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REDUCTION IN ENGINE REJECTION DUE TO SMOKE AND LEAKAGE

Mr. Snehal G Sakhare
Department of mechanical, Indira college of Engineering Pune, India
* snehal.sakhare@indiraicem.ac.in

Mr. Hanumant Jagdale
Department of mechanical, Indira college of Engineering Pune, India
hanumant.jagdale@indiraicem.ac.in

Mr. Siddheshwar S Shirbhate
Department of mechanical, Indira college of Engineering Pune, India
siddheshwar.shirbhate@indiraicem.ac.in

ABSTRACT

In today's technological production environment all organizations are striving to achieve productivity enhancement to global benchmarks. So, the main objective of this project is to understand operations performed with respect to time taken in their assigned station in order to reduce the possibility of error by either combining different operations or any removing machining errors to reduce cycle time as well as manpower involved, and to reduce the engine rejection rate during testing stages by studying the root causes for the rejection. This also provided an opportunity on shop floor for better space utilization with better organized look.

The final objectives of the project include improving the current production capacity by reducing rejection rate and cycle time and hence optimizing engine performance parameter observed during testing in the coming future.

I INTRODUCTION

Assembly lines are one of the most widely used production systems. Productivity of a manufacturing system can be defined as the amount of work that can be accomplished per unit time using the available resources. Pritchard (1995) defines assembly line productivity as how well a production system uses its resources to achieve production goals at optimal costs. The conventional productivity metrics, namely throughput and utilization rate give a substantial measure of the performance of an assembly line. These two metrics alone are not adequate to completely represent the behaviour of a production system Huang et al (2003). A set of other measures such as assembly line capacity, production lead time, number of value added (VA) and non-value added (NVA) activities, work-in process, material handling, operator motion distances, line configuration and others, along with the throughput and utilization rate, completely characterize the performance of a production system. An assembly line yields optimal performance by an optimal setting of all these factors. Flexibility and agility are the key factors in developing efficient and competitive production systems. For products involving light manufacturing and assembly, this level of flexibility can be easily achieved through the use of manual assembly systems. Manual assembly lines are most common and conventional and still provide an attractive and sufficient means production for products that require fewer production steps and simple assembly processes. Global competition is forcing firms to lower production costs and at the same time improve quality with lower production lead times. The aim is to eliminate the engines getting rejected during engine test due to problems arising in the performance test and leakage testing. As there are a lot of problems arising in the test bed where the engine is tested, few of which are related to engine performance and manufacturing defects. In order to maintain the quality and reduce rejection rate at later stages; each engine has to undergo two types of testing to move forward into manufacturing stage. If the engine passes these two tests it is attached to gearbox and send for final assembly. These two tests are

1. Leakage Testing
2. Performance Testing

1.1 LEAKAGE TESTING

The leakage testing is an essential and important stage in engine assembly line. The testing is conducted to search for leakage in engine fluid flow path i.e., oil ways and waterway of the engine. This is to ensure the safety of the engine. The leak test is conducted by blocking all the waterway and oil way opening of the engine with plugs. Some of these plugs have pneumatic adapters to fill in the oil way and waterway channels with air. Once the plugs have blocked all the openings, oil way and water way channels are filled up to 0.5 bars pressure by filling compressed air one at a time. It is allowed to stay for 90 sec cycle which starts after compressed air starts filling the cavities and leak rate is determined. if it is prescribed limit engine is passed for further process or rejected if it fails The leakage in the fluid flow lines (channels) of the engine is major concern while considering the rejection rate of engine assembly line. This is done to ensure that engine with leak are identified at preliminary stage, hence reducing risk and saving precious time and efforts. Unidentified leak issue are major concern for safety and performance as hot oil or water can leak through leaks which can injure anyone or even start fire as well as affect performance of engine at various level.

- **3L Leakage testing**

The number of port in a 3L engine variant irrespective of their model and make remains constant i.e., 13 (Except for 105 Model) which comprises 10 oil way ports and 3 oil way ports (2 For 105 Model). After plugs are plugged into the ports the leakage test is conducted for cycle of 90 sec. The oil ways are tested for leakage, and engine with leakage rate greater than 15 mm^3/min are rejected. Same works for water ways, engine with leakage rate greater than 12 mm^3/min are rejected.

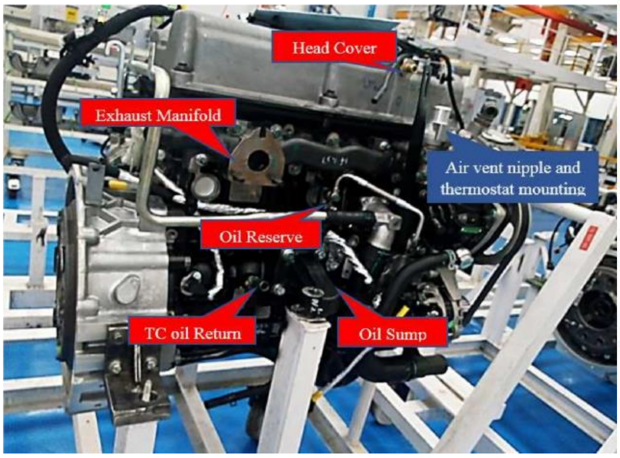

Fig 1. 3L Engine Right Side View

Fig 2. 3L Engine Left side view

- **5L Leakage testing**

The number of port in a 5L engine variant irrespective of their model and make remains constant i.e., 14 which comprises 9 oilway ports and 5 oilway ports. After plugs are plugged into the ports the leakage test is conducted for cycle of 90 sec. The oilways are tested for leakage, and engine with leakage rate greater than 50 mm3/min are rejected. Same works for water ways, engine with leakage rate greater than 20 mm3/min are rejected.

