Faults Detection and Diagnosis of the Sprockets Failure

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Abstract— The detection and location of faults on power transmission lines is essential to the protection and maintenance of a power system. Fault detection is recognizing that a problem has occurred, even if you don't know the reason. Faults may be detected by a variety of quantitative or qualitative approaches. In this study have finding the various faults related to the sprockets failure and diagnosis this fault using the various methods of the failure causes. These include many of the multivariable, model-based approaches and implement the system by reducing these faults. The main objective of this study is to find out the major breakdowns in mechanisms due to sprockets failure causing production losses to the company and to suggest counter measures by which these problems can be reduced. In the study a Root cause analysis is conducted to find the root cause of breakdowns and some parallel improvement opportunities were also identified for implementation so as to reduce the downtime. also diagnosis of the faults have also discussed.

Key words: Faults Detection, Sprockets Failure

I. INTRODUCTION

Fault detection and location has been a goal of power system engineers since the creation of distribution and transmission systems. Quick fault detection can help protect equipment by allowing the disconnection of faulted lines before any significant damage is done. Kurt Josef Ferreira [1] discussed the detection and location of faults on power transmission lines is essential to the protection and maintenance of a power system.

Hiroyuki Tsutada [2] proposes method of chain fault detection of escalator using handrail vibration which gives the idea about faults detection methods.

Accurate fault location can help utility Personnel remove persistent faults and locate areas where faults regularly occur thus reducing the frequency and length of power outages and increase the productivity also efficiency of the system a product fault refers to a defect in a system. An error is inconsistency between the observed performance of a system and its specified performance. A machine product failure occurs when the delivered product deviates from correct service and perform unexpected behavior from user requirements. A product fault or error may not necessarily cause of the failure. Fault detection is recognizing that a problem has occurred, even if you don't know the reason, Faults may be detected by a variety of quantitative or qualitative approaches. This includes many of the multivariable, model-based approaches. kiran m, cijo mathew[3] analyze the root cause analysis of the industrial study, Fault diagnosis is investigating one or more root causes of problems to the point where corrective action can be taken. This is also referred to as "fault isolation", especially when need to show the distinction from fault detection. A "fault" or "problem does not have to be the result of a complete failure of a product. Mark Doggett [4] proposed the root cause and identification of problem in a process plant, root causes of non-optimal operation might be various failures but problems might also be caused by poor choice of operation system, James J. Scutti, Massachusetts [5] proposed the failure analysis and the faults detection for the chain drive with poor feedstock quality or human error. Chain drive is important device which is used to transmit the power without slip and with high efficiency. Sprockets and chain is two main important elements in the chain drive. A sprocket is a toothed wheel, commonly used in drive systems, to which the strength and wear resistance of the teeth are important. Sprockets play an important role in the chain drive there are several methods that could be used to manufacture sprocket.Ebhota Williams, Ademola Emmanuel Oghenekaro [6]It discusses dimensioning, drafting, chemical composition, material selection, choice of manufacturing process, heat treatment, surface finish and packaging as the eight steps that need to be followed sequentially in this reverse engineering approach. The methods include milling hobbing, powder metallurgy, sintering, and steel casting. The selection of a particular process is hinged on the sprocket material, equipment availability and cost. Sprockets are conventionally fashioned by hobbing. Root cause analysis (RCA) is a method of problem solving that tries to identify the root causes of faults or problems that cause operating events

II. METHODOLOGY

1) Identification
2) Analysis data
3) Root cause identification
4) Faults detection
5) Diagnosis of faults.
6) Conclusion
7) Improvement opportunity.

III. PROBLEM IDENTIFICATION

In today's fast growing scenario manufacturing industries are facing a frequent technology changes lead to greater competition in the market. In order to survive many of industries using advanced manufacturing facilities to improve and increase both quality and productivity of the product continuously. Machine breakdowns occurring due to failure of key elements which are engaged in drive systems. So firm has to reduce the unwanted stoppages of production so as to maintain the steady production level and to meet the demands in the market. Production may be stopped due to many reasons like breakdown of machine, maintenance work, labor issues, problems in the method of production etc... Excluding all other factors like materials, method, man, etc... It is necessary to reduce the breakdown (down time) of machine or equipment's in the company for the efficient nonstop production to meet the demands. Breakdowns are the most common causes of efficiency loss

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in manufacturing industries. Eliminating unplanned down time is critical to improving Overall Equipment Efficiency.

