P-3010

WATER LEAKAGE MANAGEMENT AND CONTROL ANALYSIS IN EARTH MOVING VEHICLE'S WATER PUMP USING SIX SIGMA

By

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A PROJECT REPORT

Submitted to the

FACULTY OF MANAGEMENT SCIENCES

in partial fulfillment for the award of the degree

of

MASTER OF BUSINESS ADMINISTRATION

CENTRE FOR DISTANCE EDUCATION

ANNA UNIVERSITY CHENNAI

CHENNAI 600 025

July, 2009

BONAFIDE CERTIFICATE

Certified that the Project report titled **Water leakage management and control analysis in earth moving vehicle's water pump using six sigma** is the bonafide work of Mr. / Ms. **R.Sivakumar** who carried out the work under my supervision. Certified further that to the best of my knowledge the work reported herein does not form part of any other project report or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

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ABSTRACT

Customer satisfaction is the power that drives an organization towards success, by improving the quality of our product through reduction of customer complaint. Leakage in water pump is a major concern in the field failure of engine used in earth moving vehicles. Six sigma techniques is a statistical quality tool that improves the process performance, that leads to defect reduction, improvement in profits, product quality and customer satisfaction.

Hence our project deals with application of six sigma methodology (DMAIC) to manage the leakage problem faced in water pumps. Indepth evaluation of the problem through this quality tool, have resulted in change of manufacturing process, thus minimizing the customer complaints to a maximum extent.

ACKNOWLEDGEMENT

I would like to thank The Director, Centre for Distance Education, Anna University-Chennai for giving the opportunity to carry out this valuable project which will help to my career.

I also like to thank Dr.S.Sadasivam, Coordinator, KCT Study Centre, Coimbatore, Mr.A.Senthil Kumar, Counsellor-MBA Programme, KCT Study Centre, Coimbatore, and Prof.Dr.S.V. Devanathan, Project in-charge, and other members of Project Monitoring Committee, KCT Study Centre, Coimbatore for their valuable guidance throughout this project

I sincerely thank my beloved guide Dr. Mohandas Gandhi, Professor, KCT for his consistent support and motivation in completing this project work.

R.SIVAKUMAR

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CHAPTER 1

INTRODUCTION

1.1 RESEARCH BACKGROUND

BEML Limited (formerly Bharat Earth Movers Limited) was established in May 1964 as a Public Sector Undertaking for manufacture of Rail Coaches & Spare Parts and Mining Equipment at its Bangalore Complex. The Company has partially disinvested and presently Government of India owns 54 percent of total equity and rest 46 percent is held by Public, Financial Institutions, Foreign Institutional Investors, Banks and Employees.

During the financial year 2008-09, BEML achieved a sales turnover of INR 3013 crores and a pre tax profit of INR 387 crores. The export earnings touched INR 304 crores. BEML Limited (BEML) conferred with Mini-Ratna Category-1 Status and under the administrative control of Ministry of Defence, is a multi-technology company offering high-quality products for diverse sectors of economy such as coal, mining, steel, limestone, power, irrigation, construction, road building, aviation, defence, metro and railways. BEML is ranked as "The Largest and Most Profitable Construction Equipment Company" by Construction World - NICMAR, 2007. It has emerged in the forefront of heavy engineering industry with a track record of growth and revenues for over four decades. For its innovative management practices the company has been awarded the "Golden Peacock Innovation Management Award". BEML has also been rated as "The Fourth Largest Wealth Creator in the Country" by Dalal Street Magazine. In keeping with the global technology trends, the company is setting up R&D Centre of Excellence for Research in Metro Rail System in Bangalore. The main manufacturing facilities are located at Kolar Gold Fields, Mysore and Bangalore. These incorporate sophisticated facilities like CNC machines, hi-tech welding equipment and flexible manufacturing systems to turn out cutting-edge technology products. All three manufacturing facilities are certified for ISO 9001-2000.

(SUMMARY OF FAILURE DETAILS RECEIVED FROM THE FIELD FOR THE PERIOD)						
(FROM 01.04.08 TO 31.03.09)						
SL NO	TYPE OF FAILURE	NO OF CASES				TOTAL CASES
		01.04.08 TO 30 .06.08	01.07.08 TO 30 .09.08	01.10.08 TO 31.12.08	01.01.08 TO 31.03.09	
1	WATER PUMP	10	12	16	12	50
2	FLEX PLATE	8	6	7	6	27
3	ALTERNATOR & BELT	4	4	5	3	16
4	F.I.P (NTL. DIESEL DILUTION) / INJECTORS	5	5	3	1	14
5	AFTER COOLER CORE	3	3	4	3	13
6	OIL COOLER ELEMENT	3	2	4	3	12
7	CENTRIFUGAL FILTER / BRKT.CRACK ON BH60 EXPORT.	3	4	2	3	12
8	VALVE DROP / VALVE BREAKAGE	3	2	3	2	10
9	PISTON CHIP OFF/ PISTON RING BREAKAGE / PISTON STAMPING	3	2	4	1	10
10	FUEL CUT OFF SOLENOID / ENGINE STOP SOLENOID	2	3	4	1	10
11	TEMP SWITCH / SENSOR/ 4ST RELAY / ENGINE PROTECTION DEVICE	3	4	2	1	10
12	STARTER MOTOR	1	2	3	2	8
13	BEARING ROTATION / SEIZURE / CON ROD BEARING	3	2	1	1	7
14	MUFFLER	2	1	1	1	5
15	AIR COMPRESSOR	-	1	1	1	3
16	CRANK SHAFT GEAR / IDLER GEAR	1	-	1	-	2
17	ROCKER HSG. DUMMY HOLE. / ROCKER HOUSING / ROCKER ARM	1	-	-	-	1
18	BLOCK BURST	1	-	-	-	1
19	P.T.O	1	-	-	-	1
20	TURBO CHARGER	1	-	-	-	1
21	CYLINDER LINER	1	-	-		1

