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Eliminating Chances of Fitment of Wrong Piston and Connecting Rod in Manual Conveyor by Using Poka Yoke

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ABSTRACT

This project discuss about the potential failure mode elimination of newly developed diesel engines (HCE variants) used for tractors and how to eliminate chances of model wise wrong piston-connecting rod combination. Every engine has different HP ratings, design as per requirement, which is matched by different design aspects. One of these aspects is compression ratio. Compression ratio is changed if wrong crank train component is assembled in engine. During FMEA of HCE models with CFT (Cross functional team), major concern of wrong piston & connecting rod assembly was noted due to new variety of piston & con rod introduced. Wrong combination leads to engine failure, loss in production and rework which reduce productivity of assembly line.

Keywords: piston, connecting rod, HCE model, POKA YOKE, ZEBRA ULTRA, SU Magnetic Double Acting Cylinder, Quadtech, Mechanical Stopper.

INTRODUCTION

Mahindra Tractors is an international farm equipment manufacturer and Industrial construction equipment manufacturer. In Mahindra Farm division, Nagpur Engines of 3 major families are assembled i.e. NEF (New engine family), AVL (Austria vehicle limited) & Dhruv. Due to changing emission norms there was a need to manufacture a engine with HP ratings same as Dhruv models, strong as NEF models and within cost range of AVL models (cheapest in Mahindra diesel engine variety). To develop such a engine with properties of all three existing engine families, a complete new engine family was designed for meeting requirements. Name of this newly developed engine family is HCE (Higher Compression engine). For meeting design requirements, existing parts were not capable enough for delivering favorable results. As the name HCE says higher compression engine, these engines had highest compression ratios in whole Mahindra Farm Equipment sector i.e 21.5:1. Therefore there was need f developing all components from scratch for these models. 90% of components used for assembling these engines were exclusively developed. Among these components they have develop new piston and connecting rod assemblies for 39HP, 42HP & 49HP variants. These piston and connecting rods were almost identical as there was only 10mm stroke length difference between each HP variant component. Mahindra's R&D was able to achieve milestone of developing an engine family with properties of all the three existing engine family. In the wake of these HCE variants, a pile of new components were added to Mahindra & Mahindra portfolio.

OBJECTIIVES

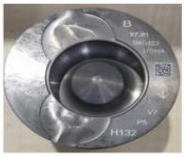
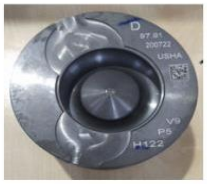
Zero chance of accident due to wrong Sub-assembly fitment of piston & connecting rod. To provide defect free product to the customer.Quality improvement. To reduce rejection of front cover sub assembly. Operator fatigue less.To avoid production loss. Cost saving by reducing rejection. First time right Quality to reduce customer irritant. Standardization of Process with reduction in rework &non value adding activity (NVA)

COMPONENTS REQUIRED

1. HCE model components

Engine Model	Image
ENG405YSL	
ENG415YSL	

2. Piston and Connecting rod

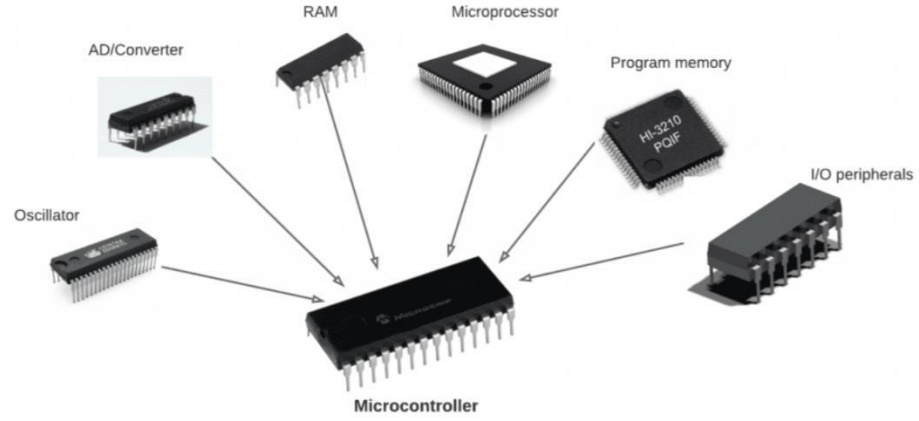
Engine Model	Piston		Connecting Rod	
	Part Number	Visual	Part Number	Visual
ENG415YSL	******229B91		******785V1	
ENG405YSL	******145B91		******467U1	

3. Zebra QR code scanner

4.Pneumatic Cylinder

5.Stainless steel Mechanical Stopper

6.Microcontroller



WORKING PRINCIPLE

The stopper will be blocking the initially. Operator has to scan to scan 11 digit engine barcode as shown above. Component numbers which need to be fitted as per combination is available in software.