Efficiency of the machine/ mechanisms in industries is totally depending on the performance of the drive accuracy, which will retard due to the malfunctioning of the drive elements i.e. sprockets. The catastrophic failure of mechanism occurring due to the frequent failure of the sprocket, after the rigorous analysis and the brainstorming session revealed the occurring defects which lead to sprocket failure.

IV. ANALYSIS

After rigorous breakdown analysis of three months data obtained from the shift log book of the company and is tabulated. The experimental study is done on the 10 sprockets. Breakdown data collected consist of all % elements breakdowns that occur in industry emphasizing on drive system failure leads to production stoppages which affect the productivity as well as increase the overall cost incurred. For that selecting the drive, after rigorous analysis the various % of the failure are finding as follows.

Sprockets wear- 60%
Deflection or fluctuation-20%
Chain climbs sprockets – 10%
Chain roller/link wear – 10%

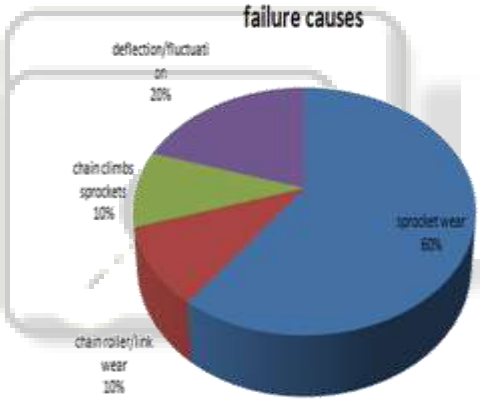

Fig. 1: Pie chart showing the causes with its failure rate

Pie chart shows the sprockets wear is the measure cause of the sprockets failure from the study of the industries also other causes are also depicted as follows, Deflection or fluctuation 20%, Chain climbs sprockets, 10% Chain roller/link wear 10%.

Also the Pareto Chart give the details of the faults as on x-axis percentage of the failure are shown and on y-axis various faults causes failure of the sprockets are shown.

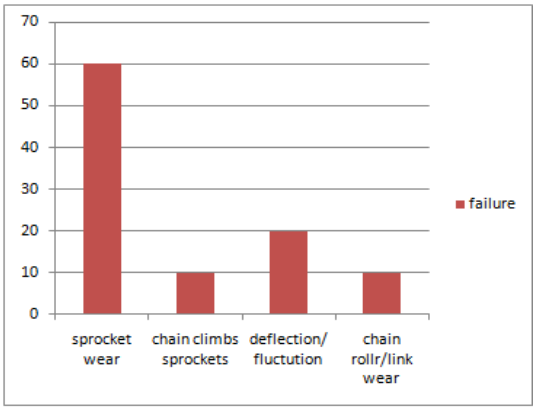

Fig 2: Pareto chart breakdowns

From this study the sprockets wear is the measure cause for the failure according to this study also we concentrated on this faults.

A. *Initial Causes and effect in Sprockets Failure*

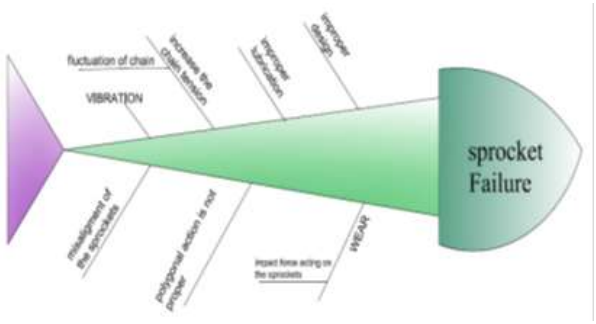

Fig. 3: Fish Bone Diagram.

Fig. shows the fish bone diagram of the various initial causes and the effect of the failure of the sprockets it is also called as Ishikawa diagram. A detailed study was conducted on causes for breakdown due to failure and final cause and effect diagram is prepared as given in Fig. In this diagram other various causes of the failure and its causes have shown.

V. IDENTIFICATION

From this study it is identified that the various causes of sprockets failure and also same brainstorming study the various faults of the failure are found are as below.