Table: 1.1 Summary of failure details received from the field for the period

1.2 Identification of problem

Of the problems explained in the table: 1.1, the leakage problem in water pump is of major concern, and hence selected for further study and analysis.

1.3 Need for study

Study of leakage problem in engine 170 series, is of key importance, as 25 failures have been accounted out of 50 failures faced in water pump as tabulated below table 1.2.

sl.no	Major problems					
	Nature of failure	No. of cases	Engine model			
			170	140	125	105
1	Water pump	50	25	3	8	14

Table 1.2: Water pump failure details

1.4 Objectives and scope

The objective of this project is to

1. To minimize customer complaints.
2. To reduce no of field failures in earth moving vehicles.
3. To improve the quality of the product (water pump) through process corrections at vendor end.
4. To improve engine performance.

5. Reducing product warranty cost.

1.5 Deliverables

The expected deliverable of this project is improved performance of water pump, improved customer satisfaction, reduced warranty costs results in increasing the overall profit of the organization.

CHAPTER 2

LITERATURE SURVEY

2.1 REVIEW OF LITERATURE

DMAIC

1. Define

   Leakage in water pump.

2. Measure

   Customer feedback through field failure reports.

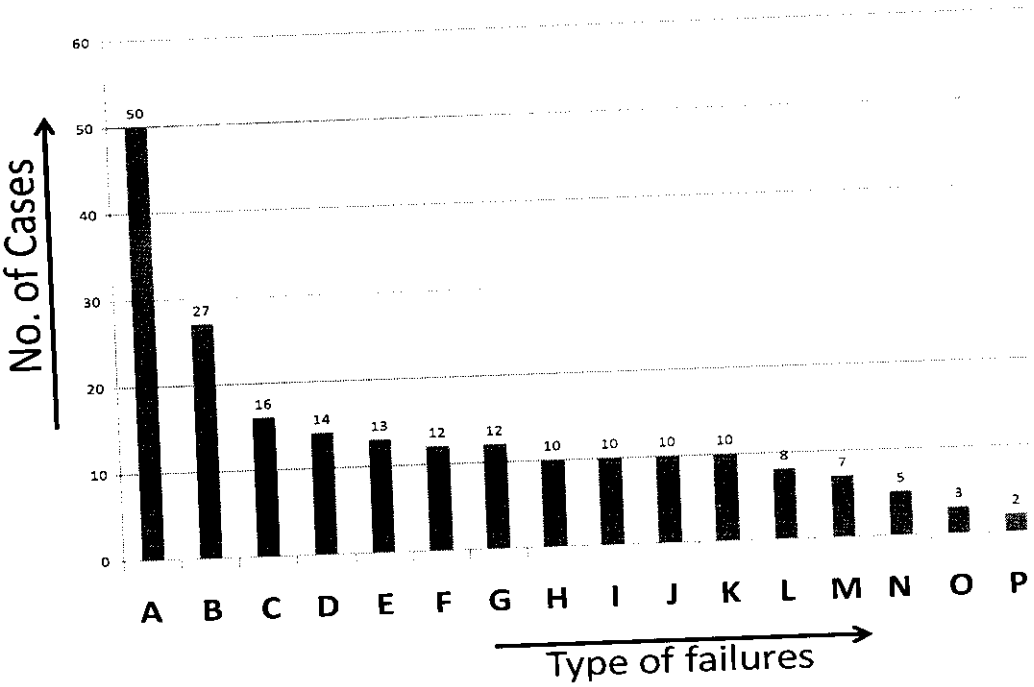
3. Analysis

   1. Study of available data

   2. Identify root cause of the problem

Bar Diagram/ Histogram:

Exhibiting details of various failures faced in engine



A	WATER PUMP
B	FIXED PLATE
C	ALTERNATOR & BOLT
D	F.I.P(NTL, DIESEL) INJECTORS
E	AFTER COOLER CORE
F	OIL COOLER ELEMENT
G	CENTRIFUGAL FILTER
H	VALVE DROP/ VALVE BREAKAGE
I	PISTON CHIP OFF/ PISTON RING BREAKAGE / PISTON STAMPING
J	FUEL CUT OFF SOLENOID / ENGINE STOP SOLENOID
K	TEMP SWITCH / SENSOR / 4ST RELAY/ ENGINE PROTECTION DEVICE
L	STARTER MOTOR
M	BEARING ROTATION / CON ROD BEARING / SEIZURE

N	MUFFLER
O	AIR COMPRESSOR
P	CRANK SHAFT GEAR / IDLER GEAR

Figure 2.1: Bar diagram

Hence from Bar diagram, it is observed that major failure in engine is faced in water pump.

