SCRAP REDUCTION DURING MACHINING PROCESS IN H-SERIES ENGINE

A PROJECT REPORT

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BONAFIDE CERTIFICATE

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ABSTRACT

Six Sigma means a measure of quality that strives for near perfection. It refers to statistical measure with no more than 3.4 defects per million. It is a disciplined data-driven approach and methodology for eliminating defects in any process, from manufacturing to transaction and from product to service. This project deals with reduction of scrap in cylinder block of H-series engine. The report follows the methodology to investigate defects and root causes, and provides a solution to reduce /eliminate these defects. The analysis indicates that the design of inspection fixture can reduce the amount of scrap/defective component of cylinder block.

The different processes involved in machining of the cylinder block in machine shop 5 are studied. The next phase involves suggesting methods that can lead to reduction of scrap. This reduction can be brought about by designing inspection fixture that will make the inspection easier at that stage.

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SYMBOLS	DESCRIPTION
v	Cutting speed
f	Feed rate
d	Depth of cut
t	Machining time
MRR	Material Removal Rate
D	Diameter of the drill

CHAPTER 1

INTRODUCTION

The identification of defect or improper dimension after machining in a component which is rejected is said to be scrap. While machining the component in machine shop due to change in dimension, the components are let out to scrap.

H-series engine are the main sources manufactured in Ashok Leyland with 4 and 6 cylinders and also conforming to BS2, BS3 & BS4 emission standards in India. H-series engine mainly consist of cylinder head and cylinder block. There are various machining process held in cylinder head and cylinder block in machine shop. The major scrap pieces occurred in exhaust manifold side milling in cylinder head and rough CAM bore operation in cylinder block. Our project deals with reduction of scrap during machining process in H-series engine.

Ashok Leyland is an Indian automobile manufacturing company based in Chennai, India. Founded in 1948, it is the 2nd largest commercial vehicle manufacturer in India, 4th largest manufacturer of buses in the world and 16th largest manufacturer of trucks globally. Operating six plants, Ashok Leyland also makes spare parts and engines for industrial and marine applications. It sells about 60,000 vehicles and about 7,000 engines annually. It is the second largest commercial vehicle company in India in the medium and heavy commercial vehicle (M&HCV) segment with a market share of 28% (2007–08). With passenger transportation options ranging from 19 seats to 80 seats, Ashok Leyland is a market leader in the bus segment. The company claims to carry more than 60 million passengers a day, more people than the entire Indian rail network. In the trucks segment Ashok Leyland primarily concentrates on the 16 ton to 25 ton range of trucks. However Ashok Leyland has presence in the entire truck range starting from 7.5 tons to 49 tons. With a joint venture with Nissan Motors of Japan the company made its presence in the Light Commercial Vehicle (LCV) segment (<7.5 tons).

Ashok Leyland's UK subsidiary Opt are has shut down its bus factory in Blackburn, Lancashire. This subsidiary's traditional home in Leeds has also been vacated in favor of a purpose built plant at Sherburne-in-Elmet.

During early 80's Ashok Leyland entered into collaboration with Japanese company Hino Motors from whom technology for the H-series engines was sourced. Many indigenous versions of H-series engine were developed with 4 and 6 cylinders and also conforming to BS2, BS3 & BS4 emission standards in India. These engines proved to be extremely popular with the customers primarily for their excellent fuel efficiency. Most current models of Ashok Leyland come with H-series engines.

1.1 OBJECTIVE OF THE PROJECT

To control and reduce the scrap during machining process in H-series Engine.

CHAPTER 2

LITERATURE REVIEW

2.1 SIX SIGMA

Six Sigma is a set of techniques and tools for process improvement. It was introduced by engineer Bill Smith while working at Motorola in 1986. Jack Welch made it central to his business strategy at General Electric in 1995. Today, it is used in many industrial sectors.

Six Sigma seeks to improve the quality of the output of a process by identifying and removing the causes of defects and minimizing variability in manufacturing and business processes. It uses a set of quality management methods, mainly empirical, statistical methods, and creates a special infrastructure of people within the organization, who are experts in these methods. Each Six Sigma project carried out within an organization follows a defined sequence of steps and has specific value targets, for example: reduce process cycle time, reduce pollution, reduce costs, increase customer satisfaction, and increase profits.

The term Six Sigma originated from terminology associated with statistical modeling of manufacturing processes. The maturity of a manufacturing process can be described by a sigma rating indicating its yield or the percentage of defect-free products it creates. A six sigma process is one in which 99.99966% of all opportunities to produce some feature of a part are statistically expected to be free of defects (3.4 defective features per million opportunities). Motorola set a goal of "six sigma" for all of its manufacturing operations, and this goal became a by-word for the management and engineering practices used to achieve it.

Figure 2.1 Six Sigma cycle

2.1.1 Doctrine

- Continuous efforts to achieve stable and predictable process results (e.g. by reducing process variation) are of vital importance to business success.
- Manufacturing and business processes have characteristics that can be measured, analyzed, controlled and improved.
- Achieving sustained quality improvement requires commitment from the entire organization, particularly from top-level management.

Features that set Six Sigma apart from previous quality-improvement initiatives include:

- A clear focus on achieving measurable and quantifiable financial returns from any Six Sigma project.
- An increased emphasis on strong and passionate management leadership and support.
- A clear commitment to making decisions on the basis of verifiable data and statistical methods, rather than assumptions and guesswork.

The term "six sigma" comes from statistics and is used in statistical quality control, which evaluates process capability. Originally, it referred to the ability of manufacturing processes to produce a very high proportion of output within specification. Processes that operate with "six sigma quality" over the short term are assumed to produce long-term defect levels below 3.4 defects per million opportunities (DPMO). Six Sigma's implicit goal is to improve all processes, but not to the 3.4 DPMO level necessarily. Organizations need to determine an appropriate sigma level for each of their most important processes and strive to achieve these. As a result of this goal, it is incumbent on management of the organization to prioritize areas of improvement.

"Six Sigma" was registered June 11, 1991 as U.S. Service Mark 74,026,418. In 2005 Motorola attributed over US$17 billion in savings to Six Sigma.

Other early adopters of Six Sigma include Honeywell (today's Honeywell is the result of a "merger of equals" of Honeywell and Allied Signal in 1999) and General Electric, where Jack Welch introduced the method. By the late 1990s, about two-thirds of the Fortune 500 organizations had begun Six Sigma initiatives with the aim of reducing costs and improving quality.

In recent years, some practitioners have combined Six Sigma ideas with lean manufacturing to create a methodology named Lean Six Sigma. The Lean Six Sigma methodology views lean manufacturing, which addresses process flow and waste issues, and Six Sigma, with its focus on variation and design, as complementary disciplines aimed at promoting "business and operational excellence". Companies such as GE, Verizon, GENPACT, and IBM use Lean Six Sigma to focus transformation efforts not just on efficiency but also on growth. It serves as a foundation for innovation throughout the organization, from manufacturing and software development to sales and service delivery functions.

The International Organization for Standardization (ISO) has published in 2011 the first standard "ISO 13053:2011" defining a Six Sigma process. Other "standards" are created mostly by universities or companies that have so-called first-party certification programs for Six Sigma.

2.1.2 Difference between related concepts

Lean management and Six Sigma are two concepts which share similar methodologies and tools. Both programs are of Japanese origin, but they are two different programs.

Lean management is focused on eliminating waste and ensuring swift while Six Sigma's focus is on eliminating defects and reducing variability.

2.1.3 Methodologies

Six Sigma projects follow two project methodologies inspired by Deming's Plan-Do-Check-Act Cycle. These methodologies, composed of five phases each, bear the acronyms DMAIC and DMADV.

- DMAIC is used for projects aimed at improving an existing business process.
- DMADV is used for projects aimed at creating new product or process designs.

2.1.3.1 DMAIC

Figure 2.2 DMAIC

The DMAIC project methodology has five phases:

Define the system, the voice of the customer and their requirements, and the project goals, specifically. Measure key aspects of the current process and collect relevant data; calculate the 'as-is' Process Capability. Analyze the data to investigate and verify cause-and-effect relationships. Determine what the relationships are, and attempt to ensure that all factors have been considered. Seek out root cause of the defect under investigation. Improve or optimize the current process based upon data analysis using techniques such as design of experiments, poka yoke or mistake proofing, and standard work to create a new, future state process. Set up pilot runs to establish process capability.

Control the future state process to ensure that any deviations from the target are corrected before they result in defects. Implement control systems such as statistical process control, production boards, visual workplaces, and continuously monitor the process. Some organizations add a Recognize step at the beginning, which is to recognize the right problem to work on, thus yielding an RDMAIC methodology.

2.1.3.2 DMADV or DFSS

Figure 2.3 DMADV

The DMADV project methodology, known as DFSS ("**D**esign **F**or **S**ix **S**igma"), features five phases:

- Define design goals that are consistent with customer demands and the enterprise strategy.
- Measure and identify CTQs (characteristics that are Critical To Quality), measure product capabilities, production process capability, and measure risks.
- Analyze to develop and design alternatives.
- Design an improved alternative, best suited per analysis in the previous step
- Verify the design, set up pilot runs, implement the production process and hand it over to the process owner(s).

2.1.4 Quality management tools and methods

Within the individual phases of a DMAIC or DMADV project, Six Sigma utilizes many established quality-management tools that are also used outside Six Sigma. The following table shows an overview of the main methods used.

