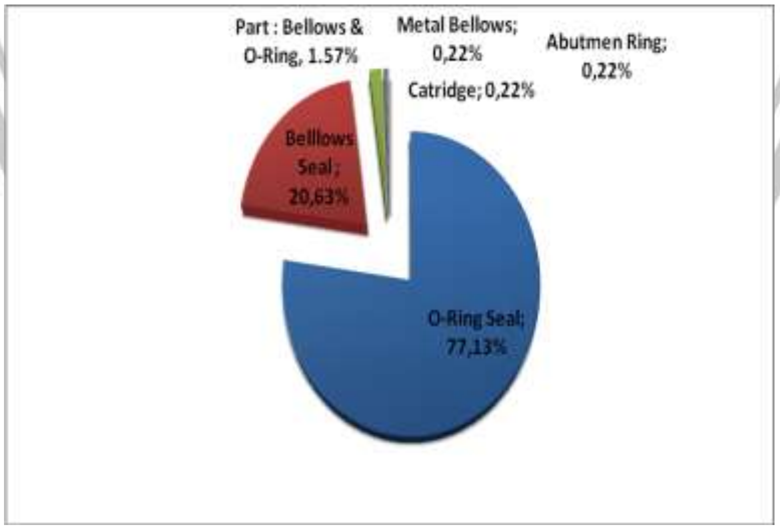

Figure 2. Mechanical Seal Failure Distribution

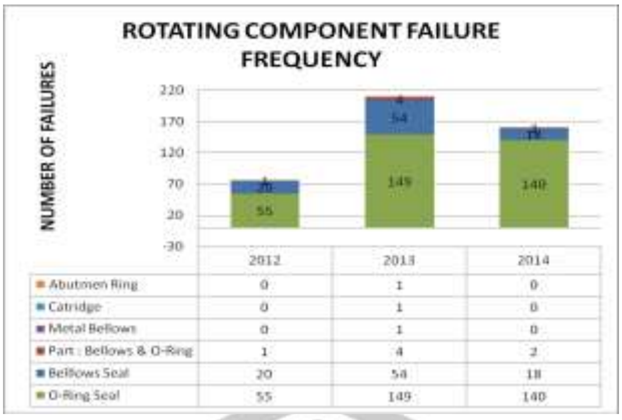

Figure 3. Rotating Component Failure Frequency

In 2012 mechanical seal failures just 76 number because the plant was built at the beginning is not as much now. Mechanical seal failuresdropped in 2013 to 2014 from 210 number to 160 number, nearly 23 % reduction delivered in major economic benefit (Figure 4).

Relationship of pump population to mechanical seal failure.There is poor relative beetwen individual plant area failure distribution and the overall profile as the data cover such a wide range performace (MTBF) and mechanical seal technology.Thus, each plant area has to be considered in its own right when specifying corrective action.This give an indications most difficult mechanical seal duties for pump that have not been upgraded.

Figure 4. Mechanical Seal Failure FrequencyYear Vs Number Of Failure

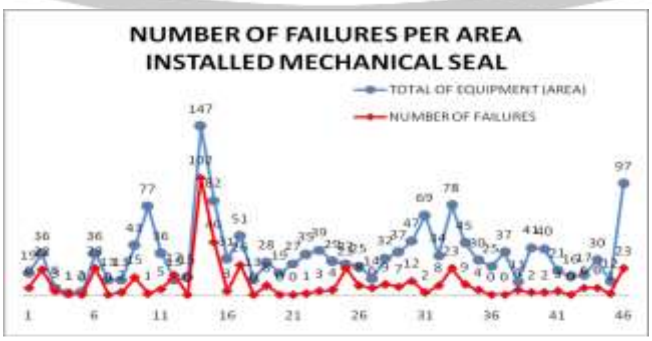

Figure 5. Number of Failures Per Area Installed Mechanical Seal

Reliability is defined as the probability that a device will perform its required function under stated conditions for a specific period of time. Predicting with some degree of confidence is very dependent on correctly defining a number of parameters. Choosing the distribution that matches the data is of primary importance. If a correct distribution is not chosen, the results will not be reliable. The confidence, which depends on the sample size, must be adequate to make correct decisions. Individual component failure rates must be based on a large enough population and relevant to truly reflect present day normal usages.

