

Optimization of Machining Cycle Time for Cylinder Head Cover

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ABSTRACT

In the development of a high performance economic engine, a cylinder head design is required that would withstand the higher combustion pressures. The existing design of cylinder head requires long manufacturing cycle time. It is necessary to reduce solidification times without compromising the casting performance in order to reduce the cost per head. So we decided to apply the knowledge from our course study with some additional information and tried to reduce the cycle time of a cylinder head cover. This research basically works with some changes in tool combination and revising some parameters like speed, feed etc. to achieve the objectives of lowering the time for each machining processes. When a manufacturing operation time is reduced, more products are turned out in less time, increasing profit margins. The outcome of reducing cycle time includes reduction in inventory, reduction in labor costs. This research focuses on lean manufacturing and reduction of cycle time through careful analysis of every step, process, and input, thus reducing costs at every point which leads to improvements in profit margins and reduction in production cost leading to increased sales of the product. Manufacturers of engine parts should remember that customer satisfaction should not be compromised while reducing cycle time. Reduction cycle time allows salespeople to meet demands and expectations of customer.

Keywords:- Cylinder Head Cover, Cycle Time, Engine, Productivity

INTRODUCTION

Reducing a cycle time for a component is a very precise and a skill oriented work. So in this research the component is a Cylinder head cover which is made up of an aluminum pressure die casting which fits in the 3.3 liter engine of Tata motors vehicle is shown in Figure 1.

The present cycle time for the component was 15 minutes and the targeted cycle time was 13 minutes. We worked on various tool combinations like providing drill and chamfer at a same time and many more which resulted into reduction in the time for machining. Present tools used were of solid carbide and now we changed it to

Polycrystalline Diamond tools (PCD) which are diamond grit that has been fused together by the application of high pressure under high temperature in presence of a catalytic metal. Diamond is most suitable material for the cutting tools because of its properties like hardness, wear resistance and thermal conductivity.

Then we focused on CNC program correction which included minimum tool movement which helped us to reduce the cycle time. We also concentrated on parameters such as speed and feed corrections for cycle time reduction. We even added high through coolant pressure as it will ensure that the drill will remain

cool and throw the chips out of the component. We focused more on lean development and careful analysis of every

step, process, and input, thus reducing costs and time required for the cylinder head cover at each and every aspect.

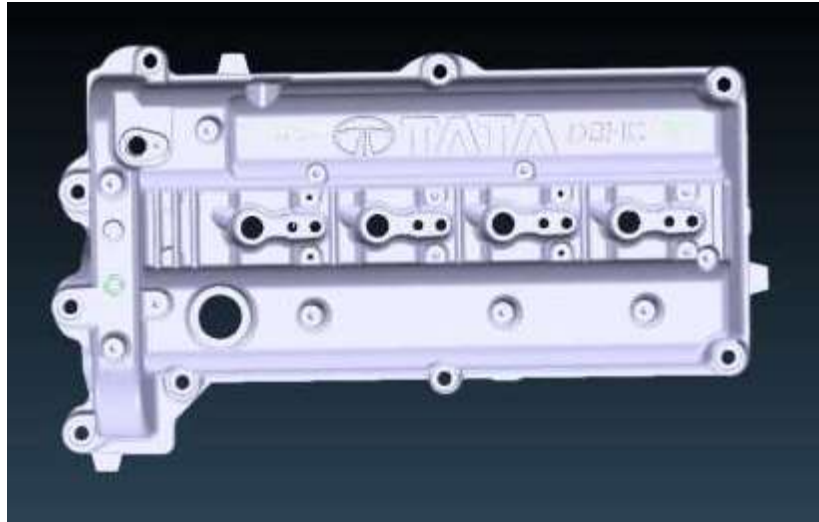


Fig.1:-Cylinder Head Cover

LITERATURE REVIEW

Brown et al. [1] discussed no cost applications for assembly line manufacturing processes cycle time reduction strategies which were applied to assembly areas of semiconductor manufacturing industries.

A study was conducted using discrete event simulation models. It was used to evaluate the current production practice of a high volume semiconductor backend operation. The objective of the study was to determine areas for productivity improvement which could result into 60% reduction in manufacturing cycle time. Simulation analysis resulted in number of recommendations for the assembly area that require no additional capital expenditure. The model studied in this research showed that cumulative impact of these assembly recommendations would be 20% reduction in average cycle time.

Lee et al. [2] investigated about the reduction of manufacturing cycle time in semiconductor fabrication line using balance control. In this paper, researcher discussed the way of determining proper

WIP level for operations, against which balance status was measured. Balance measurement was applied in mathematical modeling for bottleneck scheduling and operations management of the fabrication line. Performances were evaluated through computational experiments which showed that balance driven management leads to 15-33% more production in 21% shorter manufacturing cycle time than production driven management.