1. 5 Whys
2. Statistical and fitting tools
3. Analysis of variance
4. General linear model
5. ANOVA Gauge R&R

6. Regression analysis
7. Correlation
8. Scatter diagram
9. Chi-squared test
10. Axiomatic design
11. Business Process Mapping/Check sheet
12. Cause & effects diagram (also known as fishbone or Ishikawa diagram)
13. Control chart/Control plan (also known as a swim lane map)/Run charts
14. Cost-benefit analysis
15. CTQ tree
16. Design of experiments/Stratification
17. Histograms/Pareto analysis/Pareto chart
18. Pick chart/Process capability/Rolled throughput yield
19. Quality Function Deployment (QFD)
20. Quantitative marketing research through use of Enterprise Feedback Management(EFM) systems
21. Root cause analysis
22. SIPOC analysis (**S**uppliers, **I**nputs, **P**rocess, **O**utputs, **C**ustomers)
23. COPIS analysis (Customer centric version/perspective of SIPOC)
24. Taguchi methods/Taguchi Loss Function
25. Value stream mapping

2.1.5 Implementation roles

One key innovation of Six Sigma involves the absolute "professionalizing" of quality management functions. Prior to Six Sigma, quality management in practice was largely relegated to the production floor and to statisticians in a separate quality department. Formal Six Sigma programs adopt a kind of elite ranking terminology (similar to some martial arts systems, like Kung-Fu and Judo) to define a hierarchy (and special career path) that includes all business functions and levels. Six Sigma identifies several key roles for its successful implementation.

- Executive Leadership includes the CEO and other members of top management. They are responsible for setting up a vision for Six Sigma implementation. They also empower the other role holders with the freedom and resources to explore new ideas for breakthrough improvements by transcending departmental barriers and overcoming inherent resistance to change.
- Champions take responsibility for Six Sigma implementation across the organization in an integrated manner. The Executive Leadership draws them from upper management. Champions also act as mentors to Black Belts.
- Master Black Belts, identified by Champions, act as in-house coaches on Six Sigma. They devote 100% of their time to Six Sigma. They assist Champions and guide Black Belts and Green Belts. Apart from statistical tasks, they spend their time on ensuring consistent application of Six Sigma across various functions and departments.
- Black Belts operate under Master Black Belts to apply Six Sigma methodology to specific projects. They devote 100% of their valued time to Six Sigma. They primarily focus on Six Sigma project execution and special leadership with special tasks, whereas Champions and Master Black Belts focus on identifying projects/functions for Six Sigma.
- Green Belts are the employees who take up Six Sigma implementation along with their other job responsibilities, operating under the guidance of Black Belts.

Special training is needed for all of these practitioners to ensure that they follow the methodology and use the data-driven approach correctly. This training is very important.

Some organizations use additional belt colours, such as Yellow Belts, for employees that have basic training in Six Sigma tools and generally participate in projects and "White belts" for those locally trained in the concepts but do not participate in the project team. "Orange belts" are also mentioned to be used for special cases.

2.1.6 Certification

General Electric and Motorola developed certification programs as part of their Six Sigma implementation, verifying individuals' command of the Six Sigma methods at the relevant skill level (Green Belt, Black Belt etc.). Following this approach, many organizations in the 1990s started offering Six Sigma certifications to their employees. Criteria for Green Belt and Black Belt certification vary; some companies simply require participation in a course and a Six Sigma project. There is no standard certification body, and different certification services are offered by various quality associations and other providers against a fee. The American Society for Quality for example requires Black Belt applicants to pass a written exam and to provide a signed affidavit stating that they have completed two projects or one project combined with three years' practical experience in the body of knowledge.

2.1.7 Etymology of six sigma process

The term "six sigma process" comes from the notion that if one has six standard deviations between the process mean and the nearest specification limit, as shown in the graph, practically no items will fail to meet specifications. This is based on the calculation method employed in process capability studies.

Capability studies measure the number of standard deviations between the process mean and the nearest specification limit in sigma units, represented by the Greek letter σ (sigma). As process standard deviation goes up, or the mean of the process moves away from the center of the tolerance, fewer standard deviations will fit between the mean and the nearest specification limit, decreasing the sigma number and increasing the likelihood of items outside specification. One should also note that calculation of Sigma levels for a process data is independent of the data being normally distributed. In one of the criticisms to Six Sigma, practitioners using this approach spend a lot of time transforming data from non-normal to normal using transformation techniques. It must be said that Sigma levels can be determined for process data that has evidence of non-normality.

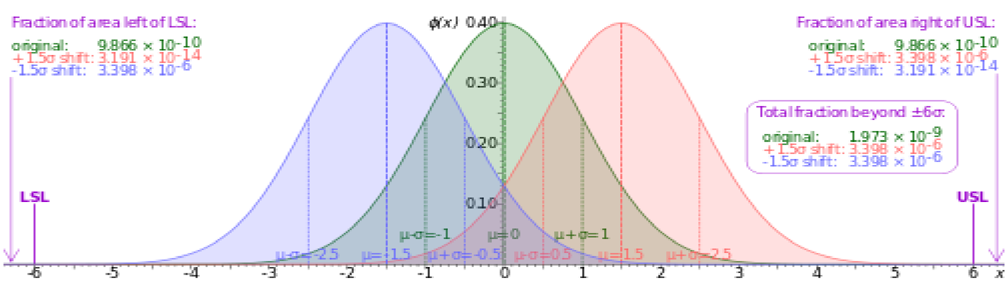


Figure 2.4 Wave form diagram for Six Sigma process

Graph of the normal distribution, which underlies the statistical assumptions of the Six Sigma model. The Greek letter σ (sigma) marks the distance on the horizontal axis between the mean, μ, and the curve's inflection point. The greater this distance, the greater is the spread of values encountered. For the green curve shown above, μ = 0 and σ = 1. The upper and lower specification limits (USL and LSL, respectively) are at a distance of 6σ from the mean. Because of the properties of the normal distribution, values lying that far away from the mean are extremely unlikely. Even if the mean were to move right or left by 1.5σ at some point in the future (1.5 sigma shift, coloured red and blue), there is still a good safety cushion. This is why Six Sigma aims to have processes where the mean is at least 6σ away from the nearest specification limit.

2.2 ENGINE

An engine or motor is a machine designed to convert one form of energy into mechanical energy. Heat engines, including internal combustion engines and external combustion engines (such as steam engines), burn a fuel to create heat, which then creates a force. Electric motors convert electrical energy into mechanical motion; pneumatic motors use compressed air. An engine consists of cylinder head and cylinder block.

2.2.1 Cylinder head

In an internal combustion engine, the cylinder head sits above the cylinders on top of the cylinder block. It closes in the top of the cylinder, forming the combustion chamber. This joint is sealed by a head gasket. In most engines, the head also provides space for the passages that feed air and fuel to the cylinder, and that allow the exhaust to escape. The head can also be a place to mount the valves, spark plugs, and fuel injectors.

2.2.2 Cylinder block

A cylinder block is an integrated structure comprising the cylinder(s) of a reciprocating engine and often some or all of their associated surrounding structures (coolant passages, intake and exhaust passages and ports, and crankcase). The term engine block is often used synonymously with "cylinder block".

In the basic terms of machine elements, the various main parts of an engine (such as cylinder(s), cylinder head(s), coolant passages, intake and exhaust passages, and crankcase) are conceptually distinct, and these concepts can all be instantiated as discrete pieces that are bolted together. However, it is no longer the normal way of building most petrol engines and diesel engines, because for any given engine configuration, there are more efficient ways of designing for manufacture (and also for maintenance and repair).

2.3 MILLING OPERATIONS

Milling is the process of machining flat, curved, or Milling machines are basically classified as vertical or irregular surfaces by feeding the work piece against a rotating horizontal. These machines are also classified as knee-type, cutter containing a number of cutting edges. The milling ram-type, manufacturing or bed type, and planer-type.

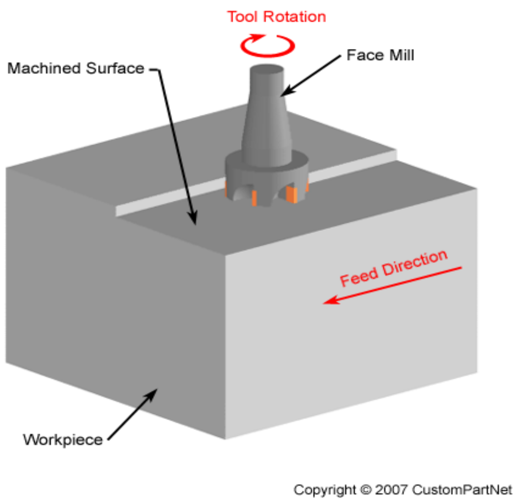


Figure 2.5 Milling

Most machine consists basically of a motor driven spindle, which milling machines have self-contained electric drive motors, mounts and revolves the milling cutter, and a reciprocating coolant systems, variable spindle speeds, and power - operated adjustable worktable, which mounts and feeds the work piece.

2.3.1 Types of milling machines

2.3.1.1 Knee-type milling machine

Knee-type milling machines are characterized by a vertically adjustable worktable resting on a saddle which is supported by a knee. The knee is a massive casting that rides vertically on the milling machine column and can be clamped rigidly to the column in a position where the milling head and milling machine spindle are properly adjusted vertically for operation. The plain vertical machines are characterized by a spindle located vertically, parallel to the column face, and mounted in a sliding head that can be fed up and down by hand or power. Modern vertical milling machines are designed so the entire head can also swivel to permit working on angular surfaces. The turret and swivel head assembly is designed for making precision cuts and can be swung 360° on its base. Angular cuts to the horizontal plane may be made with precision by setting the head at any required angle within a 180” arc. The plain horizontal milling machine’s column contains the drive motor and gearing and a fixed position horizontal milling machine spindle. An adjustable overhead arm containing one or more arbor supports projects forward from the top of the column. The arm and arbor supports are used to stabilize long arbors. Supports can be moved along the overhead arm to support the arbor where support is desired depending on the position of the milling cutter or cutters.