Percentage Analysis:

Pie chart :

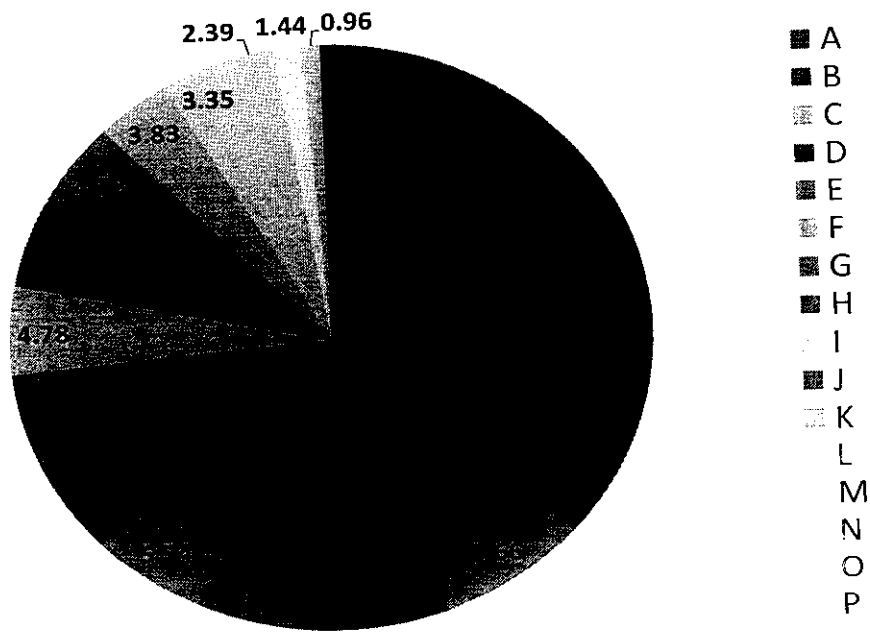


Figure 3.2: Pie chart

Cause and effect diagram

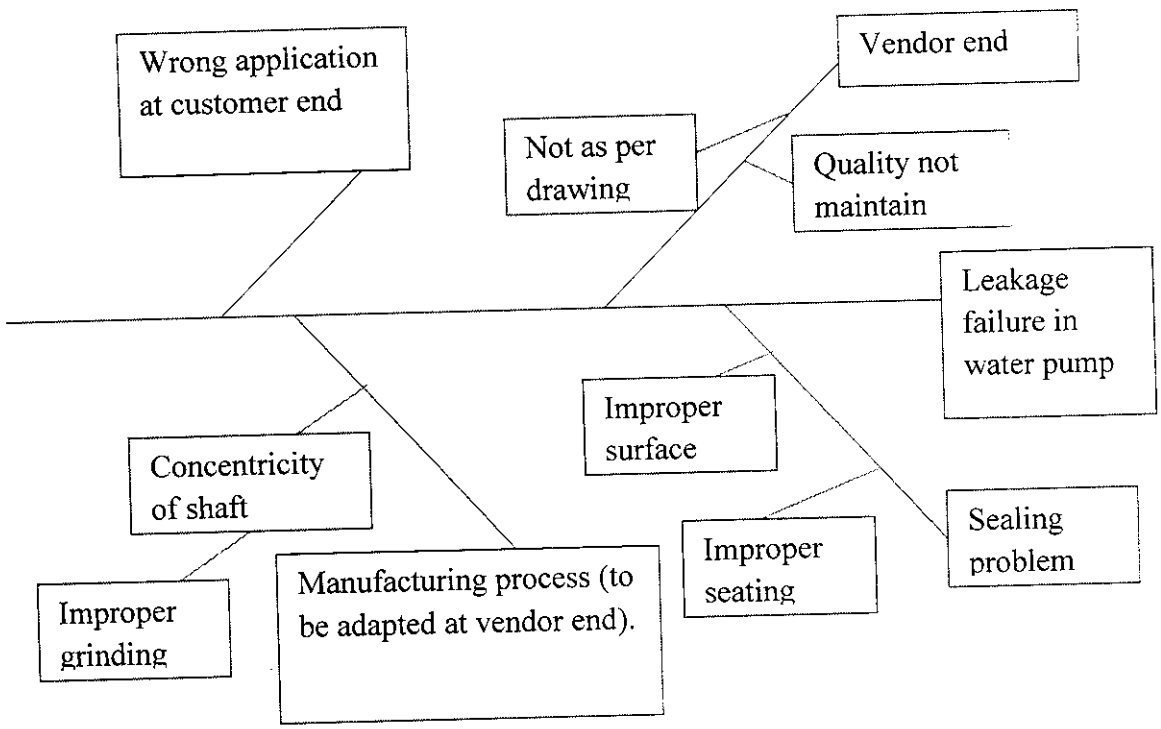


Figure 3.3: Cause and effect diagram

Reason:

Hence improper grinding process is a cause for this problem.

Improve:

Kaizen:

Change for improvement – Cylindrical Grinding Machine

Centerless-Grinding Machine:

Sl. no	1	2	3	4	5	6	7	8	9	10
concentricity	0.03	0.04	0.09	0.12	0.04	0.02	0.10	0.03	0.02	0.12

Table 2.1: Centerless Grinding concentricity values

Centerless Grinding Machine:

1. Work piece having several diameters is not easily handled.
2. Work with flats and keyways cannot be ground.
3. In hollow work, there is no assurance that the outside diameter will be concentric with inside diameter.

