Assessment of Mechanical Problems for Centrifugal Pumps in Eastern Uttar Pradesh, India

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Abstract —Centrifugal pumps are vital property of the agriculture sector. A good quality pump can assure uninterrupted water supply to irrigate crops. The consumer of agriculture sector is largely illiterate and shortcoming of the pumps is faced by farmers in the terms of wastage of money. The study has carried out to grow awareness about the technique among the farmers. In such cases reliable functioning of the pump is an absolute necessity. The major objective of this paper is the analysis of the component life and frequency of occurrence of problem in a centrifugal pump. A survey was conducted among the farmers of tube well irrigated areas and subsequently analyzed. It was found that frequency of occurrence of leakage and excessive noise are 3.17 and 3.11 years which is the most frequent shortcoming found under study. It was also found that the mean life of centrifugal pump components i.e. Bearing, Packing, Impeller, shaft and casing was found as 3.56 , 3.18 , 3.61, 4.20 and 4.64 years respectively. The package of seal has longest life for the operation of centrifugal pump. For the frequency of occurrence of these problems, four the category scale has also chosen. Value 1 refers to always occurs, 2 most frequent occurs, 3 occasionally occurs, 4 – rarely occurs. Under the study a centrifugal pump for irrigating crop has treated as vital input, which is also a key factor in boosting productivity, for the national development and food security.

Keywords— Centrifugal Pumps, Mechanical Problems, agriculture sector.

I. INTRODUCTION

A pump is a mechanical device which takes in energy and imparts it to the fluid, thus enables it to be lifted to a required level. It converts kinetic energy to potential energy. A pump works more efficiently when it work not more than 10 feet above the water level. The consumer in the agriculture sector is largely illiterate, hence do not aware from the problems occur during the successful operation of centrifugal pumps. During operation of centrifugal pump it can experience failures which can potentially cause disruption of production processes. Early detection of faults in centrifugal pumps can reduce energy consumption, service and maintenance cost, increase reliability, life cycle and safety. The basic centrifugal components are: the casing, the bearing housing, the pump shaft and the impeller. At the same time, design and operation of the pump also depends on the operation efficiency, the stability of head capacity characteristic, vibration and noise. An important issue for pump failure is due to fatigue, capitation, hydro-abrasive wear or erosion corrosion etc. Since these problems encountered with the pumps time to time, hence a study "Assessment of mechanical problems of centrifugal pump in Eastern Uttar-Pradesh, India" has under-taken with the objectives to make awareness among the farmers to keep their pumps fit and in operating condition, along with saving of energy.

II. REVIEW OF LITERATURE

Om Prakash and Pandey (1996) have suggested that proper heat treatment and a fine surface finish can improve fatigue strength of impeller. Bloch (1997) has reported in his paper that premature failure of bearing in a centrifugal pump occurs as a result of faulty assembly procedures, fabrication errors and operational error. Packing failure occurs mainly due to incorrect operating conditions, liquid contamination and misalignment of pump components. Das et.al. (1999) have identified that improper heat treatment of drive shaft and improper fitting of the drive pulley on drive shaft cause breakage of shaft in a centrifugal pump assembly. Golbabaci, M. et.al.(2009) have optimize design parameter of pump casing in order to improve the reliability of centrifugal pump. Sakthivel et. al.(2010) have diagnosed faults occurring in a centrifugal pump by considering six conditions namely normal running, bearing fault , impeller fault, seal fault, combined impeller and bearing fault and capitation. They suggested effective remedies of these faults to save energy losses. Thummar and Ashok et.al (2012) have works on four types of centrifugal pumps and their best performance points were evaluated on the basis of performance parameters