The milling machine’s knee rides up or down the column on a rigid track. A heavy, vertical positioning screw beneath past the milling cutter. The milling machine is excellent for forming flat surfaces, cutting dovetails and keyways, forming and fluting milling cutters and reamers, cutting gears, and so forth. Many special operations can be performed with the attachments available for milling machine use. The knee is used for raising and lowering. The saddle rests upon the knee and supports the worktable. The saddle moves in and out on a dovetail to control cross feed of the worktable. The worktable traverses to the right or left upon the saddle for feeding the work piece past the milling cutter. The table may be manually controlled or power fed.

2.3.1.2 Universal horizontal milling machine

The basic difference between a universal horizontal milling machine and a plain horizontal milling machine is the addition of a table swivel housing between the table and the saddle of the universal machine. This permits the table to swing up to 45° in either direction for angular and helical milling operations. The universal machine can be fitted with various attachments such as the indexing fixture, rotary table, slotting and rack cutting attachments, and various special fixtures.

2.3.1.3 Ram-type milling machine

The ram-type milling machine is characterized by a spindle mounted to a movable housing on the column to permit positioning the milling cutter forward or rearward in a horizontal plane. Two popular ram-type milling machines are the universal milling machine and the swivel cutter head ram-type milling machine.

2.3.1.4 Universal ram-type milling machine

The universal ram-type milling machine is similar to the universal horizontal milling machine, the difference being, as its name implies, the spindle is mounted on a ram or movable housing. 8-1 TC 9-524.

2.3.1.5 Swivel cutter head ram type milling machine

The cutter head containing the milling machine spindle is attached to the ram. The cutter head can be swiveled from a vertical spindle position to a horizontal spindle position or can be fixed at any desired angular position between vertical and horizontal. The saddle and knee are hand driven for vertical and cross feed adjustment while the worktable can be either hand or power driven at the operator's choice.

2.3.2 Milling machining operation

The following are different operations performed in a milling machine.

Types of milling:

1. Plain milling
2. Side milling
3. Face milling
4. End milling
5. Slotting
6. Straddle milling
7. Sawing
8. Gang milling
9. Angular milling
10. Form milling
11. Profile milling
12. Gear milling
13. Helical milling
14. Cam milling
15. Thread milling

1. Plain milling

Plain milling is the process of production of the plain, flat, horizontal surface parallel to the axis of rotation of the plain milling cutter. This operation is called slab milling.

2. Side milling

Side milling is the operation of production of a flat vertical surface on the side of a work piece by using the side milling cutter.

3. Face milling

The face milling operation is performed by face milling cutter rotated about an axis perpendicular the work surface.

4. End milling

The milling is the operation of the production of the flat surface which may be vertical, horizontal or at an angle in reference to the table surface. The cutter used in an end mill.

5. Slotting

The operation of production of keyways, grooves and slots of varying shapes and size can be performed in a milling machine by using a mills cutter, a metal slitting saw.

6. Straddle milling

The straddle milling is the operation of production of flat vertical surface on both sides of a work piece by using two sides milling cutters mounted on the same arbor.

7. Saw milling

The saw milling is the operation of production of narrow slots or grooves on a work piece by using saw milling cutter.

8. Gang milling

The gang milling is the operation of machining several surface of a work piece simultaneously by feeding the table against a number of cutters having same or different diameter mounted on the arbor of the machine.

9. Angular milling

The angular milling is the operation of production of an angular surface on a work piece.

10. Form milling

The form milling is the operation of production of irregular counters by using form cutter.

11. Profile milling

The profile milling is the operation of production of an outline of a template or complex shape of a master die on a work piece.

12. Gear cuttings

The gear cutting operation is performed in a milling machine by using a form relived cutter. The cutter may be cylindrical type or end mill type.

13. Helical milling

The helical milling is the operation of production of helical flutes or grooves around the periphery of a cylindrical work piece.

14. Cam milling

The cam milling is the operation of production of cams in a milling machine by the use of a universal dividing head and vertical milling attachment.

15. Thread milling

Thread milling is the operation of production of threads by using a single or multiple thread milling cutters.

2.4 DRILLING

Drilling is a cutting process that uses a drill bit to cut or enlarge a hole of circular cross-section in solid materials. The drill bit is a rotary cutting tool, often multipoint. The bit is pressed against the work piece and rotated at rates from hundreds to thousands of revolutions per minute. This forces the cutting edge against the work piece, cutting off chips (swarf) from the hole as it is drilled.

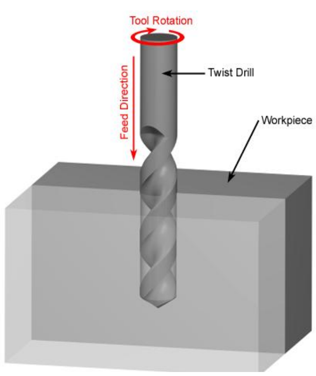


Figure 2.6 Drilling

2.4.1 Types of drilling operations

This is the operation of making a circular hole by removing a volume of metal from the job by a rotating cutting tool called drill. Drilling removes solid metal from the job to produce a circular hole. A suitable drill is held in the drill machine and the drill machine is adjusted to operate at the correct cutting speed. The drill machine is started and the drill starts rotating. Cutting fluid is made to flow liberally and the cut is started. The rotating drill is made to feed into the job. The hole, depending upon its length, may be drilled in one or more steps. After the drilling operation is complete, the drill is removed from the hole and the power is turned off.

2.4.1.1 Core drilling

Core drilling operation is shown in Fig 2.7 a core drill is a drill specifically designed to remove a cylinder of material, much like a hole saw. The material left inside the drill bit is referred to as the core.

Core drills are used for; where drilling can be done more rapidly since much less material needs to be removed than with a standard bit. This is the reason that diamond-tipped core drills are commonly used in construction to create holes for pipes, manholes, and other large-diameter penetrations in concrete or stone.

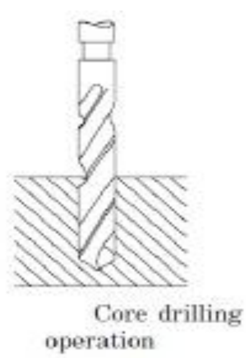


Figure 2.7 Core drilling

2.4.1.2 Reaming

This is the operation of sizing and finishing a hole already made by a drill. Reaming is performed by means of a cutting tool called reamer. Reaming operation serves to make the hole smooth, straight and accurate in diameter. Reaming operation is performed by means of a multi tooth tool called reamer. Reamer possesses several cutting edges on outer periphery and may be classified as solid reamer and adjustable reamer.

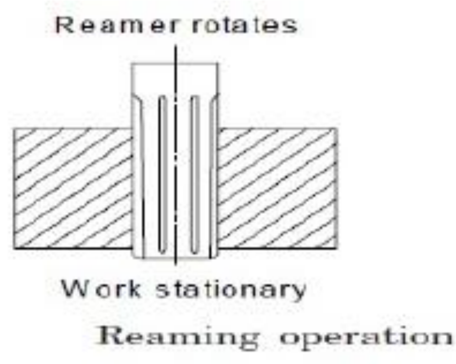


Figure 2.8 Core drilling

2.4.1.3 Boring

Fig 2.9 shows the boring operation where enlarging a hole by means of adjustable cutting tools with only one cutting edge is accomplished. A boring tool is employed for this purpose of work.

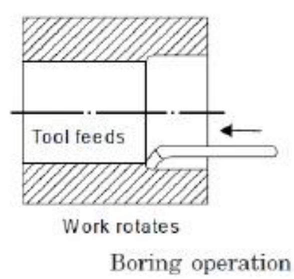


Figure 2.9 Boring

2.4.1.4 Counter boring

Counter boring operation is shown in Fig 2.10. It is the operation of enlarging the end of a hole cylindrically, as for the recess for a counter-sunk rivet. The tool used is known as counter- bore.

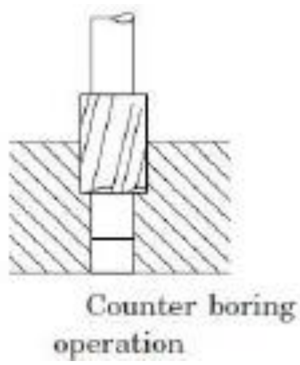


Figure 2.10 Counter Boring

2.4.1.5 Counter sinking

Counter-sinking operation is shown in Fig 2.11. This is the operation of making a cone shaped enlargement of the end of a hole, as for the recess for a flat head screw. This is done for providing a seat for counter sunk heads of the screws so that the latter may flush with the main surface of the work.

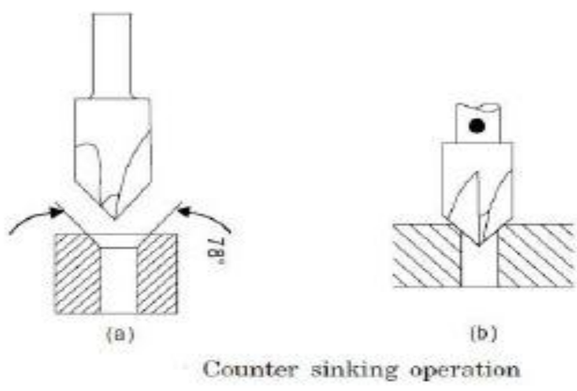


Figure 2.11 Counter Sinking

2.4.1.6 Lapping

This is the operation of sizing and finishing a hole by removing very small amounts of material by means of an abrasive. The abrasive material is kept in contact with the sides of a hole that is to be lapped, by the use of a lapping tool.