After scanning engine number, software will be requiring piston and connecting rod number which is being assembled in engine, which are available in QR on components. Operator has to scan all pistons and connecting in sequence specified by the system.

If all the components are correct then the stopper will retract for 128 seconds (cycle time of operation is 115 seconds) and cylinder block will be able to move forward to next station after completing work content.

If wrong component is scanned then stopper will not retract and software will show “NOT OK” alarm on screen. After scanning correct component, the “NOTOK” dialog box will be closed and stopper will again retract.

After the dwell time of 128 seconds, stopper will again return to its initial position i.e. between the conveyor path and block it till next correct combination as per model is scanned.

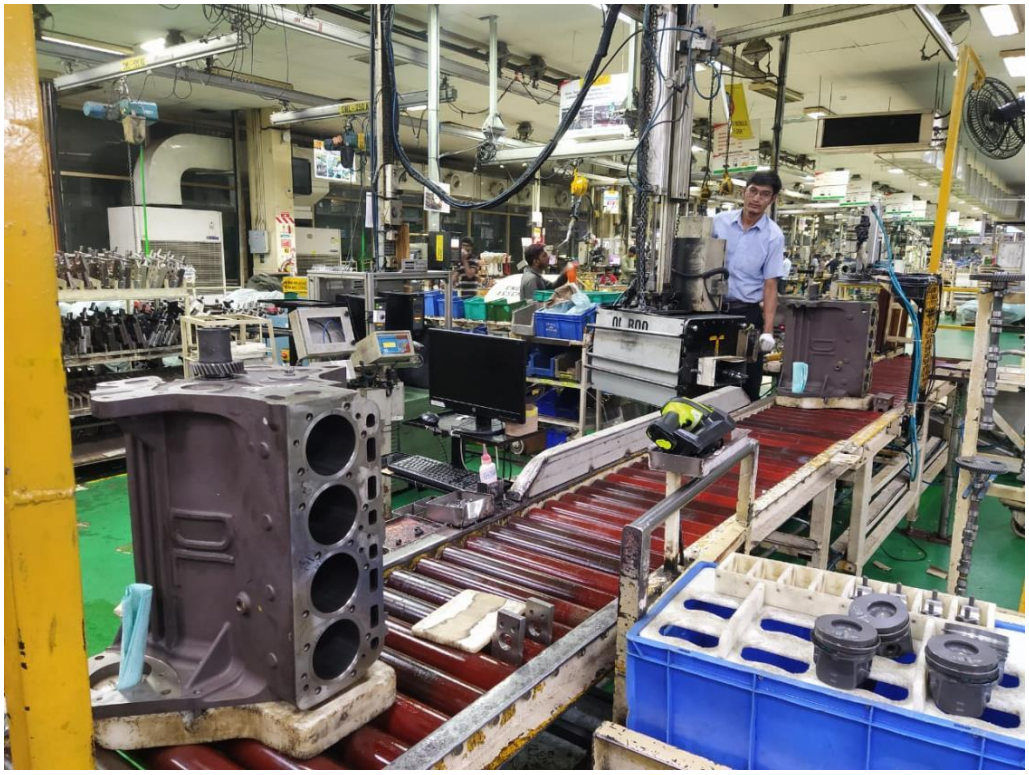


Fig:- Layout of Project

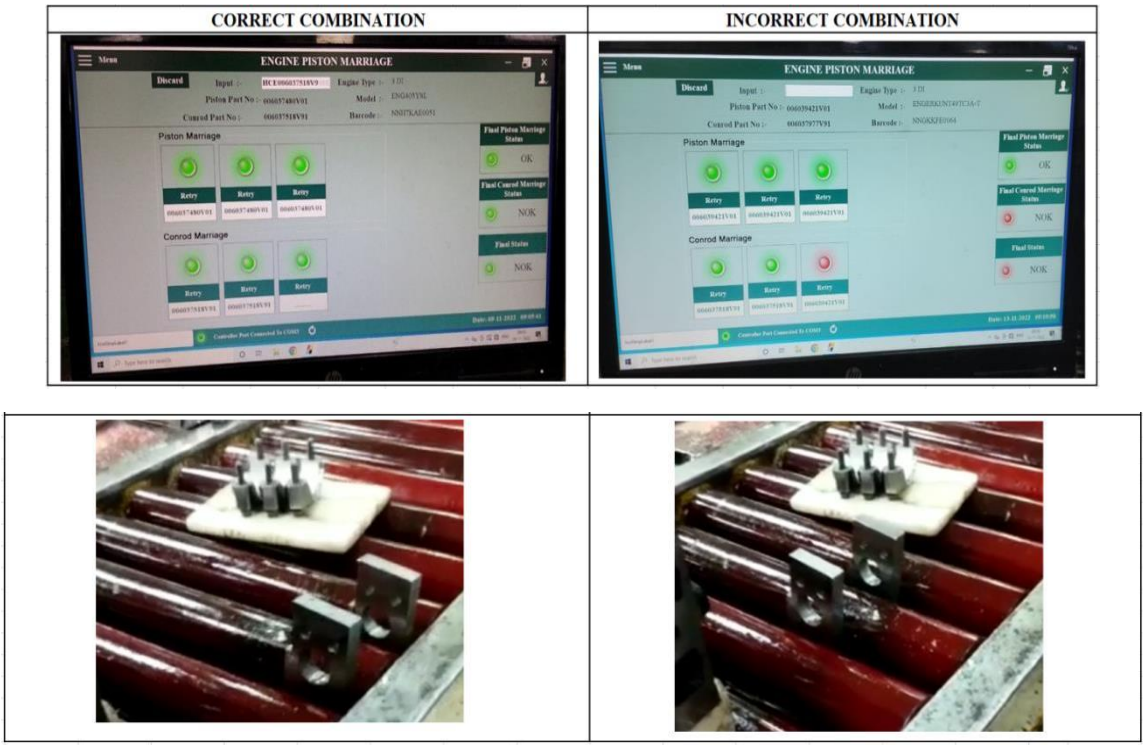


Fig:- Correct/Incorrect combination display with stopper position

RESULT AND DISSCUSSION

TRIAL OUTCOMES

Process Verification: Process validation done in two ways.

- Poison's Test: One type of audit carried at Engine assembly line, where wrong component is given at assembly station deliberately to check if Poka Yoke is working properly or not. During trails of our project, system detected all wrong components during poison test.
- Software Backup: All scanned data is stored in software logs and can be retrieved easily. Data is stored for 6 months from the date of being scanned. Weekly log data was monitored and cross verified with poison test data and numbers were 100% matching.