Cylindrical-Grinding Machine:

sl no	1	2	3	4	5	6	7	8	9	10
concentricity	0.02	0.02	0.03	0.03	0.04	0.04	0.02	0.03	0.04	0.02

Table 2.2: Cylindrical Grinding concentricity values

Cylindrical-Grinding Machine:

Cylindrical grinding is also known as "between centres" or "o/d" grinding. It is utilised for the grinding of multiple diameter shafts and parts where concentricity to the centre line or concentricity between one or more diameters is important.

Control:

1. Ensuring change of manufacturing process at vendor end.
2. Proper inspection of water pump received from vendor.
3. Analysis of feedback received from customer through field failure reports.
4. Through continuous improvement of design and process.

CHAPTER 3

METHODOLOGY

3.1 Type of project

The project taken for study is of descriptive-Experimental type that involves deriving a solution through indepth study of present problem, need of change either design/process, further analysis, implementation and feedback.

3.2 Target Respondents

1. To minimize the customer complaints in water pump to nearly 70%, thus improved customer satisfaction.
2. To bring down the warranty cost in water pumps to nearly 20%, thus cost reduction.

3.3 Assumptions, constraints and limitations

The project involves change of manufacturing process. I.e. center grinding instead of center less grinding in manufacturing of shifts used in water pump. Hence process change is required at vendor end.

Quality assurance from vendor end is a major importance for better results.

Time is a limitation for further feedback and analysis, regarding the performance of water pump.

3.4 Proposed sampling methods

The failures occurred in the engine for the financial year of 2008~2009, that too specifically in the water pump have been taken for study, hence this project involves purposive sampling method.

3.5 Data collection and processing

The data regarding failures faced in water pump from various customers, at various time due to various causes and results have been explained in the table3.1.

sl no	EQPT SL NO.	E. model	ESN	CUSTOMER	D.O.D	HMR	FLR. DATE	Failed system
1	13661	170	Z111100308	M / S E & K CONSTRUCTION)	05.04.08	1040	11.11.08	WATER PUMP
2	BD65	170	Z301130217	M/S TNEB TUTICORM THERMAL POWER STATION	26.05..08	1478	13.01.09	WATER PUMP
3	10351	170	Z301130364	M/S MCD BALASWA DELHI	01.04.08	1784	07.01.09	WATER PUMP
4	10354	170	Z301130375	ASSITANT ENGINEER SLF SITE BULLDOZER WORK SHOP	24.04.08	1472	16.02.09	WATER PUMP
5	14881	170	Z301160217	M/S T.T.P.S TUTICORIN	28.05.08	1478	08.01.09	WATER PUMP
6	6491	170	Z304510101	A/C PLR	18.03.08	1335	20.08.08	WATER PUMP
7	3115	170	Z414520119	WCL MAKARDHKRA OCM MNS	29.11.05	3006	10.06.08	WATER PUMP
8	3158	170	Z414520166	M/S BHARATPUR OCP MCL TALCHAR	16.03.08	1219	29.12.08	WATER PUMP
9	757	170	Z427870067	M/S CHETTINAD CEMENTS DINDIGUL	09.01.08	2257	03.03.09	WATER PUMP
10	12715	170	Z511251093	SECL KUSHMUNDA	20.01.08	1397	20.06.08	WATER PUMP
11	11248	170	Z511300855 Z511300721	SECL KUSHMUNDA	13.12.07	1448	07.05.08 02.07.08	WATER PUMP

Table 3.1: Continued

14	12654	170	Z511251140	A/C SCCL MHR	11.06.07	3048	31.07.08	WATER PUMP
15	12688	170	Z511251180	CCL PUNDI	02.12.07	4690	23.11.08	WATER PUMP
16	12691	170	Z511251189	PTPS NEW DELHI	27.12.07	1240	25.04.08	WATER PUMP
17	12699	170	Z511251194	NLC NEYVELI	21.12.07	968	14.05.08	WATER PUMP
18	12701	170	Z511251195	NLC NEYVELI	24.12.07	1685	05.11.08	WATER PUMP
19	12706	170	Z511251196 Z511251202	NLC NEYVELI	04.01.08	1298	12.11.08 03.11.08	WATER PUMP
20	12747	170	Z511251197	M/S FSNL	27.03.08	1239	11.08.08	WATER PUMP
21	12705	170	Z511251200	NLC NEYVELI	21.12.07	1363	13.05.08	WATER PUMP
22	12708	170	Z511251205	M/S NCL NEYVELI	24.12.07	2440	03.03.09	WATER PUMP
23	12725	170	Z511251217	A/C WCL GONDEGAON	08.02.08	4480	06.03.09	WATER PUMP
24	12703	170	Z511251309	NEYVELI	04.01.08	1298	12.11.08	WATER PUMP
25	11261	170	Z511300863	OCP SAYAL	26.02.08	4442	13.03.09	WATER PUMP
26	10164	140	Z057840064	M/S D.R.S ENTERPRISES	23.08.08	400	31.12.08	WATER PUMP
27	13650	140	Z111100263	SURAT MUNICIPAL CORPORATION	22.12.07	632	13.07.08	WATER PUMP
28	16286	140	Z111551337	SANJEET MATHEW & CO	18.03.08	346	25.05.08	WATER PUMP
29	7312	125	Z109970071	C/O 16 WING AF HASIMARA JALPAIGURI WEST BENGAL	15.07.08	PRE	19.07.08	WATER PUMP
30	13665	125	Z111100167	M/S L. PUMZANAG IMPAL	19.02.08	225	20.05.08	WATER PUMP
31	13646	125	Z111100276	SMC-SURAT	22.12.07	755	27.10.08	WATER PUMP
32	13696	125	Z111100322	AGRICULTURE, KAWARDHA	10.11.08	654	07.03.09	WATER PUMP
33	12344	125	Z51125	WCL CHANDRAPUR	12.05.08	398	12.09.08	WATER PUMP
34	12736	125	Z511251237	WCL UKNI MNC	07.03.08	727	17.05.08	WATER PUMP
35	12767	125	Z511251265	ECL KOTTADIH	19.05.08	372	18.06.08	WATER PUMP