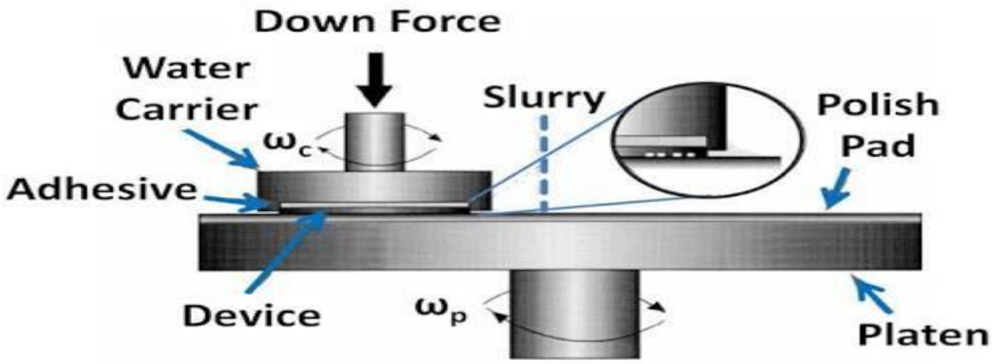


Figure 2.12 Lapping

2.4.1.7 Spot facing

This is the operation of removing enough material to provide a flat surface around a hole to accommodate the head of a bolt or a nut. A spot-facing tool is very nearly similar to the counter-bore.

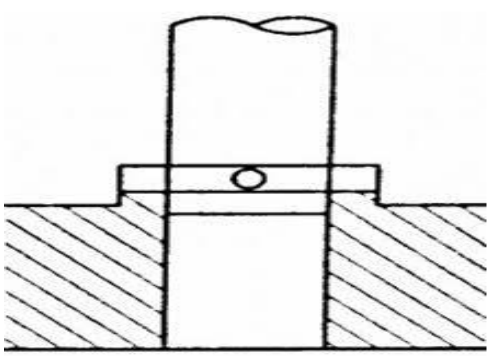


Figure 2.13 Spot facing

2.4.1.8 Tapping

It is the operation of cutting internal threads by using a tool called a tap. A tap is similar to a bolt with accurate threads cut on it. To perform the tapping operation, a tap into screwed in to the hole by hand or by machine. The tap removes metal and cuts internal threads, which will fit into external threads of the same size. For all materials excepts cast iron, a little lubricate oil is applied to improve the action. The tap is not turned continuously, but after every half turn. It should be reversed slightly to clear the threads. Tapping operation is shown in Fig 2.14.

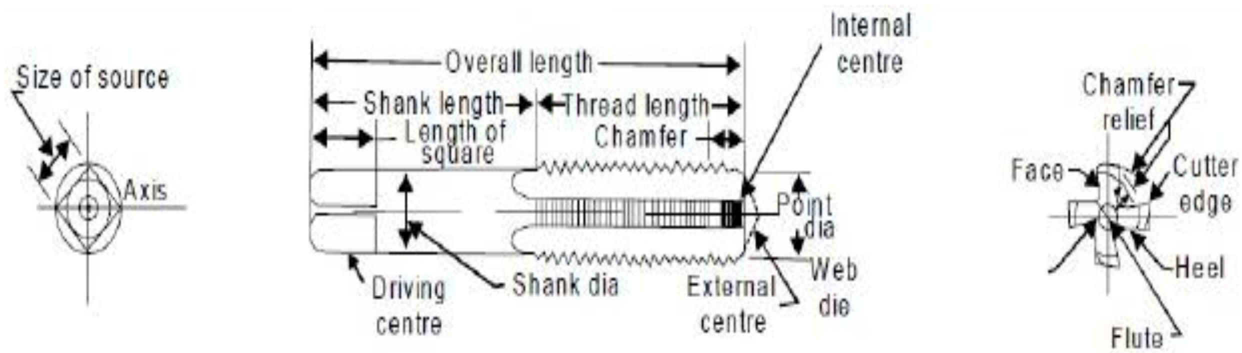


Figure 2.14 Tapping

2.4.2 Drilling parameters

1. **Cutting Speed (v)**

   It's the peripheral speed of the drill. The cutting speed depends upon the properties of the material being drilled, drill material, drill diameter, rate of speed, coolant used etc.

   $v = D \times N$

   Where,

   D = diameter of the drill in m

   N = Speed of rotation in rpm

2. **Feed Rate (f)**

It's the movement of drill along the axis (rpm).

3. **Depth of Cut (d)**

The distance from the machined surface to the drill axis.

$$d = D/2$$

As the depth of hole increases, the chip ejection becomes more difficult and the fresh cutting fluid is not able to cutting zone. Hence for machining the lengthy hole special type of drill called 'gun drill' is used.

4. **Material Removal Rate**

It's the volume of material removed by the drill per unit time.

$$MRR = (D / 4) \times 2f \times N \text{ mm}^3 / \text{min}$$

5. **Machining Time (T)**

It depends upon the length (L) of the hole to be drilled, to the Speed (N) and feed (f) of the drill.

$$t = L/fN \text{ min}$$

CHAPTER 3

PROJECT DESCRIPTION

3.1 PROBLEM IDENTIFICATION IN CYLINDER BLOCK

In cylinder block, while cam boring operation the axis becomes offset. When the axis becomes offset, this problem has occurred because the axis is moved, while casting the cylinder block.

3.1.1 Complaint reported

Position shift / offset during rough cam bore operation of cylinder block in H-series engine.

3.1.2 Quantity loss

Due to position shift, it is observed that 28 components were declared Scrap in the month of November, 2015. This resulted in a loss as seen in the following graph: -

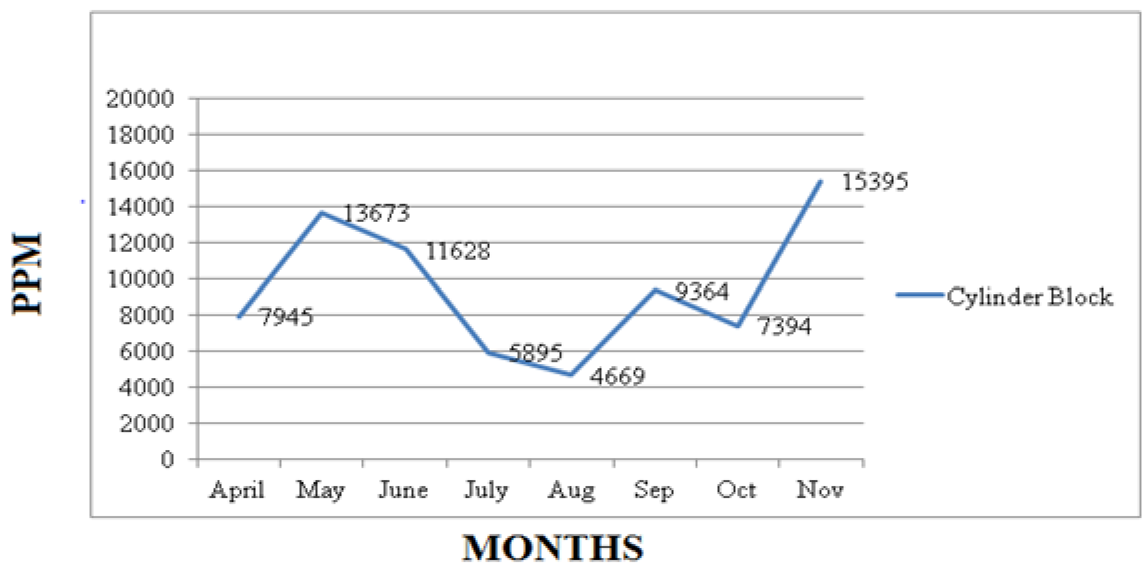


Figure 3.1 Operation scrap – H series 6 cylinder Block

3.2 CURRENT STATUS

As the solution for the problem is pending, changes are made on the machines for the rough cam bore operation which includes change of tools i.e. boring cutter & insert and dowel pin. The problem is to be rectified before loss occurs.

3.3 DATA COLLECTION

The following data is being collected using Co-ordinate Measuring Machine (CMM) from metrology lab. The graph shows that how many scraps obtained in each month details.

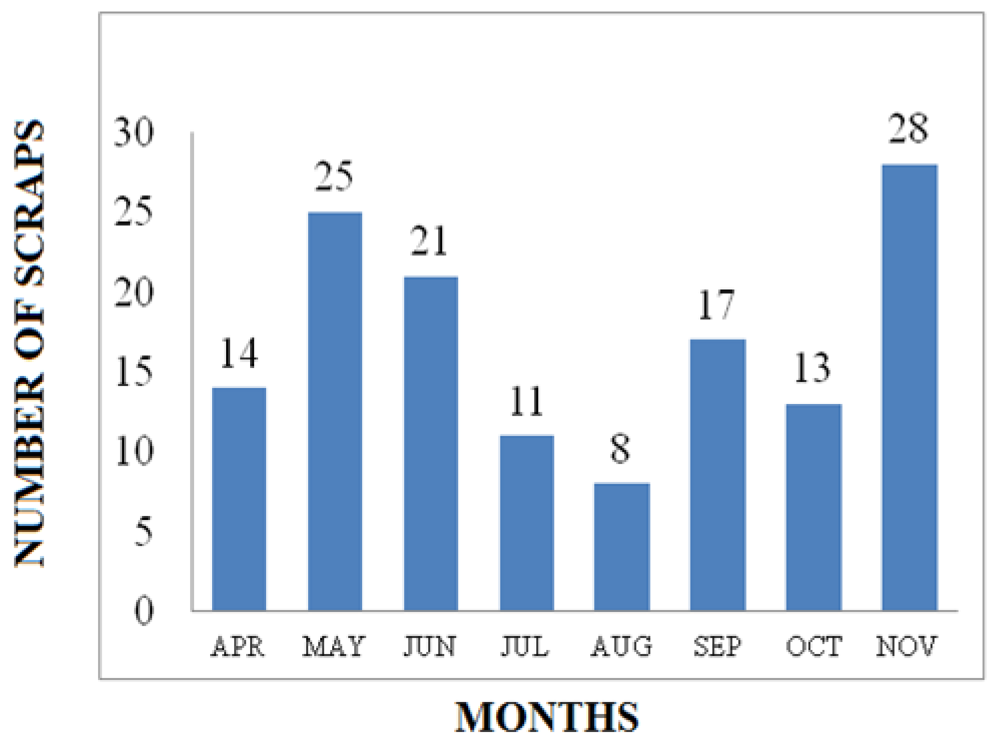


Figure 3.2 Number of scraps in cylinder block vs months

The reading shows the diameter and the value of X and Z co-ordinates for cam1 and cam4 with and without offset.