Masood et al [3] investigated about the improvement of productivity through computer integrated manufacturing. A world market has been created due to efficient transportation networks in which everyone participate on daily basis. For any country to compete in this must have companies that provide timely high quality products to customers in an economical way.

The importance of integrating product and process design is to find a production system which cannot be overemphasized. However, even once a design is finalized, industries must be willing to accommodate customers by allowing last minute design

changes without altering product quality and delaying shipping schedules. Therefore most of the U.S. based industries have to shift from conventional to computer integrated manufacturing styles to provide this flexibility in their manufacturing system.

Kumar et al. [4] discussed the problem of low productivity for Indian plywood and black board industry. The whole research work was done in two stages. During first stage a pilot survey was carried out using a questionnaire, specially designed for such industries.

During this stage some important factors responsible for high input cost and poor productivity were found. A case study on GMG Plywood's Pvt. Ltd. was done in second stage to have in depth picture of the working of the units especially with respect to work methods, processes,

productivity and quality. The total productivity index of the unit was calculated by using Financial Ratio Model as 1.0059. It was based on the data collected for financial years 2001-02, 2002-03 and 2003-04. After implementation of energy conservation and proper wood utilization techniques, total productivity index increased up to 1.1663 along with an increment of 15.95% in overall productivity of the unit.

DETAILS CYLINDER HEAD COVER

In this research our component was a cylinder head cover which was made up of an aluminum pressure die casting which fits in the 3.3 liter engine of Tata motors vehicle. The Front view, Rear view and Side view of the cylinder head cover is as shown in Figure 2, 3 and 4 respectively. The fixture for this cylinder head cover is shown in Figure 5.

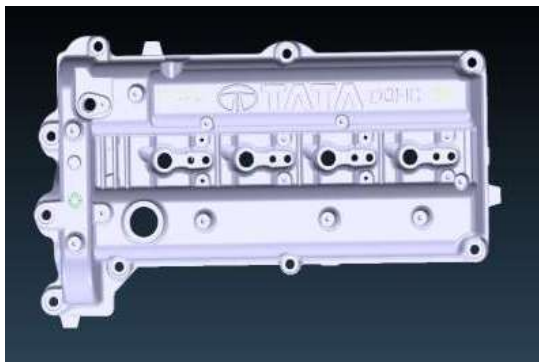


Fig.2:-Front View

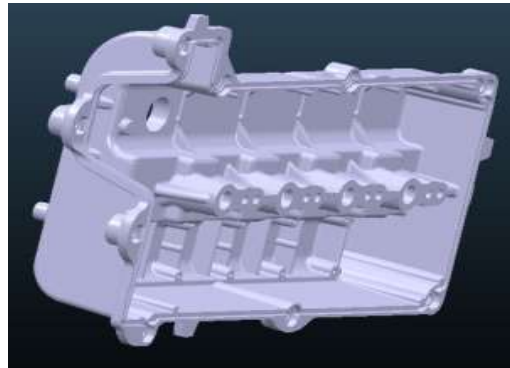


Fig.3:-Rear View



Fig.4:-Side View

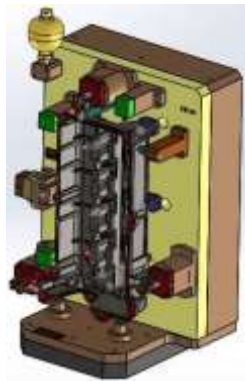


Fig.5:-Fixture containing Cylinder Head Cover

METHODOLOGY

This block diagram gives us the path way dividing it into steps as shown in Figure 6. So our aim is to reduce the cycle time by using the PCD tools by changing over the old solid carbide tools to increase the rate of production. Firstly we will recognize the problem and find the probable causes which are responsible for more time for

conducting an operation then we will shortlist the actual causes and collect the data over it. Then we will analyze the data and work on the improvement sector where the time could be reduced by designing the new PCD tools which will work in combination. Then we will again analyze the data with new tools inserted and then the result would be obtained.