Table 3.1: Continued

36	12771	125	Z511251273	ECL SONEPUR BAZARI	24.06.08	114	24.06.08	WATER PUMP
37	13747	105	Z111100284	HPPWD NURPUR JAMMU	01.05.08	186	12.07.08	WATER PUMP
38	770	105	Z057840064	M/S RUBU CONSTRUCTION	22.08.08	528	11.01.09	WATER PUMP
39	16074	105	Z111551062	M/S SEW TRUCK ,SOUTH AFRICA	01.02.07	20	03.07.08	WATER PUMP
40	16226	105	Z111551224	CHANADAKA ENGG MCA	PRE DELIVE RY	86	04.06.08	WATER PUMP
41	10350	105	Z301130362	A/C MCD	01.04.07	651	03.10.08	WATER PUMP
42	14881	105	Z301160217	M/S T.T.P.S TUTICORN	28.05.08	478	08.01.09	WATER PUMP
43	6514	105	Z304510121	A/C SCCL GKOC	30.05.08	587	19.09.08	WATER PUMP
44	12784	105	9511251279	A/C SCCL PK.OC MANUGURU	07.07.08	814	18.09.08	WATER PUMP
45	12266	105	Z51125	WCL CHANDRAPUR	09.01.08	689	12.05.08	WATER PUMP
46	12747	105	Z511251247	A/C FSNL	07.03.08	496	08.09.08	WATER PUMP
47	12768	105	Z511251261	ECL MUGMA	31.05.08	75	12.06.08	WATER PUMP
48	12742	105	Z511251274	KRISHNA PING ALLOYS PVT LTD	25.02.08	895	23.10.08	WATER PUMP
49	16353	105	Z511251433	ECL KOTTADIH	05.04.08	42	11.04.08	WATER PUMP
50	3148	105	Z539550024	M/S H.D ENTERPRISES VARTAN MINES	09.01.09	146	16.01.09	WATER PUMP

Table 3.1: Failures faced in water pump from various customers at various times

The failures occurred in the engine for the financial year of 2008~2009, that too specifically in the water pump have been taken for study, hence this project involves purposive sampling method.

3.6 Tools for Analysis

Six Sigma methodology provides the techniques and tools to improve the capability and reduce the defects in any process.

It was started in Motorola, in its manufacturing division, where millions of parts are made using the same process repeatedly. Eventually Six Sigma evolved and applied to other non manufacturing processes. Today you can apply Six Sigma to many fields such as Services, Medical and Insurance Procedures, Call Centers.

Six Sigma methodology improves any existing business process by constantly reviewing and re-tuning the process. To achieve this, Six Sigma uses a methodology known as **DMAIC** (**D**efine opportunities, **M**easure performance, **A**nalyze opportunity, **I**mprove performance, **C**ontrol performance).

Six Sigma methodology can also be used to create a brand new business process from ground up using **DFSS** (Design For Six Sigma) principles. Six Sigma Strives for perfection. It allows for only **3.4** defects per million opportunities for each product or service transaction. Six Sigma relies heavily on statistical techniques to reduce defects and measure quality.

Six Sigma experts (Green Belts and Black Belts) evaluate a business process and determine ways to improve upon the existing process. Six Sigma experts can also design a brand new business process using *DFSS* (*Design For Six Sigma*) principles. Typically its easier to define a new process with DFSS principles than refining an existing process to reduce the defects.

Six Sigma incorporates the basic principles and techniques used in Business, Statistics, and Engineering. These three form the core elements of Six Sigma. Six Sigma improves the process performance, decreases variation and maintains **consistent quality** of the process output. This leads to defect reduction and improvement in profits, product quality and customer satisfaction.

Six Sigma statistically ensures that 99.9997% of all products produced in a process are of acceptable quality.

Six Sigma allows only 3.4 defects per million opportunities.

Six Sigma includes five steps: define, measure, analyze, improve and control (commonly known as DMAIC):

Define. Practitioners begin by defining the process. They ask who the customers are and what their problems are. They identify the key characteristics important to the customer along with the processes that support those key characteristics. They then identify existing output conditions along with the process elements.

Measure. Next the focus is on measuring the process. Key characteristics are categorized, measurement systems are verified and data are collected.