Through the above mention graph we come to know the weight of cylinder block per month.

Weight of the cylinder block = 136.1kg (300 pounds)

Total weight of scrap = 136.1x 28

= 3810.8kg

Rough Cam Bore – LA 4439 – OPN.NO:130

WITHOUT OFFSET:

DATE: November 19, 2015

CAM-1

Table 3.1 CAM-1 WITHOUT OFFSET

Names	Axis	Actual (mm)	Nominal (mm)	Positive Tolerance (mm)	Negative Tolerance (mm)	Difference (mm)
X value	X	204.4806	204.5000	0.3000	-0.3000	-0.0194
Z value	Z	-301.5174	-301.4800	0.3000	-0.3000	-0.0374
Diameter	D	58.0625	58.1000	0.2000	-0.2000	-0.0375

CAM – 4

Table 3.2 CAM-4 WITHOUT OFFSET

Names	Axis	Actual (mm)	Nominal (mm)	Positive Tolerance (mm)	Negative Tolerance (mm)	Difference (mm)
X value	X	204.4546	204.5000	0.3000	-0.3000	-0.0454
Z value	Z	-301.5124	-301.4800	0.3000	-0.3000	-0.0324
Diameter	D	58.0452	58.1000	0.2000	-0.2000	-0.0548

WITH OFFSET:

DATE: November 19, 2015

CAM-1

Table 3.3 CAM- 1 WITH OFFSET

Names	**Axis**	**Actual (mm)**	**Nominal (mm)**	**Positive Tolerance (mm)**	**Negative Tolerance (mm)**	**Difference (mm)**
X value	X	203.5556	204.5000	0.3000	-0.3000	-0.9444
Z value	Z	-301.4125	-301.4800	0.3000	-0.3000	0.0675
Diameter	D	58.1353	58.1000	0.2000	-0.2000	0.0353

CAM-4

Table 3.4 CAM -4 WITH OFFSET

Names	**Axis**	**Actual (mm)**	**Nominal (mm)**	**Positive Tolerance (mm)**	**Negative Tolerance (mm)**	**Difference (mm)**
X value	X	203.3817	204.5000	0.3000	-0.3000	-1.1183
Z value	Z	-301.3815	-301.4800	0.3000	-0.3000	0.0985
Diameter	D	58.0703	58.1000	0.2000	-0.2000	-0.0297

3.4. WORKING METHOD

3.4.1 Before machining

The figure shows the before machining in cylinder block in cam bore. The cylinder block is just water washed before the machining process is done. Then the cylinder block will be placed for cam bore operation.

Figure 3.3 Before Machining

3.4.2 During machining

The figure shows cylinder block is placed for cam bore machining operation into the machine. The cylinder block is placed into the machine for came bore operation, where cam boring is done from both the sides of the came hole in cylinder block. The cam boring is done up to Ø58.3 ±0.2 in cylinder block.

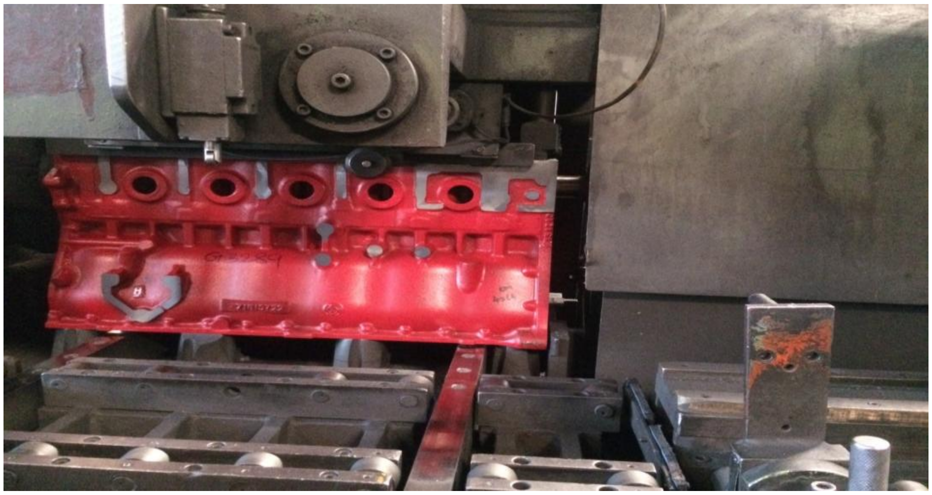


Figure 3.4 During Machining

3.4.3 After machining

The figure shows the cylinder block after the cam bore machining operation is done. The cam bore operation is finished in the cylinder block and the component is pushed out for next operation.

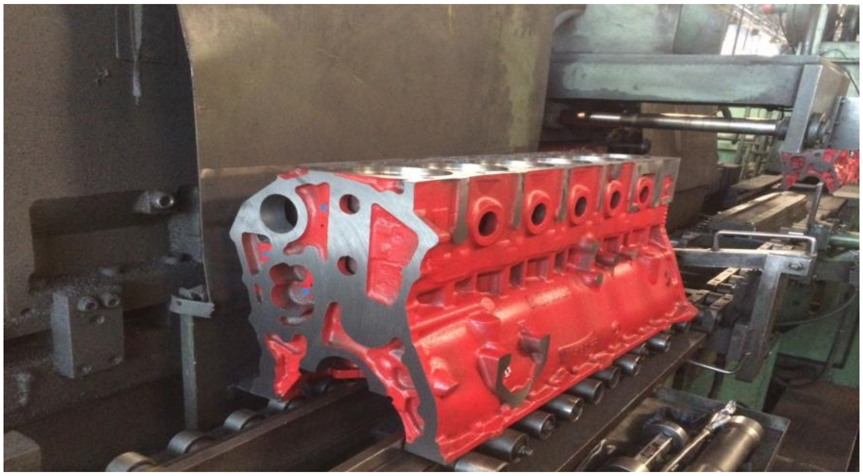


Figure 3.5 After Machining

The tools and gauges used in the operation 130 for rough cam bore operation is as follows:-

Table 3.5 Components

S.NO	TYPE OF TOOL	IDENTIFICATION NO	DESCRIPTION
1	Machine	LA4439	LML 2 WAY ROUGH BORER
2	Tool	T76YC0940003	CCGT 09T304-UM H13A
4	Gauge	G01GP1210044	PLUG GAUGE
5	Gauge	G01GZ0111205	CHECK BAR DIA 57.8

3.5 ANALYSIS

The block is being placed on the line boring machine in a perfectly horizontal position. Once the block is set up, a perfectly horizontal cutting bar moves slowly and the line boring process is repeated until the desired thickness is removed.

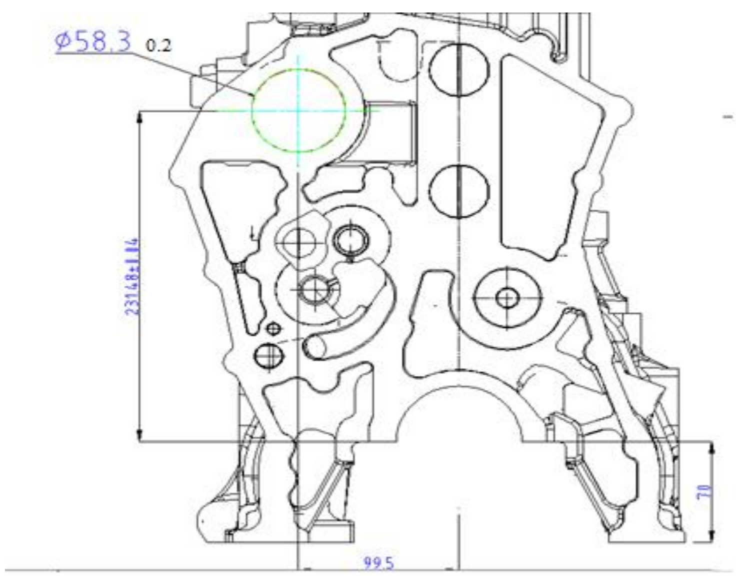


Figure 3.6 Cylinder block Front face View

The reason for defect in the machining process of rough cam bore as analyzed:-

3.5.1 Casting

'Core shifts' during casting process can create offset. The result can be cylinder bores with thick / thin areas, and the thin areas in many cases can either be too weak to maintain the roundness during engine operation.

As rigid as an engine block might seem, there is actually quite a bit of residual stress in most castings. The residual stresses left over from the original casting process tend to distort and warp the engine. This affects the alignment of the cam bores as well as cylinders. Eventually, the block becomes more or less stable.

3.5.2 Improper seating of component

3.5.2.1 Carelessness of the worker

The workers being careless about the seating of the cylinder block on the dowel pin in the machine. Passing of component from one operation to next operation is done by the worker irrespective of the dowel hole in the sump face of the block getting properly seated over dowel pin. Dependency on the automatic processing of machine causes the worker to be carefree thus resulting defect in the cylinder block. This small mistake can create impact resulting in a loss.

3.5.2.2 Displacement in dowel pin

Dowel pin used in the machine wear off /gets damaged after certain period of time. Here, dowel pins are being used more than its life time and this causes oversize and undersize of dowel pins. Due to which, vibration occurs thus resulting in improper seating of component. High moisture content can create oversized dowel and low moisture content creates undersized dowel.