Table 2.Mean Time Beetwen Failure (MTBF) and Reliability of Mechanical Seal 2012

	2012								
	Apr 12	May 12	Jun 12	Jul 12	Aug 12	Sep 12	Oct 12	Nov 12	Dec 12
Total of Equipment	997	997	997	997	997	997	997	997	997
Number of Failure	6	4	9	6	9	17	9	7	9
Number of failed Tag. No.	6	4	9	6	9	16	9	7	9
Failure Rate (per Day)	0.020%	0.013%	0.030%	0.020%	0.030%	0.057%	0.030%	0.023%	0.030%
MTBF (Days)	4,985.00	7,477.50	3,323.33	4,985.00	3,323.33	1,759.41	3,323.33	4,272.86	3,323.33
MTBF (Years)	13.66	20.49	9.11	13.66	9.11	4.82	9.11	11.71	9.11
Reliability	99.400%	99.600%	99.101%	99.400%	99.101%	98.309%	99.101%	99.300%	99.101%

Table 3. Mean Time Between Failure (MTBF) and Reliability of Mechanical Seal 2013

	2013											
	Jan 13	Feb 13	Mar 13	Apr 13	May 13	Jun 13	Jul 13	Aug 13	Sep 13	Oct 13	Nov 13	Dec 13
Total of Equipment	997	997	997	997	997	997	997	997	997	997	997	997
Number of Failure	19	20	12	15	22	23	22	18	21	18	13	7
Number of failed Tag. No.	19	19	12	14	19	21	22	18	20	18	11	6
Failure Rate (per Day)	0.064%	0.067%	0.040%	0.050 %	0.074 %	0.077 %	0.074 %	0.060 %	0.070 %	0.060 %	0.043 %	0.023 %
MTBF (Days)	1,574.21	1,495.5 0	2,492.5 0	1,994. 00	1,359. 55	1,300. 43	1,359. 55	1,661. 67	1,424. 29	1,661. 67	2,300. 77	4,272. 86
MTBF (Years)	4.31	4.10	6.83	5.46	3.72	3.56	3.72	4.55	3.90	4.55	6.30	11.71
Reliability	98.112%	98.014 %	98.804 %	98.507 %	97.818 %	97.719 %	97.818 %	98.211 %	97.916 %	98.211 %	98.705 %	99.300 %

Table 4. Mean Time Between Failure (MTBF) and Reliability of Mechanical Seal 2014

	2014											
	Jan 14	Feb 14	Mar 14	Apr 14	May 14	Jun 14	Jul 14	Aug 14	Sep 14	Oct 14	Nov 14	Dec 14
Total of Equipment	1596	1596	1596	1596	1596	1596	1596	1596	1596	1596	1596	1596
Number of Failure	14	16	25	8	16	11	15	12	10	2	15	16
Number of failed Tag. No.	13	16	24	8	16	11	15	12	10	2	15	16
Failure Rate (per Day)	0.029 %	0.033 %	0.052 %	0.017 %	0.033 %	0.023 %	0.031 %	0.025 %	0.021 %	0.004%	0.031 %	0.033 %
MTBF (Days)	3,420. 00	2,992. 50	1,915. 20	5,985. 00	2,992. 50	4,352. 73	3,192. 00	3,990. 00	4,788. 00	23,940. 00	3,192. 00	2,992. 50
MTBF (Years)	9.37	8.20	5.25	16.40	8.20	11.93	8.75	10.93	13.12	65.59	8.75	8.20
Reliability	99.127 %	99.003 %	98.446 %	99.500 %	99.003 %	99.313 %	99.065 %	99.251 %	99.375 %	99.875 %	99.065 %	99.003 %

Figure 6. Number of Failures VS Number of Failed Tag No.