- Sprockets wear
- vibration in the sprockets
- Chain climbs sprockets
- Polygonal action
- Misalignment of the chain and sprockets

VI. DIAGNOSIS OF THE FAULTS

A. *Sprockets Wear*

For these faults various studies and researches have been done, this is important to find the wear rate and its causes for the system. For various study the material is responsible for the cause of the various wear and its heat treatment process are also responsible for these cause. But in this study material is safe and keeping same and goes through the sprockets design consideration for reducing the wear in the sprockets. It is observed from study that the main cause of this wear is the backlash and the undercut in the sprockets and chain. These causes discuss as below. Fig .4.3 shows here exist gaps D1 and D2 between the roller and sprocket teeth. This gap or backlash causes loss of movement when the transmission is made in forward and reverse direction. Due to this the wear in the sprockets occurs. This non theoretical tooth profile causes uncertainty of power transmission, and thus produces noise and vibration also.

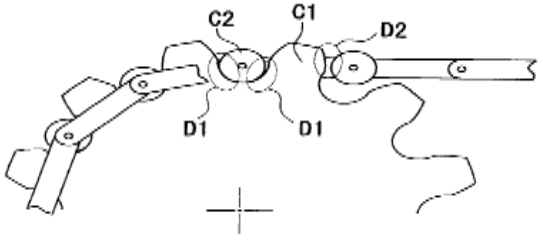

Fig. 4: Backlash

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B. Vibration in the sprockets

A body is said to vibrate when it describes an oscillating motion about a reference position. The number of times a complete motion cycle takes place during the period of one second is called the Frequency and is measured in hertz (Hz).The profile of the sprockets tooth is defined in many national and international standards. These conventional designs use a combination of the several circular arts and the straight lines for the profile. For example, FIG.4.2 shows a typical conventional design of the tooth profile, it is known that the theoretical contact between a circle and a line makes the involutes curve as a contour of a point on the line. It is seemed, from this theory, that it is better to use an involutes curve as the roller center path for the sprocket tooth. However, it leads to "undercut" of the profile, and precise transmission cannot be expected. This causes the vibration and noise in the drive.

C. Polygonal Action

The polygonal action means that the pitch line of the chain is a tangent or secant line of the pitch circle of the sprocket alternately. The pitch line of the chain keeps moving up and down. The instantaneous transmission ratio between driving and driven sprockets is variable. Those features are able to cause an uneven chain velocity, transversal and longitudinal vibration, noise and meshing impact, and damage the synchronization and evenness of the transmission, so that the application of the roller chain drive is used to be limited in a lower speed. Polygonal action plays an important role in the transition of the power in the chain drive.

The chain passes around the sprockets as a series of chordal links. This action is similar to that of non slipping belt wrapped around a rotating polygon. The variation in the velocity is given by,

$(V_{max} - V_{min}) < (1-\cos(\theta/2))$ as the $\theta = 180$ $(V_{max} - V_{min}) < (1-\cos(180/z))$,

As the number of teeth increases to φ, cos (180/z) will approach unity and (Vmax – Vmin) will become zero. Therefore, the variation will be zero. In order to reduce the variation in the chain speed, the no of the teeth on sprockets should be increase. It has been observed from various researches that speed variation is 4 % for the sprockets with 11 teeth, 1.6% for the sprockets of 17 teeth, and less than 1% for the sprockets teeth of 24 teeth.

D. Chain Climbs Sprockets

It is observed that the chain climbs the sprockets while running at constant speed. In this fault the chain climbs the sprockets due to improper design of the sprockets and the selecting of the improper chain also excessive chain slack and material build-up on the sprockets tooth pockets are the same lesion for this defects. Due to this fault in the sprockets, power of the machine loss may very high due to this the efficiency of the drive and the system get reduce.

VII. MISALIGNMENT OF THE CHAIN AND SPROCKETS

Accurately installation of the sprockets is very important to the life of machines. That is, sprocket alignments can maximum drive life also gives the efficient to the system. Chain and sprockets misalignment is directly affected to the drive system performance. Proper alignment increases the life of the drive also. It is observed that the sprockets alignment of the drive does not follow any standard procedure to align the sprockets and the misalignment in between two sprockets is up to 10 mm to 50mm. which is affected the drive performance. To avoid this problem in the drive fallow the procedure of the drive alignment as per standard and follow various research related this topic.

VIII. CONCLUSION & IMPROVEMENT OPPORTUNITY

The main objective of the study was to identify the faults in the failure of sprockets, because of this; breakdown causes the production loss of the industries. Root causes of breakdowns were identified using cause and effect diagram. Counter measures and parallel improvement opportunities for major breakdowns because of which production loss takes place also being discussed. Finally diagnosis of the faults for eliminating causes had been studied.

One can eliminate the faults occurred in sprockets by designing new sprocket tooth profile and same parallel improvements.

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