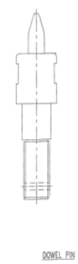


Figure 3.7 Dowel pin

3.6 IDEA GENERATION

The following idea listed after complete analysis of machine:-

a) Replacement of tool should be done based on their given frequency to avoid change in tool angle and hence vibration.

b) Dowel pin should be checked as per the schedule so that wear /damage of pin that can cause position offset during cam bore operation can be avoided.

c)The position measurement is planned only through 3 Co-ordinate measuring machine (CMM).To ensure the position of rough cam bore at stage itself , new type inspection fixture from reference face to cam bore can be planned. Since only two reference face are present in the cylinder block after the machining process of rough cam bore operation , two different types of inspection fixture can be designed which is as follows :-

c.1) Taking half diameter of the Bearing cap reg. width as reference face, inspection fixture can be designed to avoid position offset/co-ordinate misalignment. The required dimension to design is known i.e. reg. width, height from center of bearing cap reg. width to center of the cam bore (both X and Z axis).

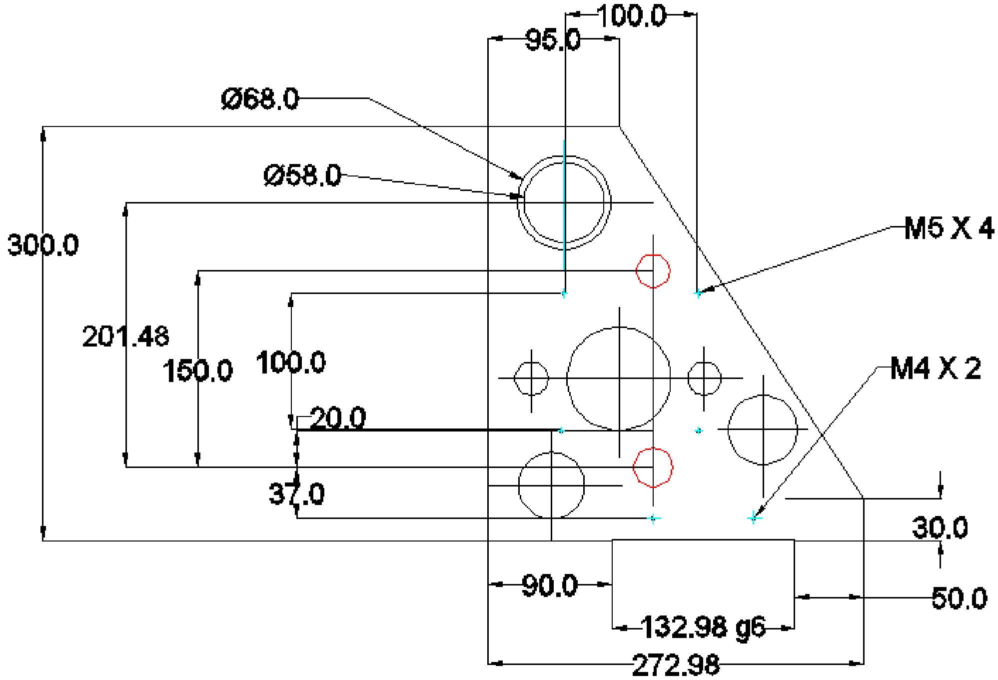
c.2) Taking the dowel hole in the sump face of the cylinder block as the reference face, inspection fixture can be designed. But TOT is required after the completion of rough cam bore operation so that the component can be turned upside down for taking dowel hole as reference to check for position offset. The inspection fixture will be L-shaped fitted in the dowel hole with all the required dimension and gauge (rod like) to check diameter of the cam bore .If there is a variation in the diameter of the cam bore, it will not move in thus showing that there is position offset in the block.

3.7 IMPLEMENTATION

Table 3.6 Components need for designing the gauge

PARTS	NO. REQUIRED	DIMENSIONS (mm)
Surface plate	1	272.98x16x300
Block for bearing cap register Width	1	132.98x24x14.1
Bush	1	Inner dia. : 58mm Outer dia. : 68mm Width :15mm
Screw	2	M4 x 40

The position offset during the cam bore operation can be avoided by implementing the ideas i.e. Design of inspection fixture with reference to bearing cap register width. The inspection fixture to check offset is designed using the dimensions which is shown in the above table.



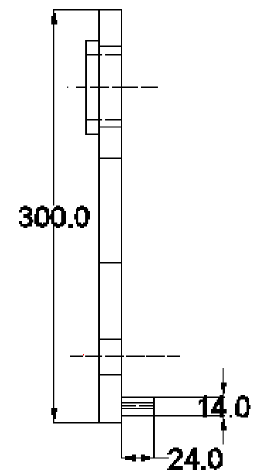


Figure 3.8 Fixture – Front View **Figure 3.9 Fixture - Side View**

All Dimensions are in mm

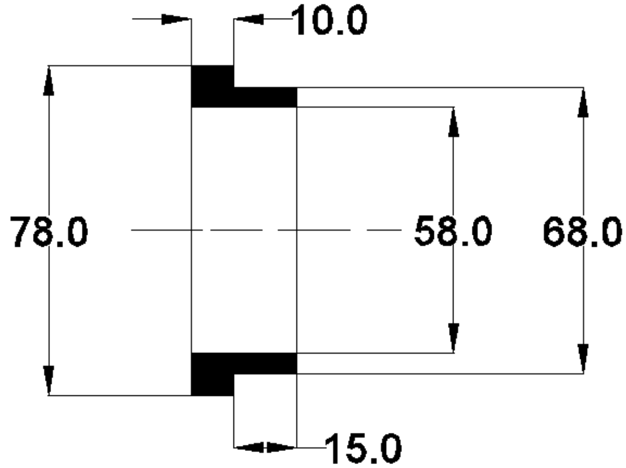


Figure 3.10 Bush

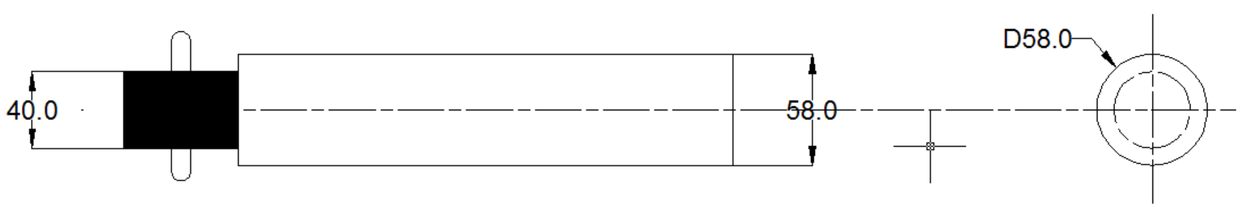


Figure 3.11 Gauge

All Dimensions are in mm

3.8 DESCRIPTION

A surface plate i.e. flat plate is used as a reference for inspection after cam bore operation. The plate has a dimension of 272.98 x16 x300 mm (l x b x h) and weight reduction holes of different diameter are used to lower the weight of the plate. A cam bore hole as shown in the figure is used to check position offset with respect to bearing cap reg. width. Tapping screws are being fixed on the surface plate along with the hole for fixing the block. The Block here is made as per the dimension of bearing cap reg. width i.e. 132.98 x 24 x 14.1 mm to be fixed on it. The bush used on the cam bore hole in the plate to avoid wear in the hole and also proper fixing. Tapping screw of M4 x 40 is used to fix the block on the surface plate. Separate Gauge being used to check the diameter of cam bore hole. Handle is provided on the plate for easy lifting and checking of position offset.

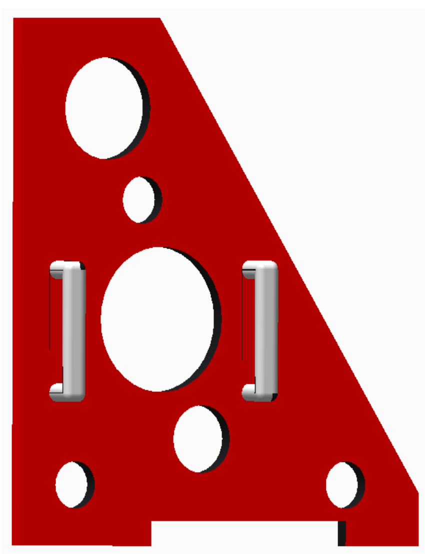


Figure 3.12 Fixture Front View

Figure 3.13 Fixture side View

Figure 3.14 Gauge **Figure 3.15 Block**

3.9 PROCEDURE

The surface plate designed is placed on the front end of the cylinder block after the machining process of cam bore operation. It is placed with reference to bearing cap register width where block is being fixed with screws tightened. Then, the gauge to check diameter of the cam bore hole is inserted. If both are within the prescribed tolerance, the gauge will move inside showing that there is no shift in position and thus no defects after rough cam bore operation.

3.10 MATERIAL

Two different types of material can be used:

1) Carbon Steel EN32
2) Oil hardening Non Shrinking Steel (OHNS)

3.10.1 Carbon steel EN32

EN32 is a carbon case hardening steel. Components when carburized have core strength range of 430-490 N/mm^2, with a hard wearing surface

Table 3.7 Chemical composition of EN32

ELEMENT	Min %	Max %
Carbon, C	0.10	0.1
Manganese, Mn	0.70	1.10
Silicon , Si	0.05	0.35

Table 3.8 Mechanical Properties of EN32

Tensile Strength N/mm^2	Elongation %	Impact Izod J	Impact KCV J
430	18	39	35

a) Hardening

Harden at a temperature of 760-780 ˙C. Refine at temperature of 970-900 C, cool in air, oil or water.

b) Applications

Used for general engineering lightly stresses application that are subject to wear.