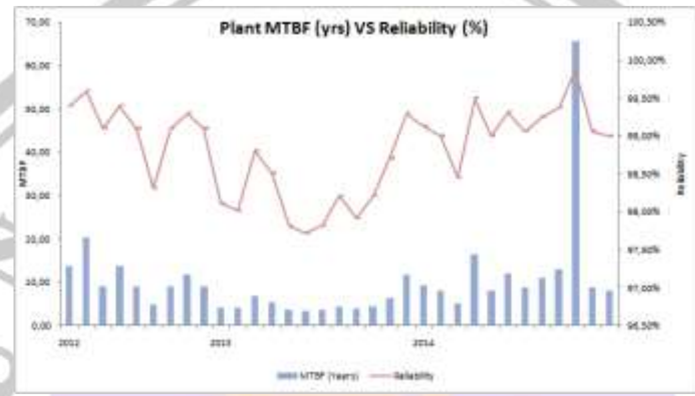

Figure 7. Plant MTBF VS Reliability (%)

Table 5. Bad Actor Number of Failures (Year)

Year	Tag No.	Number of Failures
2012	**FATTRAP**	**4**
	MX 311	**3**
	114 G 02	**3**
	112 G 08	**2**
	214 G 01	**2**
	PX 518	**2**
2013	**FATTRAP**	**14**
	PU 622	**4**
	212 G 03	**4**
	116 G 02	**4**
	PU 701	**4**
	MX 13 A	**3**
2014	**214 G 01**	**4**
	CONDENSAT	**3**
	FATTRAP	**3**
	211 G 04	**3**
	290 26.1	**3**

The correct maintenance and operation of the mechanical seal system is imperative in ensuring acceptable mechanical seal life. Failure to maintain the o – ring seal and bellows seal was the root cause of ninety seven percent of all the failure examined, see table 1. The most number of failures per area installed mechanical seal is Fa I - Glycerine & Glycerine – Tianjin plant has 102 number of failures, see Figure 5. From Figure 7 shown thereliabilityofmechanicalsealswas in range 97% - 99 % confidence limits (CL). That is well because in common usage, a claim to 95% confidence in something is normally taken as indicating virtual certainty. In statistics, a claim to 95% confidence simply means that the researcher has seen something occur that only happens one time in twenty or less. Based on the number of failures that occur, the CL will then be provided as well.

By identifying the cause of failure and addressing the problems using defect elimination techniques, there liability can be improved. The extent and rate of reliability improve mental so varies dependent upon the initial start point and the differential function plant area. The investment required toachieve higher reliability should be off setagainst the benefit when deciding on the most suitable plan of recommendation actions. The direct cost of repair should be considered in addition to the indirect cost sassociated with maintenance. A cost benefit analysis can be carried out to justify the time and cost sassociated with reliability improvement.

CONCLUSIONS

After doing the process of calculation and analysis quantitatively by mathematical calculation of reliability. Data seal installation and components failure of the mechanical seal on the pump system in PT. Wilmar Nabati Gresik Indonesia during 33 months (April 2012 – December 2014). The results of the analysis in accordancereliability of components is the greatest failure of the mechanical seal due to failure of the component o - ring seals (77,13%), bellows seal (20,63%) and others (2,24%). O – ring seal and bellow seal are all important target areas for reductions in mechanical seal failure and correcting the problems involves much more that just looking the components. The most number of failures per area installed mechanical seal is Fa I - Glycerine & Glycerine – Tianjin plant has 102 number of failures.Reliabilityofmechanicalsealswas in range 97% - 99 % confidence limits (CL). That is well because in common usage, a claim to 95% confidence in something is normally taken as indicating virtual certainty. Identifying the cause of failure and addressing the problems using defect elimination techniques, there liability can be improved. The investment required toachieve higher reliability should be off setagainst the benefit when deciding on the most suitable plan of recommendation actions. A cost benefit analysis can be carried out to justify the time and costs associated with reliability improvement.

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