Analyze. Once data are collected, it is analyzed. The

Intent is to convert the raw data into information that provides insights into the process. These insights include identifying the fundamental and most important causes Of the defects or problems.

Improve. The fourth step is to improve the process.

Solutions to the problem are developed, and changes are made to the process. Results of process changes are seen in the measurements. In this step, he company can judge whether the changes are beneficial, or if another set of changes is necessary.

Control. If the process is performing at a desired and predictable level, it is put under control. This last step is the sustaining portion of the Six Sigma methodology. The process is monitored to assure no un expected changes occur. Focusing on the primary area of variation reduction produces other secondary effects, too. Quality is improved. Process investigation produces the re-evaluation of the value added status of many elements. Some elements are modified, while others are discontinued. Elements are refined and improved. Mistakes and opportunities for mistakes are reduced.

7 QC Tools has been used to analyze the data collected from the field failure reports. The 7 Qc Tools are,

1. Check Sheet
2. Pareto Chart
3. Ishikawa Diagram
4. Flow Chart
5. Control Chart
6. Histogram
7. Scatter Diagram

Check Sheet is used to easily collect data. Decision-making and actions are taken from the data.

Pareto Chart is used to define problems, to set their priority, to illustrate the problems detected, and determine their frequency in the process.

Ishikawa Diagram (Fishbone Diagram) is used to figure out any possible causes of a problem. After the major causes are known, we can solve the problem accurately.

Flow Chart shows the process step by step and can sometimes identify an unnecessary procedure.

Control Chart provides control limits which are generally three standard deviations above and below average, whether or not our process is in control.

Histogram shows a bar chart of accumulated data and provides the easiest way to evaluate the distribution of data.

Scatter Diagram is a graphical tool that plots many data points and shows a pattern of correlation between two variables.

CHAPTER 4

DATA ANALYSIS AND INTERPRETATION

4.1 Data Analysis

4.1.1 Engine

BEML Limited, the trusted name for over 40 years in mining and construction industry, channels its expertise into the priority sector of energy with the manufacture of fuel-efficient diesel engines. Established in the year 1991 in Mysore, with technical know-how from Komatsu Japan, BEML diesel engines are built for maximum reliability, high performance and lasting value. These engines are backed by the facility of application engineering, multi location sales & service network and rehabilitation facility.

Engine Division manufactures heavy duty Diesel Engines for application on a wide variety of Earth Moving, Mining and Construction Machinery. Apart from these, the engines are also offered for other industrial applications as well as diesel generator sets. BEML Engines are used on Bull Dozers, Dump Trucks, Motor Graders, Wheel Loaders, Pipe Layers, Hydraulic Excavators, Loading Shovels, C Crane, Aircraft Towing Tractors, Backhoe Loaders, Water Sprinklers, Water Well Rigs and DG sets. These Engines are capable of operations over a wide terrain right from sea level conditions to high altitude (20,000ft) as well as under sub zero conditions.

Engine Series:

- 105 Series - 105 ~ 170 HP

- 125 Series - 140 ~ 250 HP
- 140 Series - 300 ~ 400 HP
- 170 Series - 400 ~ 700 HP

Diesel Generator Set:

- 550,380, 250 & 125 Kva

Salient Features of BEML Engines:

- High Quality
- Heavy Duty
- Proven Reliability
- Economical Operation
- Longer Life
- Wide Application
- Standard Fitment
- Optional Fitment

4.1.2 Water pump

The water pump is the heart of the cooling system. The pump circulates coolant between the engine and radiator to keep the engine from overheating. Inside the pump is a metal or plastic impeller with blades that push the water through the pump. The impeller is mounted on a shaft that is supported by the pump housing with a bearing and seal assembly. The water pump is usually belt driven and is mounted on the front of the engine.

A water pump is used to circulate water throughout the engine block, cooling and heater systems. The water pump is driven by the engine via multi rib belt in most cases.

When a water pump fails it can produce a squeaking or rattling sound. Also, a water pump can leak engine coolant through a relief port that allows coolant to pass when the shaft seal fails. This port is created so engine coolant will not contaminate the shaft bearings causing a worse problem. If a failing or failed water pump is allowed to operate it can cause the engine to overheat or completely fall apart causing cooling system or other sub sequential damage. The water pump circulates coolant continuously; a thermostat is used to control cooling system operation. A water pump is comprised of a main housing body, flange, main shaft, bearings, impeller, seals and a gasket to seal in against the block. The water pump flange is used to bolt a pulley to the water pump. This pulley use used to allow a multi ribbed drive belt to be attached to provide power to the pump.

When engine RPM increases so does the water pump flow rate. A water pump will typical last between 60,000 and 100,000 miles and is a normal replacement item. When replacing a water pump always insist on high quality replacement parts to avoid premature failure. To check your water pump condition, make sure the engine is off, next grab a hold of water pump flange and try to move it back and forth. There should be little to no play in the main shaft bearing. If excessive play exists the water pump has failed and needs replacement. Some engine designs can have the engine's timing belt or chain to drive the water pump. When this style of water pump design fails it can cause engine coolant to enter the crankcase. This situation can be bad because the engine oil is compromised and can cause the engine to fail. The water pump is responsible for supplying coolant the heater core for proper heater operation. If the water pump impeller is defective it can cause the heater to not work or the engine to overheat. If the thermostat sticks closed it can cause the water pump to not circulate coolant resulting in the engine to overheat.

