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Maintenance of Bucket Elevator (Case of the Cement Plant of El Malabiod, Algeria)

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Abstract

The most important objective of this work is to examine the failures of the Bucket Elevator based on the cost of the parts. We use a both methods, Pareto Analysis and Ishikawa diagram, to predict areas of parts affected by breakdowns. The hexagonal head bolts and the square head bolts represent 74.92% of the total cost of the changed parts. We consider, in perspective, to review the design of elevator and apply the recommendations of the manufacturer to increase the lifespan of the lift and improve its reliability.

Keywords : Bucket Elevator; Pareto diagram; Faillure; Cost; Ishikawa diagram

Introduction

The primary concern of a company is the improvement of the safety, the maintenance and the availability of its equipment, due to their direct influences on the smooth running of the tasks, the respect of the deadlines and the increase of production. Condition monitoring in mining industry is not as well developed as it is in other branches (i.e. power engineering, oil industry etc). One of the reasons is that mine is the specific kind of company with harsh environment and dissipation of assets in wide area. There are a lot of different mechanical systems in a lignite mine but one of the most important is a transportation system [1]. According to the study reported by Mobley, from 15% to 40% (average 28%) of total production cost is attributed to maintenance activities in the factory [2]. The complexity of maintenance in modern mining systems is based on the combination and use of various resources and the characteristics of the dynamic environment in which they exist. Maintenance is usually categorized into preventive, corrective, and predictive types [3]. In NF EN 13306 standard maintenance is defined as: "the assembly of all administrative and management technical actions during the life cycle of an asset, intended to maintain or restore it in a state which in, it can perform a required function.

Face to the development and competition to competitiveness, which drives the search for quality and above ail; cost reduction, maintenance has become one of the strategic functions in the company [4]. The Italian economist Vilfredo Pareto (1848-1923) observed in 19th century Italy that 20% of the population owned 80% of the usable land [5]. Pareto chart has been used to evaluate mining equipment failure frequency. A Pareto chart is a tool which enables factors influencing a phenomenon to be organized. By means of this graphic picture it is possible to present both relative and absolute distribution of the types of errors, problems and their causes. The detection and exclusion or reduction of the problems inherent in the Bucket elevator machine using a continuous process improvement tool will be significantly valuable in the argument of reduced machine down time, minimized repetitive stops, and diminished cost of replacing spare parts and productivity increase. The principle of this paper is to analyze the functioning of strategic equipment (elevator machine), considered the most essential machines in the cement plant of El Malabiod, Algeria. Its damage causes the stopping of the production chain. The cost of lost production and maintenance caused by this blockage is very high. In this context, the Pareto chart is undoubtedly a real optimization tool maintenance cost. The present paper will characterize the maintenance of buckets elevator type 250 by the root cause analysis methodology based on the combination of Pareto Analysis and Ishikawa diagram. The Pareto analysis is used to identify the major causes while the cause-effect relationships are illustrated by a Fishbone diagram.

History of bucket elevators

Bucket elevators are the most efficient means of elevating free flowing granular materials and most materials even some sticky materials. Bucket elevators of the centrifugal discharge are normally used, and most are of belt type. Friable materials are best handled in continuous bucket elevators that operate at low speeds. The continuous buckets are discharged by gravity on the back of the preceding bucket while passing over the head pulley, thus reducing breakage caused by the centrifugal force discharge of a centrifugal elevator. Bucket elevators usually require the least amount of horsepower for vertical conveying of any conveying system. The bucket elevator has been in used in the USA for many over a century. In addition, for the most part the same basic design has been followed. Leonardo da Vinci in the 1400's believed art was the chief instrument of man's search for knowledge. The ancestors of the modern-day bucket elevator first appeared at these devices were predominantly used for elevating water by the use of pots attached to an endless rope. It is believed that the water used for the famous Hanging Gardens of Semiramus was brought up to a height of 300 feet by this means. A remarkable achievement, having regard to the fact that modern elevators rarely work to heights greater than 150 feet. Since this time, the bucket elevator has gone through a period of evolution. There was a flourish of activity in elevator design and patents between 1850 and 1930. Since that time there has been very little new work or mathematically supported designs developed. As Leonardo da Vinic said, "Art is never finished, only abandoned", this can be said for the design of bucket elevators, development has been abandoned [6].

Practical Use of a Pareto Chart for Evaluating Bucket Elevator Failure Frequency

In the mining industry a Pareto chart is used to monitor and control mining machines (a cutter-loader, chain conveyor, belt conveyor, crushers as well as power supply and control equipment) which are an important element of the mining process. It is important to evaluate these machines' failure frequency and reliability as well as to find which of the discovered causes responsible for the high failure rate may be eliminated in the first place [7].

