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The Study of Failure Analysis of Centrifugal Pump on the Basis of Survey

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Abstract: ***In this paper, the studies of failure analysis of centrifugal pump from the perspective of life its components and frequency of occurrence of failure in it has done. Hence, a survey was conducted in industrial users based on questionnaire and data collected through the survey were subsequently analyzed.***

Keywords: Centrifugal Pump, Reliability

1. Introduction

Centrifugal pumps are one of the most important components in any plant which have to deal with fluids as essential part of its industry. The primary function of moving those fluids which are undergoing any kind of transformation through other components of the plant such as furnaces, reactors, heat exchangers, and so on, make of the pumps a special focus of attention from reliability, safety, and financial viewpoints.

The reliability and maintainability of centrifugal pump systems have in the overall plant availability plays a very important role of a suitable maintenance strategy. The key issues of this strategy are not only the reduction of unplanned shutdowns and component repair times, but also failures of critical components elimination, once and for all, of chronic failures and unplanned downtime.

Figure 1: Centrifugal Pump Set-up [BHEL Bhopal Source]

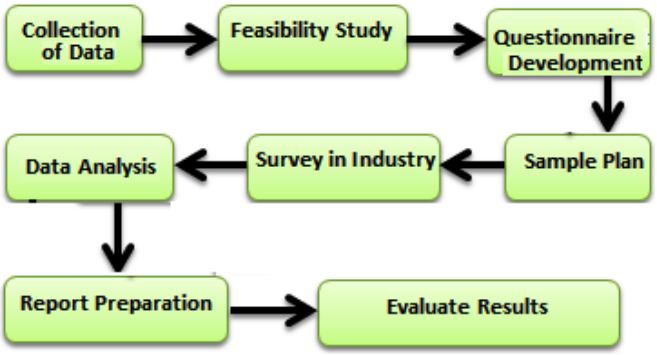
2. Literature Review

S. Srinivasa Rao identifies the remedial actions are to be taken to ensure safer operation of total motor and pump unit [1]. Sakthivel et al., identified and diagnosed faults occurring in a centrifugal pump by normal running, bearing fault, impeller fault, seal fault and bearing fault and cavitation [2]. Bloch diagnosis premature failure of bearing in a centrifugal pump occurs and packing failure occurs mainly due to incorrect operating conditions, liquid contamination and misalignment of pump components [3].

3. Research Methodology

This paper defines the failure occurrence in centrifugal pump with critical component most on the basis of questionnaire survey in industry. It covers the following key points:

- Collect data of centrifugal pump users and analyze
- Frequency of occurrence of problems in the centrifugal pump.
- Useful life of centrifugal pump components prior to failure.



Research Methodology of Centrifugal pump on the Basis of Survey

4. Statistical Package for Social Sciences (SPSS) Software

SPSS is a frequently used program for statistical analysis in technology, science, market researchers, survey companies like as- engineering, medical etc., government, education researchers, data miners. [4] Statistics included in the base software: [5]

- It predicts numerical outcomes: Linear regression
- Its prediction for identifying groups: cluster analysis, Discriminant, Factor analysis.

4.1 Hypothesis Formulation

Table 1: Questionnaire Related Pair of Centrifugal Pump the value of Cronbach's Alpha.

Hypotheses	*Significance of Responses*
Null Hypotheses(Ho)	Survey items are not significant.
Alternative Hypotheses (Ha)	Survey items are significant.

Questionnaire Pair Of Centrifugal Pump	Cronbach's Alpha Value Industrial Users
Group 1 Survey	0.849
Group 2 Survey	0.925

- Cronbach's Alpha Value Analysis defines internal consistency of collected data
- For Reliability, the value of Cronbach's Alpha should not be less than 0.7.

Cronbach's alpha coefficient values calculated for the two groups of questions are 0.849 & 0.925 for industrial users, as shown in Table-1. Therefore, above values are greater than 0.7, the survey data are considered to be reliable and used for analysis. [6]

4.2 Hypothesis Testing

Non-parametric Friedman test collected data with a 0.05 level of significance. With the help of SPSS, critical values from survey table are compared with test statistics calculated and these values of test statistic exceed critical values for two group sets of questions, as shown in Table-2. Hence, alternative hypothesis Ha is accepted and null hypothesis H0 is rejected. [7]