WATER PUMP PROBLEMS:

Water pumps typically fail one of two ways: the shaft seal start to leak, or the impeller inside breaks, comes loose or the blades erode and wear down (which is more of a problem with pumps that have plastic impellers).

When a water pump starts to leak, the cooling system will lose coolant. If the leak is not discovered, the loss of coolant will eventually cause the engine to overheat. The drive may not realize anything is wrong until the temperature warning light comes on. If this happens to you, shut the engine off immediately. Severe engine damage can result if an overheating engine is driven too far.

If the engine has overheated, the entire cooling system (radiator, hoses, water pump and engine) must all be inspected to see if there are any coolant leaks. If coolant is leaking out of the water pump shaft or vent hole, the water pump needs to be replaced. Cooling system sealer cannot stop this kind of leak.

Water Pump Seals:

We put froth precision engineered water pump seals, which are used to provide safety & tapped holes so that they directly bolt water pump and stop the leakage. These seals are made using corrosion proof materials, which make them highly durable in quality. Easy to install, our range of seals is available in different Varities such as

- Open Type
- Rubber Bellow Type
- J1 & J2
- Honda Type
- Robin Type

- Kaco Type
- Crane Type
- JI MG1

Water Pump Bearings:

1. Water pump bearings are used in various types pumps, basically consisting of standard double row bearings.

2. We can supply all kinds of auto Water Pump bearings. These bearings are available in two main types:

1) Ball-ball: With two rows of balls

2) Ball-roller: With one row of balls

3. With high-quality material and advanced technology, the qualities of the products have get continuous promotion and have got the praise of customers.

Our bearing:

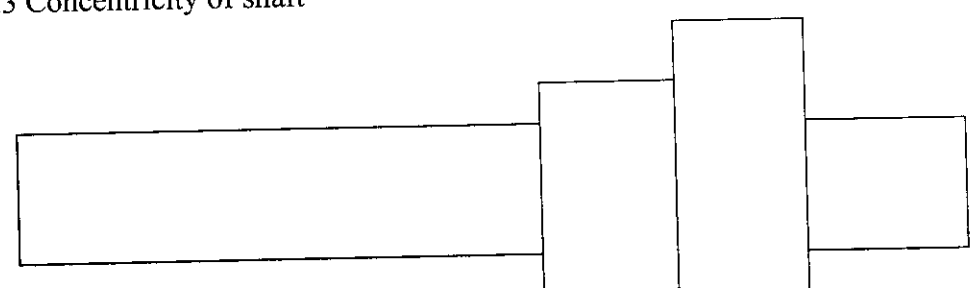
1) High quality bearings

2) Competitive price

3) Prompt delivery

4) Good service.

4.1.3 Concentricity of shaft



concentricity	0.05

Concentricity is the condition where the medium points of all diametrically opposed elements of a cylinder are congruent with the axis of a datum feature. A medium point is the midpoint of a two point measurement.

Concentricity control is a geometric tolerance that limits the concentricity error of a part feature. The tolerance zone for a concentricity control is three dimensional; it is a cylinder that is coaxial with the datum axis. The dia of the cylinder is equal to the concentricity control tolerance value. The medium points of correspondingly located elements of the feature being controlled, regardless of feature size, must lie within the cylindrical tolerance zone, when using a concentricity control, the specified tolerance and the datum reference always apply an RFS basis.

Application:

In industry concentricity controls are only used in few unique applications, concentricity is used when a primary consideration is precise balance of the part, equal wall thickness, or another functional requirement that calls for equal distribution of mass. When specifying concentricity the form of the tolerance diameter is allowed to vary to a greater extent than if a runout control was used.

4.1.4 Grinding process

Value of Grinding as Finishing Process. When greater accuracy than that obtainable on the milling machine or the lathe is required, recourse is had to grinding. This operation depends upon the abrasive or cutting qualities of emery, corundum, and carborundum. With

work properly held to a solid grinding wheel, it is not difficult to attain great accuracy. By means of the grinding machine, parts may be economically finished, even in hardened steel that could not possibly be machined on such shop tools as the lathe, planer, or shaper. With such a machine, round surfaces may be ground so that the variation from the nominal diameter is less than .0001 inch.

Features of Grinding Process:

The grinding machine consists of a strong base A, upon which there is mounted a headstock B and a tailstock C, similar in action to those of an ordinary lathe. Back of these is an emery wheel driven by a separate belt. The principle of operation for round surfaces, is that the part to be ground is put upon the centers, and driven exactly as in the ordinary lathe. The only additional precaution to be taken is that the driving apparatus should be secure, so that none of the parts are loose. This insures a continuous motion for the piece with no possibility of backlash. The piece runs toward the operator, and the emery wheel runs in the same direction. The two surfaces of wheel and work in contact are therefore moving in opposite directions. The headstock and tailstock are mounted upon a traveling table D, which moves back and forth in the same manner as the platen of a planer. It is made to stop automatically at each end of the stroke.

4.1.4.1 Centerless grinding process:

Centerless grinding is an OD grinding process. It differs from other cylindrical processes in that the workpiece is not mechanically constrained. On traditional OD machines, the work is held between centers or chucked and rotated against the faster spinning grinding wheel by an external motor usually located in a workhead.