Using one of the important quality management tools a Pareto chart. A Pareto chart has been constructed according to the following steps:

a) Data on the type of failures of the Bucket elevator type 250 has been collected.

b) Spare parts have been assigned to particular failures with costs.

c) Cumulative percentage values have been calculated (Cost of the different replacement parts of the elevator with their cumulative percentage)

Description of the the bucket elevator

The bucket elevator has the advantages of big conveying capacity, high hoisting height, stable and reliable operation and long service life. Performance and parameter are in accordance with JB3926-85 Vertical Bucket Elevator, which is consistent with the international and foreign advanced standards and the towing circle chain is in accordance with MT36-80 High-Strength Circle Chain for Mine. The machine is applicable for conveying the power, grain and block materials, such as coal, cement, block, sand, clay and ore. The bucket elevator can convey materials with high temperature when armed with special circle chain structure (Figure 1). The bucket takes the materials from the storage silo below, follows the conveyor to the top, around the top wheel and then turns to the bottom, and pours material into the acceptance trough at the end. The conveyor which drives the belt bucket elevator is always the rubber belt, it is installed in the drive roller at the top or bottom and in the changing roller at both sides. But for the type 250 chain bucket elevator, it is always to install two parallel drive chains, with chain wheel torque and that of change to upper or lower. Generally, the bucket elevator is equipped with the hull to prevent floating dust.

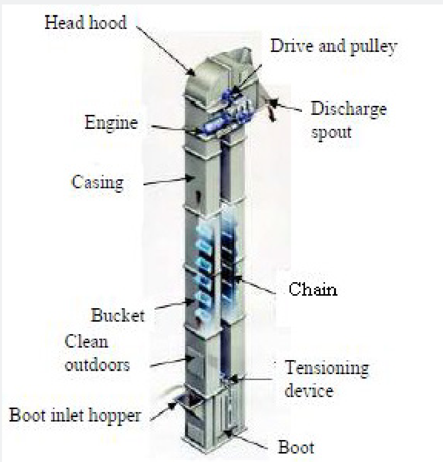

Figure 1: Bucket Elevator Type 250 with an Auxiliary Rotating Motor with a Power of 10KW.

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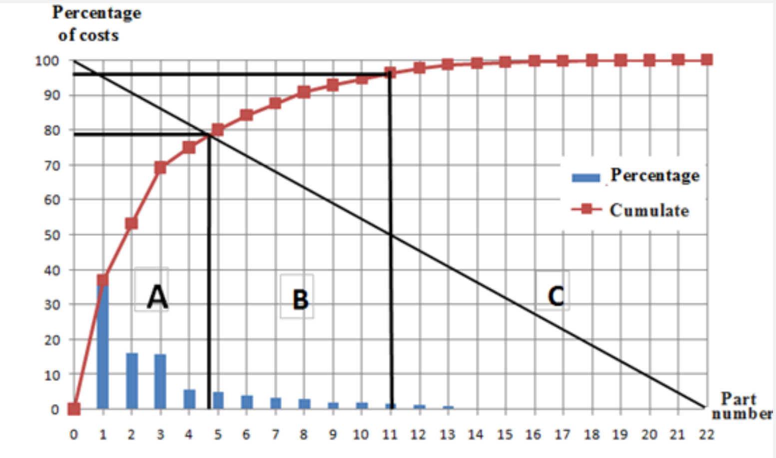

Figure 2: Pareto Diagram.

Table 1: Cost of the various Replacement Parts of The Elevator with their Percentage.

N°	Part	Nbre	Unit Price (DA)	Total Cost(DA)	Total Cost (%)	Cumulate (%)
1	Hexagon bolt M27x50	220	1320.3	290472	36.92	36.92
2	Strand of chain with 10 links in	5	25548	127741	16.24	53.16
3	Hex head bolt complete M27x2	120	1050	126000	16.01	69.17
4	Square head bolt M36x80	55	822	45210	5.75	74.92
5	clamping sleeve	2	20019	40038.02	5.09	80.01
6	Reduction gear	2	16790	32580	4.14	84.15
7	bearing 32221	2	13849	27698.82	3.52	87.67
8	Bolt with square head with locknut	10	2449	24490.34	3.11	90.78
9	Strand of chain with 5 links in	2	8283	16566	2.11	92.89
10	Acetylene	35	415.77	14552	1.85	94.74
11	Hex head bolt complete M20x60	12	1000	12000	1.53	96.27
12	Reducer wheel	2	5894	11788	1.5	97.77
13	Cylinder bearing	2	4017.3	8033.16	1.02	98.79
14	Rotor bearing	1	2973.6	2973.6	0.38	99.17
15	Steel bucket	10	248	2480	0.32	99.49
16	Split pin	99	17	1683	0.21	99.7
17	split pin 6x100	40	17	680	0.09	99.79
18	halogen lamp	3	197.97	593.85	0.08	99.87
19	split pin 5x65	20	22.55	451.84	0.06	99.93
20	Sealing tube hermetic	2	210	420	0.05	99.97
21	joint spi 40x63x10	1	174.6	174.6	0.02	99.99
22	Wear ring for elevator	2	72.85	145.16	0.01	100

Application of the pareto method

In Table 1, we present the cost of the various replacement parts of the elevator with their percentage. We present the Pareto diagram in Figure 2.

Interpretation of pareto chart

Zone A: Parts number 1, 2 & 3 (hex bolt, 10-link chain strand, full hex head bolt and M36x80 square bolt respectively) account for 74.92% of the total cost of the parts changed. It should be noted that this zone (A) is the most important one that must be given priority.