Table 2 Non-parametric Friedman's Test Results

S.No	Questionnaire	D.O.F. (n-1)	Critical Value ($\chi 2\alpha$)	Calculated test statistic Industrial user	Result
1	Life of centrifugal pump Components	4	9.495	74.52	H0 is rejected
2	Failure frequency of occurrence in centrifugal pump	4	9.495	34.64	H0 is rejected

Table 3: Components Life of Centrifugal Pump

Life → / Component ↓	Industrial User	
	Mean	**Standard Deviation**
Impeller	3.42	0.609
Bearing	3.30	0.719
Mechanical Seal	3.24	0.678
Shaft	4.15	0.689

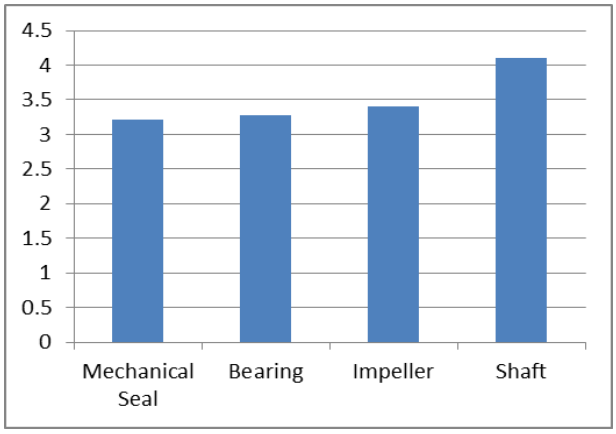


Figure 3: Useful Life of components in years of Centrifugal pump

5. Results

Rank of Critical Parts in Centrifugal pump	*Components*	*Mean Values*
1	Mechanical Seal	3.24
2	Bearing	3.30
3	Impeller	3.42
4	Shaft	4.15

6. Troubleshooting Chart

Trouble	**What to inspect**	**Actions**
Bearing failure	Unit overload	Reduce loading or replace with drive of sufficient capacity. Abnormal loading results in flaking, cracks, and fractures of the bearing.
	Bearing speed	Reduce speed or replace with drive suitable for speed.
	Coupling alignment	Disconnect couplings, check alignment and realign as required.
	Coupling lateral float	Adjust spacing between drive motor, and so on, to eliminate end pressure on shafts. Replace flexible coupling with type allowing required lateral float.
	Bearings adjustment	Bearings must not be pinched and adjustable tapered bearings should be fit at proper bearing lateral clearance. All shafts should spin freely when disconnected from load. If bearing is too free or not square with axis, erratic wear pattern will appear in bearing races.
	Bearings lubrication	Improper lubrication causes excessive wear and discoloration of bearing.
	Rust formation due to entrance of water or humidity	Make necessary provisions to prevent entrance of water. Use lubricant with good rust-inhibiting of properties. Make sure bearings are covered or with sufficient lubricant. Turn over gear unit humidity more frequently during prolonged shutdown periods.
	Bearing exposure to abrasive substance	Make necessary provision to prevent entrance of abrasive substance and clean and flush drive thoroughly and add new oil.
	Damage due to improper storage or	Prolonged periods of storage in moist air and at ambient temperatures will cause destructive storage or rusting of bearings

	prolonged shutdown	and gears. When these conditions are found to have existed, the unit must be disassembled and inspected and damaged parts either thoroughly cleaned of rust or replaced.

Trouble	What to inspect	Actions
Shaft failure	Type of coupling used	Rigid couplings can cause shaft failure. Replace with coupling that provides required flexibility and lateral float.
	Coupling alignment	Realign equipment is required.
	Overhung load	Reduce overhung load and replace with drive of sufficient capacity.
	Unit overload	Reduce loading or replace with drive of sufficient capacity.
	Presence of high energy loads or extreme repetitive shocks	Apply couplings capable of absorbing shocks and, if necessary, replace with drive of sufficient capacity to withstand shock loads.
	Torsional or lateral vibration condition	These vibrations can occur through a particular speed range. Reduce speed to at least 25% below critical speed. System mass elastic characteristics can be adjusted to control critical speed location.
	Alignment of outboard bearing	Realign bearing as required.

7. Conclusions

- This survey paper presented a methodology to analyze the component failure and problems occurring in a centrifugal pump and diagnose or taking care them their priority.
- Questionnaire was tested for its validity and reliability and data collected from the industrial users were analyzed and get optimum results for components life of centrifugal pump.
- Most critical components in a centrifugal pump are packing and bearing, as per analysis of survey data.
- Hence, increase reliability and productivity of performance set-up of centrifugal pumps components.

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