3.10.2 Oil hardening non shrinkage steel (OHNS)

Table 3.9 Chemical composition of OHNS

ELEMENT	**%**
Carbon , C	0.95
Silicon ,Si	0.25
Manganese, Mn	1.10
Chromium, Cr	0.60

Steel Properties

- Cold work tool steel
- Very high resistance to cracking
- High machinability.
- Medium toughness and resistance to wear.
- Dimensional stability at heat treatment.
- High surface hardness and toughness after hardening and tempering.
- The Rockwell method measures the hardness of O1 tool steel to be in the range of 64RC to 58RC.
- Maximum Hardness: 60-64
- Hardening temperature: 760-870 ˙C

3.11 PROBLEM IDENTIFICATION IN CYLINDER HEAD

In cylinder head, while rough milling the exhaust manifold side, the axis may get inclined. The dowel hole of cylinder head is not seated properly on dowel pin. This problem has occurred because the burrs are located on its sides.

3.11.1 Complaint reported

Angle inclination in exhaust manifold side (EMF) milling during machining operation of cylinder Head in H-series Engine.

3.11.2 Quantity loss

Due to angle inclination, it is observed that 18 components were declared scrap in the month of November, 2015. This resulted in a loss as seen in the following graph:-

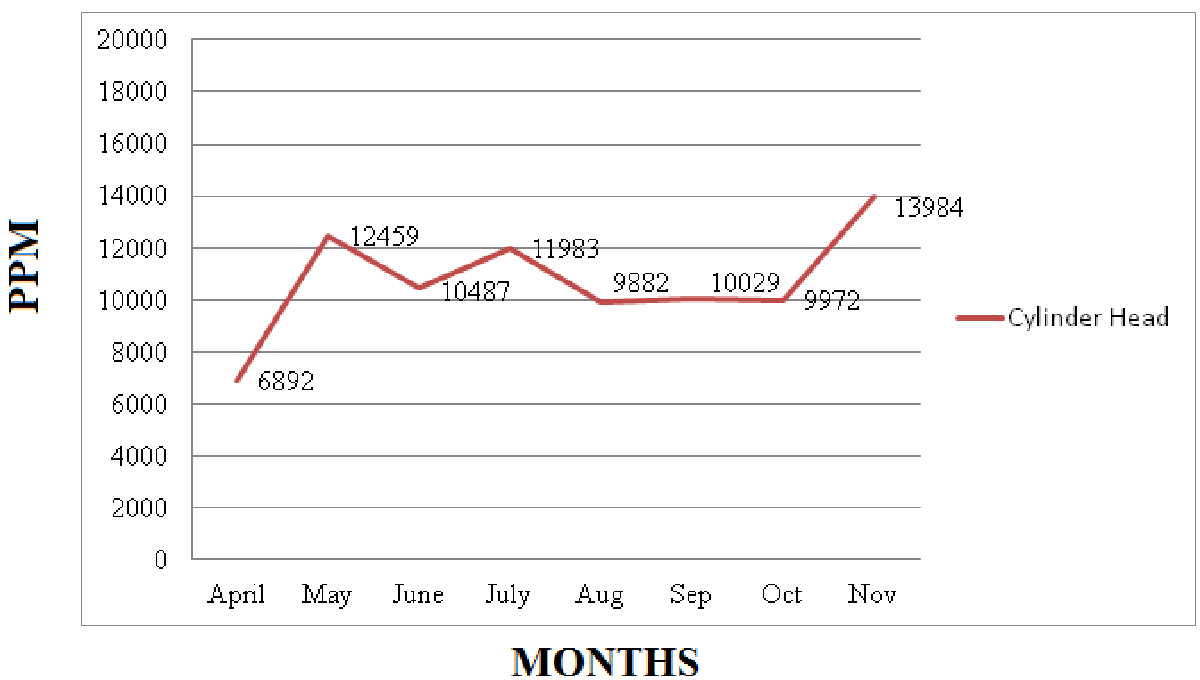


Figure 3.16 Operation Scrap - H series 6 Cylinder head

3.11.3 Current status

As the solution for the problem is pending, changes are made on the machines for the Exhaust manifold side operation which includes placing the component manually i.e. adjusting by hands. The problem is to be rectified before loss occurs.

3.12 DATA COLLECTION

The following data is being collected using Co-ordinate Measuring Machine (CMM) from metrology lab.The graph shows that how many scraps obtained in each month details.

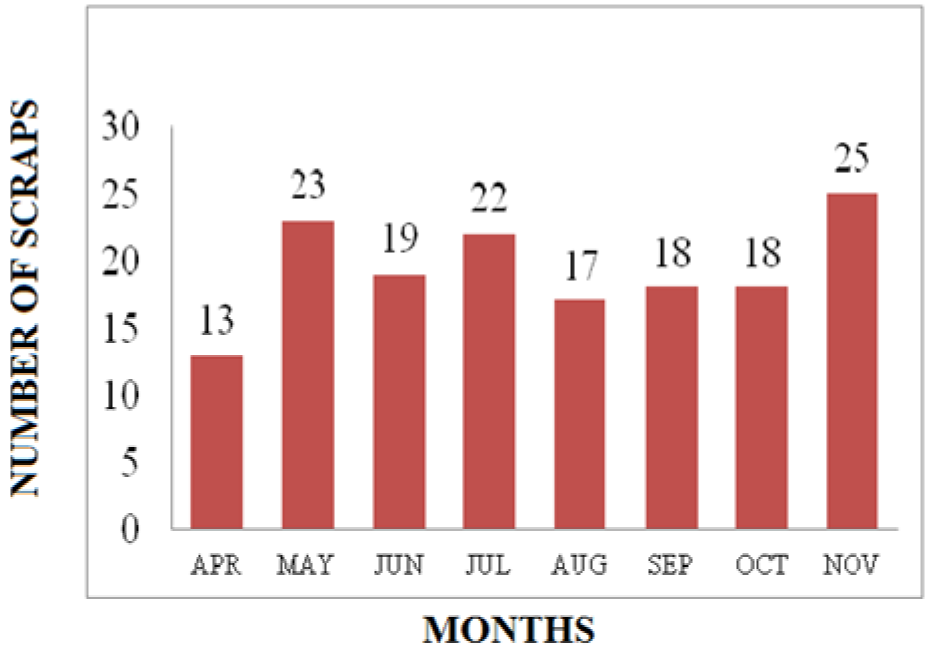


Figure 3.17 Number of scraps in cylinder head vs months

Through the above mention graph we come to know the weight of cylinder head per month.

Weight of the cylinder head = 27.21kgs(60 pounds)

Total weight of scrap = 27.21 x 25

= 680.25kgs

3.13 MACHINE ARRANGEMENT

3.13.1Guide way clearance

The guide way clearance is improper therefore the Exhaust Manifold face of the head is not properly located. The burr particle is located in IMF side of the head.

3.13.2 Burr

A burr is a raised edge or small piece of material remaining attached to a work piece after a modification process.

3.13.3 End stopper

It is reference point for component loading.

Figure 3.18 End stopper

3.14 IDEA GENERATION

The scrap in the cylinder head can be removed by implementing the following methods. They are:

3.14.1 Guide way clearance

It’s the distance between the component and its loading edge of a milling machine. It must be in a proper arrangement.

3.14.2 Air nozzle arrangement

It contains many air Nozzles in this arrangement. It used to remove the burr particle located in nozzle in combustion face of the cylinder head .The pressure of air is 5 bar to 10 bar. The air nozzle arrangement is shown in the figure.3.15.The component loading in air nozzle is shown in fig.3.16.

Figure 3.19 Air nozzle arrangement

Figure 3.20 Component loading in air nozzle

3.14.3 Location of burrs

The burrs are located on the Exhaust manifold side of the cylinder head.

3.14.4 Position of end stopper

End stopper strikes the front face of the cylinder head.

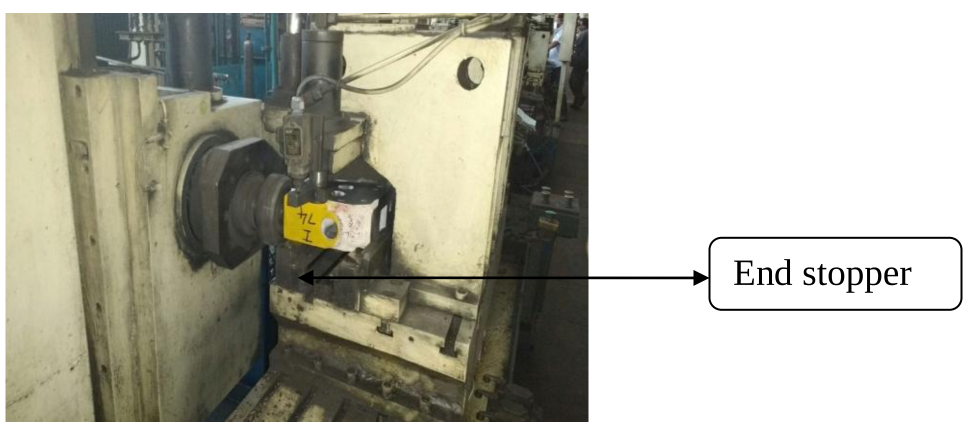


Figure 3.21 Position of End stopper

3.14.5 Position of rough guide

The rough guide is placed near the support of the machine.