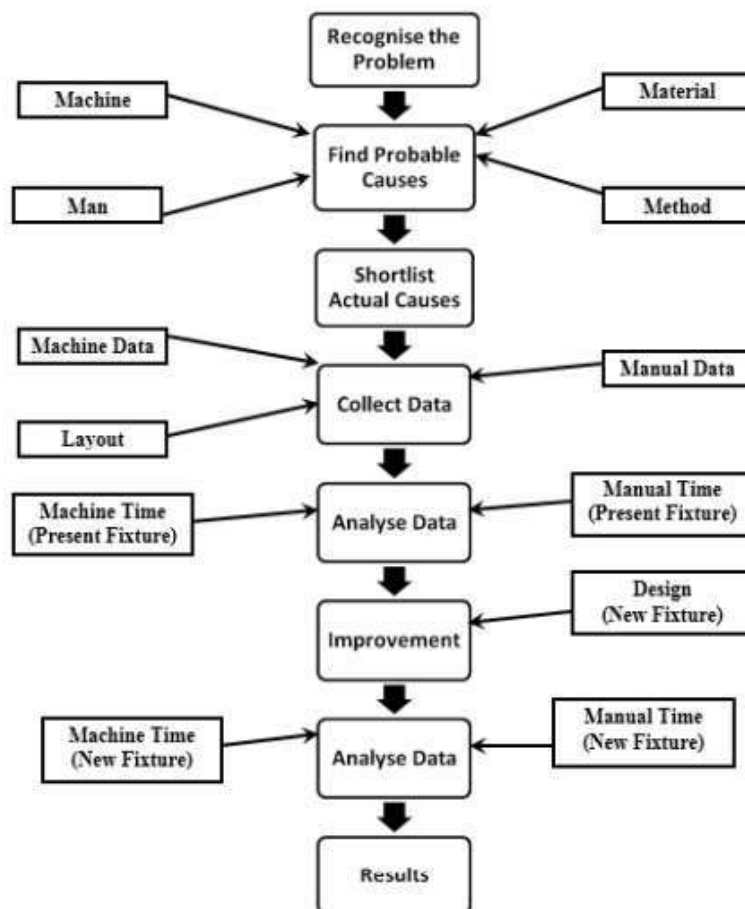


Fig.6:-Flow Chart of Cycle Time Reduction Process

COMPARISON OF DATA SHEETS BEFORE AND AFTER PROCESS OPTIMIZATION

Sr. No.	TOOL DESCRIPTION	TOTAL TIME TAKEN BEFORE USING PCD TOOLS	TOTAL TIME TAKEN AFTER USING PCD TOOLS	TOTAL TIME SAVED
Operation 1				
1	Milling Cutter Ø80	2.1	2.1	0
2	Ø15.1 X Ø21.6 Comb. Drill	0.89	0.76	0.13
3	Ø14.5 X Ø21.6 Comb. Hole Mill	0.43	0.43	0
4	Ø15H7 Reamer	0.35	0.25	0.1
5	Ø11 Three Fluted TC Drill	0.34	0.28	0.06
6	Ø12 Three Fluted TC Drill	0.34	0.28	0.06
7	Ø22.5 Cutter	0.65	0.28	0.37
8	Ø17 SC End Mill Ctr.	0.93	0.66	0.27
9	Ø5.5 Burnishing Drill	0.95	0.95	0
10	SC Chamfer Cutter	1.04	1.04	0
11	Ø50 Brazed Chamfer cutter	0.47	0.47	0
12	Back Spotface Cutter	0.79	0.79	0
13	Pre M22 Tap hole & spotface	0.16	0.16	0
Operation 2				
1	Ø7.0 Drill	0.98	0.75	0.23
2	Ø7.5 Drill	1.26	0.88	0.38
3	Ø5.5 Burnishing Drill	0.14	0.14	0
4	Ø6.5 Burnishing Drill	0.49	0.49	0
5	Comb. Cutter Ø42 & spotface	0.17	0.17	0
6	Ø18.2H9 SC Reamer	0.18	0.14	0.04
7	Ø50 Milling Cutter (Sensor Face)	0.16	0.16	0
8	Ø25 End Mill (Profile Milling)	0.60	0.46	0.14
9	160° Front Spotface Ctr.	0.43	0.43	0
TOTAL CYCLE TIME=		13.85 min	12.07 min	1.78 min

CONCLUSION

We worked on component which was a cylinder head cover made up of an aluminum pressure die casting which fits in the 3.3 liter engine of Tata Motors vehicle.

The cycle time of the component before process optimization was 13.8 minutes which is been brought to 12.07 minutes. In the machining cycle, there were total 22 operations in the machining of the

component. These operations were carried out by using various tools made from solid carbide material.

But after analyzing the data we came to know instead of using the solid carbide tools we can replace it with the polycrystalline diamond tools commonly called as PCD tools which have higher efficiency and much precise. During the optimization process it was impossible to change all the solid carbide tools with

PCD tools so we analyzed the data and designed PCD tools only for those operations which were time consuming and important. During the time of improvement we have listed out the data in a tabular form compares the data before and after process optimization and gives the required improvement in the cycle time of cylinder head cover which is been performed at Accura Tech, Kolhapur.

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