Process Feasibility: Cycle time reduced at stage as manual inspection has been eliminated resulting in direct fitment of sub assembly if piston and connecting rod after scanning.

- Cycle time with existing method of fitment: 150 seconds30
- Cycle time with mistake proofing system: 120 seconds

Poka Yoke Accuracy:

- Trial Taken : 150 Engines
- Wrong Combination detected by system : 150 Engines
- Crankcase blocked by stopper on conveyor : 150
- Accuracy : 100%

CONCLUSION

In this research report, we discussed about a mistake proofing system that can detect wrong component fitment on engine assembly line at source i.e. at fitment stage. This project also directly resulted in reduction in cycle time by 30 seconds at work station. This project has demonstrated the desired outcomes that we intend to achieve for our conclusion, avoiding assembly line rejection by detecting wrong component fitment at fitment stage. The scanned data is stored for 6 months ad can be retrieved whenever required.

The authors gracefully acknowledge **Prof. Vaibhav Bankar** for their guidance, support and direction.

Advantages

Benefits to the organization:

- Lower RPN rating
- Zero RPH
- Initialization of Industry 4.0 Concept
- Detection of wrong fitment at source
- First time right & Every time right approach achieved
- Less cycle time at workstation

Benefits to Team:

- Morale Boost
- Introduction and Learning of new technology

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