like overall efficiency, cavitations, slip factor and losses etc. It has observed that if the total head increases the overall efficiency also increases. But it also follows the same nature as that of power consumption. Sharma and Nagendra et.al; (2015) have conducted a study for on the effects encountered on performance of a centrifugal pump and studied the problems commonly encountered i.e. leakage, excessive noise, excessive heat, suction lag and damage of components along with the major reason due to which these problems are occurred. They also studied for the continuous operation of centrifugal pumps in industries, paper mills, textile mills and refineries. Major objective of their study was the analysis of component life and frequency of occurrence of problem in a centrifugal pump. It was concluded that the prevalence of corrosive environment causes formation of cracks and subsequent fracture in the shaft, impeller and casing etc. Selva kumar J. and Nataranjan K (2015) worked on the leakage, excessive noise, excessive heat, suction log and the damage of the components of centrifugal pumps. A survey was conducted among pump users to collect data on the component life and occurrence of problems in pumps. Data collected through the survey were subsequently analyzed and was found that successful remedies of the above problems are directly proportional to energy savings.

III.   MATERIALS AND METHODS

The study area (Sultanpur District) lies between 81°32' – 81°41' east longitude and 25°59'-26°40' north latitude in Uttar Pradesh, India. A tube well irrigated block (Kadipur) of this district has under-taken for the study during the year 2007-2012. The climate of the area is characterised by a hot summer and cold winter. Average annual rainfall is 1076 mm. The gross sown area of Kadipur block during the kharif, Rabi and Zaid is 11287 ha, 13959 ha, and 397 ha respectively. Since Sultanpur district lies in the large alluvial tract of Indo – Gangetic plain, hence the average ground water table exist within 5m depth. Three villages in the tube well irrigated Kadipur block viz: Kisundaspur, Sariya Kemaura and Shukulpur has selected for the study. A questionnaire for the micro-level study of the selected villages has developed. Each tube well owner farmer having a centrifugal pump facility for irrigation was adopted for the detailed study. The 92 farmers of Kisunpur village, 86 farmers of Saraiya Kemaura village and 103 farmers of shukulpur village (Total 281 farmers) have surveyed. The farmers response about the performance of the pump, trouble shooting, repair/maintenance facility, discharge, running hours/day and area to be irrigated and type of crops grown has collected simultaneously.

The common problems occurring in a centrifugal pump which are considered for the study like noise, overheat, leakage in suction line and no delivery of water were collected. The occurrence of these problems have separately analysed on priority basis, during the exhaustive survey. Response of the tube well owner and farmers have also collected. Life of components of the centrifugal pumps also evaluated. The first step of the survey has based on the site visit and the gathering of all the available information on the failed component and the in-service conditions of the component. The next step of the survey includes non destructive examinations. The most common is the visual examination aiming to determine the general mechanical and structural conditions of the components. The results of visual examinations is a record in the form of sketch, dimension-measurement data or a photography , indentifying discontinuities or imperfection on the surface of the components such as cracks, wear, tear, corrosion, erosion etc. based on the results of a visual examination and the on-site information further decision on the course of examination are made.

IV.   RESULT AND DISCUSSION

On the basis of data collected and Methodology adopted this has found that the common problems occurring in centrifugal pumps, which are considered for this study are excessive noise, overheat, leakage, suction lag and no delivery. A five point category scale was used to obtain responses. For frequency of occurrence of these problems, the category scale chosen, value 1 refer to always occurs; 2-most frequently occurs; 3 – occasionally occurs; 4 – rarely occurs. Mean value for frequencies of occurrence of five problems are shown in Fig-1. In the agricultural applications leakage and excessive noise are the two problems which occur most frequently. The percentage value of frequency for their occurrence is 31.7 for leakage and 31.1 for excessive noise for domestic and agricultural usage (Table - 1). Packing or seal is provided in the pump assembly to control leakage. Packing has to be inspected once in three months to ensure adequacy of its performance. Leakage rate of 60 drops per minute is permitted in a pump, in order to cool the packing and shaft, provided the liquid being pumped is clear water. Excessive leakage occurs in a pump as a result of improper selection of packing material, abrasive wear and misalignment. Suspended solid such as sand and dirt in pumped liquid causes abrasive wear of packing, impeller and shaft. Correct alignment of shaft, impeller and bearings; selection of correct grade packing material and proper fitting of packing help to overcome the leakage problem in a centrifugal pump. The results are in corroboration to the study conducted by Thummar, A. et.al.(2012) in an experimental investigation of open well centrifugal pump troubles and performances.