Zone B: In this area the maintenance actions on the parts, 5, 6, 7.11 represent 21.35% of the total cost of the faulty parts. By analyzing the historical file, it is noted that the causes of these failures are related to a design error, and zone (B) has lower costs compared to the first zone.

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Zone C: Contains 50% of the number of rooms, and it represents only 3.73% of total cost, we contend that it is the smallest zone compared to the first two zones.

Ishikawa diagram (Figure 3)

Cause-and-effect diagrams or Ishikawa diagrams (Fish bone diagram) is one of the seven basic tools of quality, which is used to identify potential factors causing an overall effect. This technique helps the users to identify the top causes that need to be addressed to resolve the 80% of the problems. Once the major causes are identified, tools like the Ishikawa diagram or Fish-bone diagram can be used to illustrate the root causes of the problems. Then efforts can be made to remove the major obstacles in order to develop a more sustainable process [8]. To try to surpass this problem is to know all the causes that may give rise to know '' the five M: Machine, Materials, Methods, Manpower and Milieu, to deduce the causes (Table 2).

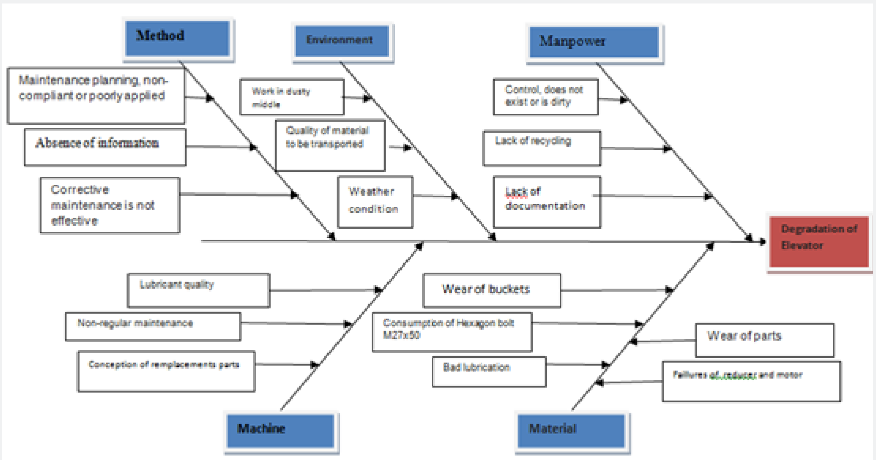

Figure 3: Ishikawa Diagram.

Table 2: Operations to be Carried out at Elevator Level in Different Zones.

Zone	Operation to be Realized	Month of Inspection
Ciment	Internal inspection of the elevator (condition of links, buckets). Change of worn organs if necessary	General Inspection (MARCH)
Clinker	preventive maintenance for the elevator	General Inspection (NOVEMBER)
Clinker	Change buckets and deformed links and replace two rings and two bushings and alignment	General Inspection (JANUARY)
Baking	Changing two sheared links and one bolt	General Inspection (MAY)
Grinding	Cleaning the elevator foot and other places.	General Investigation (APRIL)
Ciment	*Replace worn rings, of the elevator tension drum. *Switch the rotary encoder back on.	Inspection général (FEBRAUARY)
Baking	*Change buckets and deformed links. *Replacements zipper tracking for tension adjustment and alignment.	General Inspection (JANUARY)

Interpretation of ishikawa diagram:

According to Ishikawa diagram, we may hire the following:

Material: Inappropriate quality of replacement parts and lubricant quality are the most factors affecting the profitability of the machine.

Environment: The dusty environment is the major factor that increases downtime.

Manpower: The lack of training and qualification of workforce are major problems it is necessary to resolve.

Machines: The machines are typically used in reduced condition (poor lubrication, improper adjustment).

Method: The absence of information on the state of the machine and the ineptitude of the corrective maintenance makes the task of maintenance personnel difficult.

Proposition

To provide solutions that improve maintenance and increase the lifespan of the equipment (elevator) we propose the application of the maintenance range based on the manufacturer's recommendations with the aim of:

a) Eliminate air and material leaks.

b) Cleaning of the installations, and their surroundings.

c) Operate the hoists on elevators before the long stop (or replace them)

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d) Return to service of emergency stops for carriers

e) Infrared bar control before long stop or inspection of busbar during stop

f) Rehabilitation of the protection of rotating installations

g) Cleaning the workplace.

Conclusion

The failures problems of buckets elevator in cement plant of El Malabiod are analyzed. Pareto chart and Cause and- Effect Diagram are used to identify and evaluate different defects and causes for these failures responsible for breakdowns of buckets elevator. According to the Pareto analysis Parts (hex bolt, 10-link chain strand, full hex head bolt and M36x80 square bolt respectively) account for 74.92% of the total cost of the replacement parts. It should be noted that this part is the most important that must be given priority.

According to the root cause, the preventive maintenance action is recommended to reduce defects in order to minimize the replacement of parts.

Acknowledgement

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