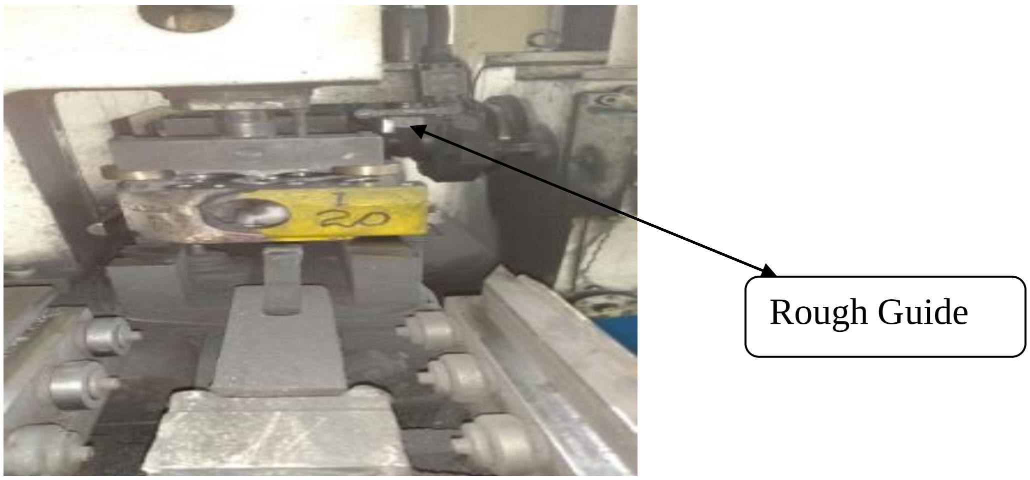


Figure 3.22 Position of rough guide

3.15 ANALYSIS

The head is being placed on the line milling machine in a perfectly position. Once the head is set up, a perfectly horizontal milling tool moves slowly and the milling process is repeated until the desired thickness is removed.

3.16 IMPROPER SEATING OF COMPONENT

3.16.1 Carelessness of the worker

The workers being careless about the seating of the cylinder head on the dowel pin in the machine. Passing of component from one operation to next operation is done by the worker irrespective of the dowel hole in the combustion face of the head getting properly seated over dowel pin. Dependency on the automatic processing of machine causes the worker to be carefree thus resulting defect in the cylinder head. This small mistake can create impact resulting in a loss.

3.16.2 Displacement in dowel pin

Dowel pin used in the machine wear off /gets damaged after certain period of time. Here, dowel pins are being used more than its life time and this causes oversize and undersize of dowel pins. Due to which, vibration occurs thus resulting in improper seating of component. High moisture content can create oversized dowel and low moisture content creates undersized dowel.

3.17 IMPLEMENTATION

While milling the exhaust manifold side of the cylinder head the burrs located on its sides. **In order to reduce this, turn over device and pressure coolant washing method can be used.**

The cylinder head is placed in turn over device and locked before the exhaust manifold side milling process. By using it and turn upside down, the scrap will fall down in scrap bin.

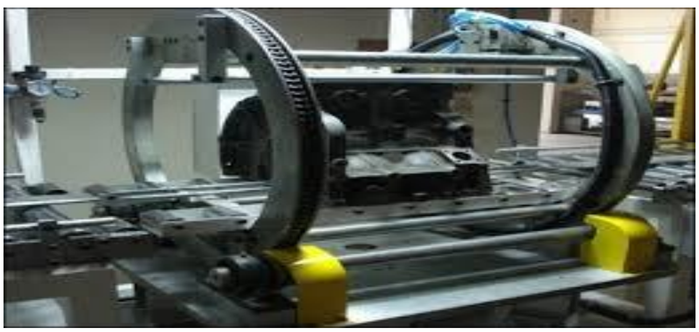


Figure 3.23 Turn over device

Even though we are using turn over device the small burrs are located in cylinder head. So, we are placing it in pressure coolant washer. By using the coolant in high pressure to clean it the burrs can be removed.

Figure 3.24 Pressure coolant washing

CHAPTER 4

RESULTS AND DISCUSSION

The scrap can be reduced by implementing these ideas in machining cylinder block and cylinder head n H-series engine. In this project we have identified that the cam bore offset can be reduced by designing a fixture for checking its offset in cylinder block and for cylinder head the scrap can be removed by using a turn over device and pressure washing method in H-series engine.

The graph mentioned below represents that scrap obtained in each month. The scrap is reduced more in last month by implementing these ideas.

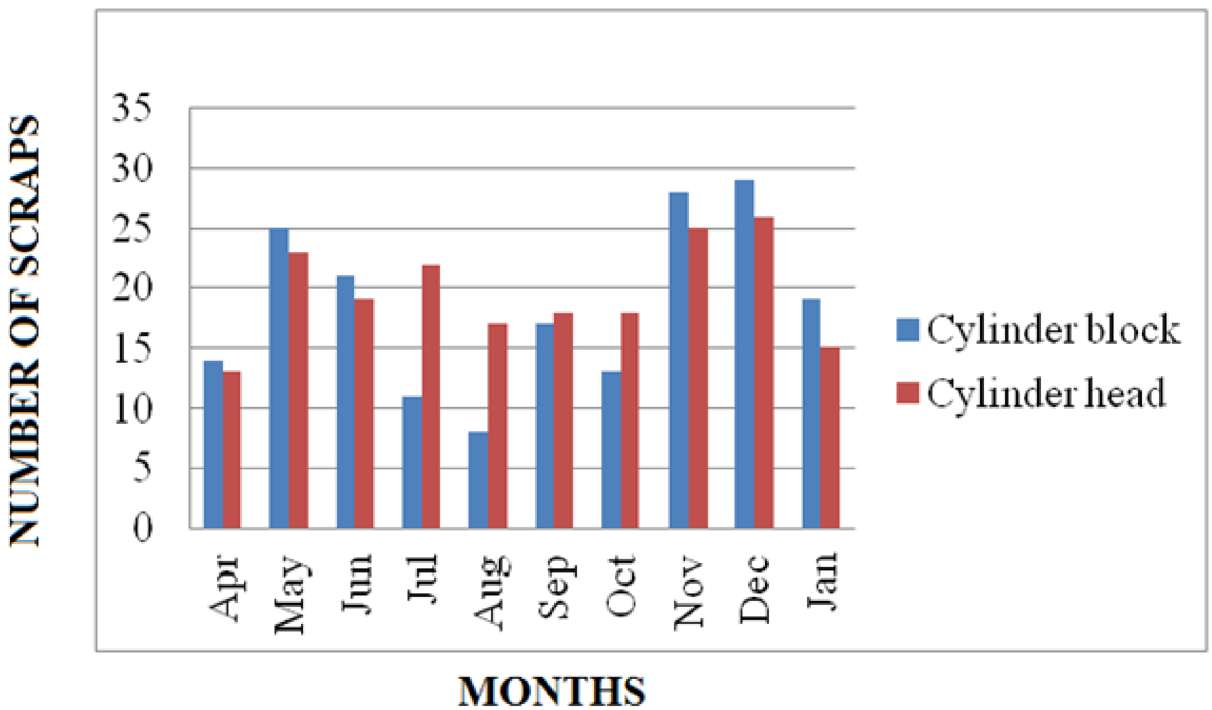


Figure 4.1 Number of scraps vs month

CHAPTER 5

CONCLUSION

The inspection fixture scrap during machining process in cylinder block in H-series engine is reduced to a considerable level. By using turn over device and pressure coolant washing burrs are eliminated. Thus reducing scrap in cylinder head to considerable level.

CHAPTER 6

SCOPE FOR FURTHER STUDY

- In H-series engine, by using the gauge in cylinder block the cam offset distance can be found out and scrap can be reduced easily.
- The implementation of gauge and fixture will reduce the scrap produce during the machining process in machine shop.
- In cylinder head, by using turn over device and pressure coolant washing before machining operation the burrs placed in the components can be removed easily.
- By implementing the turn over device and pressure coolant washing before any machining operations the burrs and small chips can be removed easily and cleaned properly.

REFERENCES

1. Badadhe A.M., Metrology and Quality Control, Pune.
2. Francis T. Farago, Mark A. Curtis, Handbook of Dimensional Measurement, Third edition.
3. Ferreira J. E., Lopes I. S., “ Improvement of Scrap Request Process with Six Sigma Methodology”.
4. Kiyoshi funtani “Heat treatment of automotive components: current status and future trends” IMST Institute, Nagoya, Aichi 467-0004 JAPAN.
5. Kalpakjian S and Schmidt S.R., “Manufacturing Engineering and Technology”,2000.
6. Mantha S.S.. “SCRAP REDUCTION BY USING TOTAL QUALITY MANAGEMENT TOOLS”, Prof. & Head, Mechanical Engg. VJTI, Matunga, Mumbai.
7. Patil R. A., Shinde V. D., “ PERFORMANCE OF HIGH PRESSURE COOLANT ON TOOL WEAR”, Associate Professor, Department of Mechanical Engineering, D.K.T.E. Society’s Textile and Engineering Institute, Ichalkaranji, Kolhapur, Maharashtra, India.
8. Raghavendra, Krishnamurthy, “Engineering Metrology and Measurements”,2013.
9. Ravindra R. Navthar “Design and Analysis of Cylinder and Cylinder head of 4-stroke SI Engine for weight reduction” Dept. of Mechanical

Engineering, P.D.V.V.P. College of Engineering, Ahamednagar, Maharashtra , India.

10. Shailesh Pachbhai S., “A Review on Design of Fixtures”, Research Scholar, Department of Mechanical Engineering, G.H.Raisoni college of Engineering, Nagpur 440016.

APPENDIX

1. Presented a project titled “Scrap reduction during machining process in H-series Engine” in National Level Technical Symposium in Mechanical Engineering at Thiagarajar College of Engineering, Madurai on 24^{th} February 2016.

2. Presented a paper titled “Scrap reduction during machining process in H-series Engine” in National Level Technical Symposium at Government College of Engineering, Salem on 1^{st} March 2016.

2. Presented a paper titled “Scrap reduction during machining process in H-series Engine” in National Level Technical Symposium at Karpagam University, Coimbatore on 1^{st} March 2016.