Table.1: The percentage frequency of occurrence of problem in centrifugal pump.

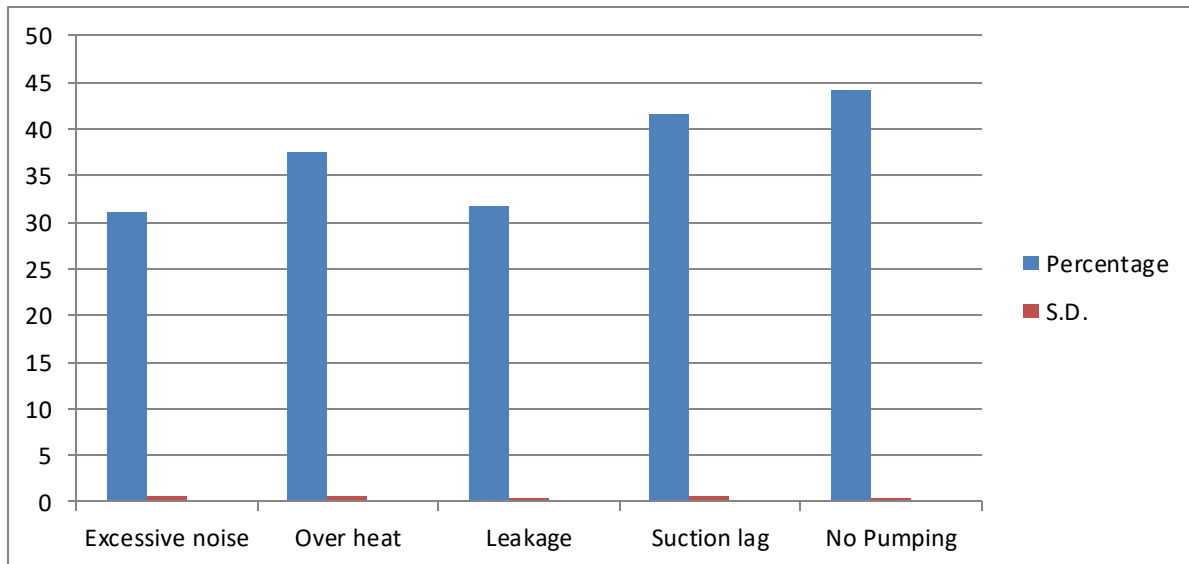| Problems	Agricultural Uses	
	Percentage	**S.D.**
Excessive noise	31.1	0.618
overheat	37.5	0.669
leakage	31.7	0.452
Suction lag	41.5	0.628
No pumping	44.2	0.515

Fig.1 : Percentage value of frequency of occurrences for various problems in centrifugal pump.

The packing or seal in a centrifugal pump has lowest life among the five major components, as indicated in figure - 2. The mean values of life of packing are 3.18 years for the agriculture uses. Main function of packing or seal in a centrifugal pump is to prevent leakage of pumped liquid from the volute casing. In the agricultural application load on pump ranges from light to medium, in terms of operating hours. The bearing the second component with a shorter life of 3.56 years. The factors responsible for failure of bearing are the presence of reactive environment and high temperature of the pumped liquid. Remedial measures to be adopted are correct lubrication, misalignment or improper rotating parts of pump and periodic maintenance activities. Impeller failure ranks in terms of component life i.e. 3.61 years for agricultural uses. An impeller fails due to fatigue failure caused by cyclic loading and pressure pulsations in the pump. Selection of the suitable type of material with high fatigue strength and better surface finish are some of the way to improve the strength of an impeller. Impeller failure occurs due to improper heat treatment, poor surface finish or insufficient radial clearance between impeller and volute casing. Corrective measures to be adopted to increase the life of impeller (Table-2). Failure of shaft and casing are not adopted a common occurrence in a centrifugal pump.