Unlike center-type or chucker-type grinding, parts made using a centerless process do not require center holes, drivers or workhead fixtures. Instead, the workpiece is supported on its own outer diameter by a workblade located between a high speed grinding wheel and a slower speed regulating wheel with a smaller diameter.

It's the relationship among these three basic components—grinding wheel, regulating wheel and workblade—that makes the difference between a successful centerless grinding application and one that gives headaches and bad parts. On the centerless grinder there are no centers, so it would appear that there is no means to control the workpiece size or roundness. However, quite the opposite is true.

Centerless grinding, if set up properly, will achieve roundness, surface finish and dimensional tolerances that are among the best available in metalworking. Moreover, the process is able to improve the roundness of out-of-round workpiece blanks. Creating roundness from out-of-round conditions is the claim to fame of the centerless grinding process. It does this by virtue of the relationship among the grinding wheel, regulating wheel and the workblade.

Side-viewed, from the operator's perspective, the centerless grinder has the grinding wheel on the left, workblade in the middle and the smaller diameter regulating wheel on the right. For most applications, the centerline of the grinding wheel and regulating wheel are in the same plane, at equal heights above the machine bed.

To achieve rounding action, the workblade must be set so that the centerline of the workpiece is above the centerline of the grinding and regulating wheels. This is a critical relationship for successful centerless grinding.

If the workpiece rests on a flat workblade that is on center with the regulating and grinding wheels, the contact points form three sides of a square. As the part is ground in this setup, any high spot on the workpiece will shift the work slightly on the blade, allowing the grinding wheel to cut a directly opposite low spot. Over time this setup will create three lobes on the workpiece that may be dimensionally accurate but far from round.

Setting an angled workblade so it slopes toward the regulating wheel and supports the workpiece centerline above the centerline of the regulating and grinding wheels is how the centerless operation is able to generate roundness. In this setup if a high spot comes in contact with either the blade or the regulating wheel, it does not create a directly opposite low spot because of the angle created between the centerlines of the wheels and workpiece.

Instead of grinding a lobe shape in the workpiece, the high spot is gradually reduced by the action of the grinding wheel. So rather than creating a low spot on the periphery of the work equal to the high spot, the grinding wheel generates a proportionally smaller low spot at its contact with the workpiece. To better visualize this rounding action, imagine a workpiece with several high spots. Now imagine that part being ground with only a single rotation. When the part is removed, it would show only the high spots had been touched.

The angle of the workblade helps keep the workpiece in contact with and under the control of the slower rotating regulating wheel to resist any tendency to "spin up" to the speed of the grinding wheel. In some cases, a spin-up can take a workpiece from 850 rpm to near 60,000 rpm in the blink of an eye. This is not something you want to have happen.

Disadvantages of centerless grinding:

1. Work piece having several diameters is not easily handled.
2. Work with flats and keyways cannot be ground.
3. In hollow work, there is no assurance that the outside diameter will be concentric with inside diameter.

4.1.4.2 Cylindrical grinding process:

Cylindrical Grinding Machine.

Cylindrical grinding is also known as "between centres" or "o/d" grinding. It is utilised for the grinding of multiple diameter shafts and parts where concentricity to the centre line or concentricity between one or more diameters is important. It is also used for bigger work that exceeds the capacity of our universal grinding machines.

When work is being done, the piece is centered, with its axis parallel to the line of travel of the table. With the piece and emery wheel in motion, the former travels to and fro in front of the wheel The wheel is then gradually moved forward until it has ground the work down to the size required.

It is not intended that large amounts of metal shall be removed by this machine. Its object is to reduce to accurate dimensions the work that has already been turned in the lathe. The proper method to pursue is to turn the piece to as nearly the required diameter as possible in the lathe, care being taken that it is left a trifle large. This may be .01 inch on each 2 inches of diameter. The surplus metal may then be removed by grinding. In the machine illustrated in Fig. 247, the transverse movement of the wheel-stand is adjusted by a hand-wheel graduated to read to .001 inch on the diameter of the work. The machine is also provided with an automatic cross-feed, which gives a range of advance of the wheel varying from .00025 inch to .004 inch at each reversal of the table. This feed, furthermore, is so arranged that it can be automatically released at any point.

4.2 Deliverables:

The deliverables of this project is to satisfy the needs and expectations of the customer and increase the profit of the organization.

CHAPTER 5

CONCLUSIONS

5.1 Summary of finding

The water leakage in water pump of earth moving vehicle engine has reduced after applying the six sigma quality tools. The main root cause of water leakage is due to deviation of shaft parameter in the water pump. The deviation is eliminated in the shaft after finding out the root cause, hence the water pump failures before the warranty period is reduced. So the customer satisfaction is fulfilled and also the quality of product is increased by this problem elimination. Customer satisfaction and quality are very important for company / industry improvement, both of us achieved by this project.

5.2 Suggestions and recommendations

This project only 170 model engine water pump failures are analyzed and reduced. To concentrate in all type of model engine, the company gets lot of profit and same time customer satisfaction will improved.

5.3 Conclusion

Leakage in water pump of engine used in earth moving vehicles can be minimized, through change in the manufacturing process of shaft used in it.

This solution had been derived, based on application of quality tools through six sigma methodology.

This results in improved customer satisfaction and reduced warranty costs.

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