Table.2: Life of Centrifugal Pump Components

Components	Agricultural Uses (Life in years)	
	Mean	**S.D.**
Bearing	3.56	0.635
Packing	3.18	0.622
Impeller	3.61	0.515
Shaft	4.20	0.608
Casing	4.64	0.573

Mean value of life of these component exceed 4 years. Mohammed, M. It.al. (2010) also found similar results in their case study for reliability assessment of centrifugal pumps in petrochemical plants. They worked for removing these trouble shootings and proper management of pumps.
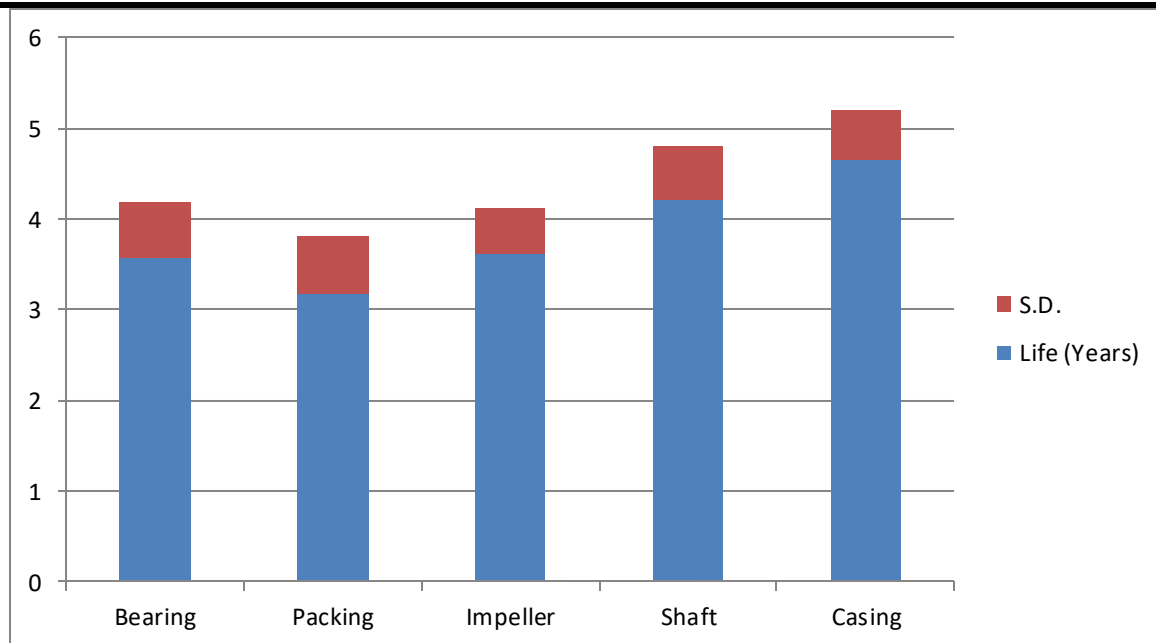
Fig.2 : Life of Centrifugal Pump Components (In years).

V. CONCLUSION

The study presents and actual status of problems faced by the tube well owners and farmers of the tube well irrigated area under Kadipur block of Sultanpur district in Eastern Uttar Pradesh. In the study it has concluded that the percentage frequency of occurrence of various problems faced varies from 31.1 percent to 44.20 percent. For which the calculated standard deviation varies from 0.452 to 0.669 under various problems faced by centrifugal pumps used in agricultural. The life expectancy of various component parts of the centrifugal pump varies from 3.18 years to 4.64 years with the variation in standard deviation as 0.515 to 0.635. On the basis of these conclusions our study reflects the acceptances of problems to overcome in the stipulated time period for proper functioning of pumps.

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