Fig 3. 5 L Left side view

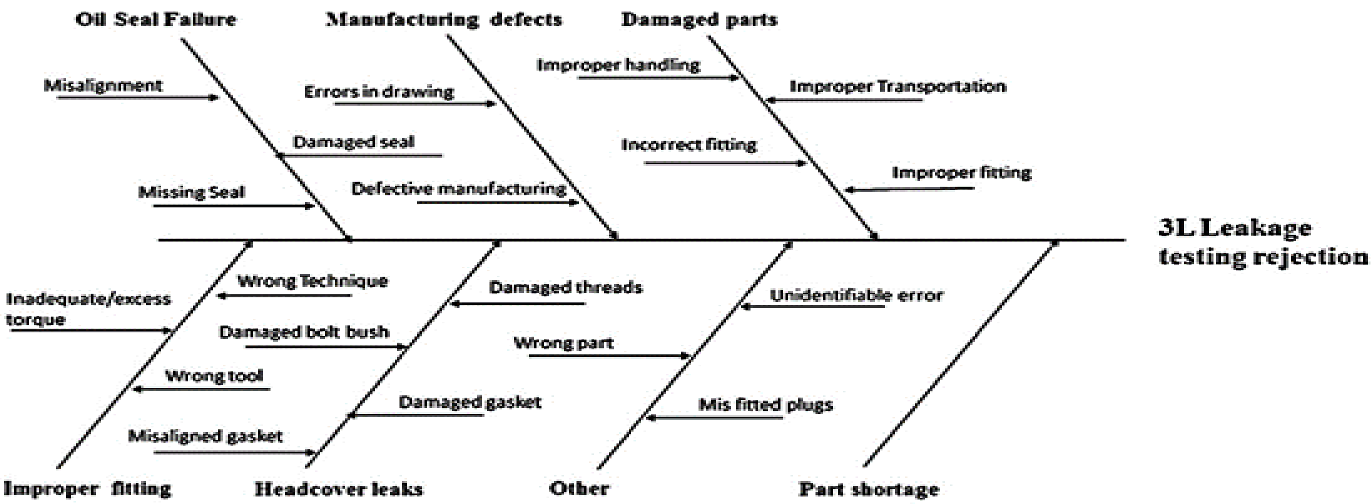

Fig 4. 3L Cause and Effect Diagram

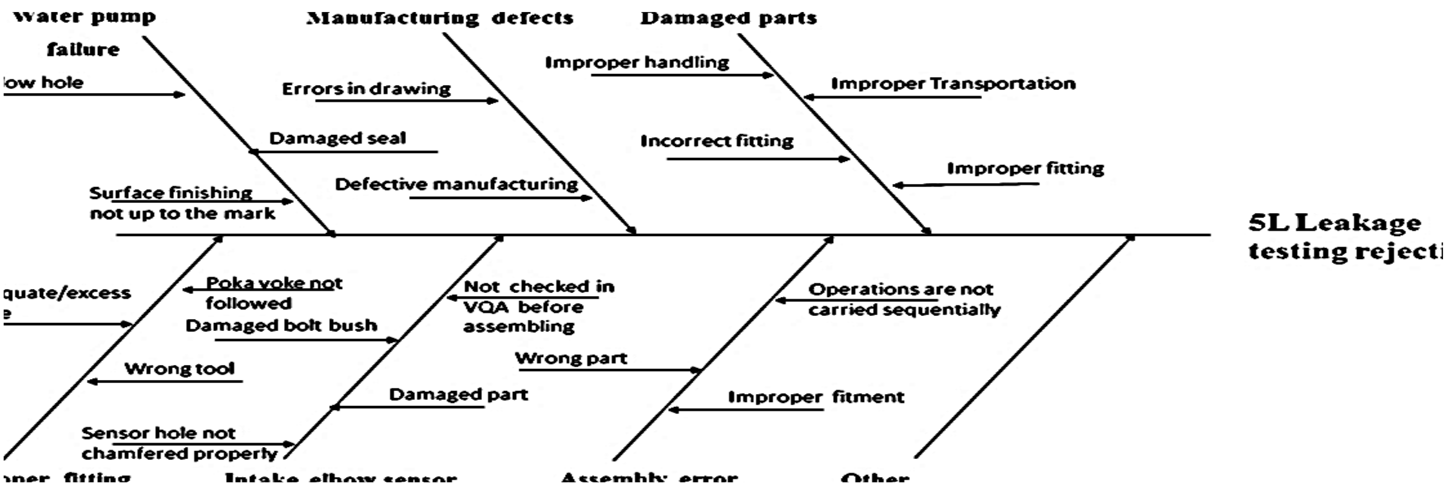

Fig 5. 5L Cause and Effect Diagram

5L Oilway Failure Modes Analysis | 3L Oilway Failure Modes Analysis

Failure modes	Reason	Solution	FAILURE MODES	REASON	SOLUTION
Dipstick leakage	Manufacturing defect , improper torque, leakage due to washer	Proper torque should be provided as mentioned, washer should be fitted properly	Oil seal Failure	Oil sealed misaligned /damaged/missing, etc.	Proper fitting of oil seal in to the groove using provided lubricant.
Intake elbow sensor leakage	Part not manufactured as per standard drawing	Pre-inspection of parts should be done as per its drawing	Manufacturing defects	Damaged parts supplied to assembly line	Pre- inspection of parts at store/sub assembly before sending to assembly.
Head cover leakage	Due to improper fitment of rubber gasket	Proper trained workers should do that fitment	Damaged parts	Improper handling and fitting of parts, damaged	Use of proper tools and torque, Pre-
OMS leakage	Manufacturing defect	Pre-inspection of parts should be done		during transit	inspection of parts.
PRV leakage	Fitment not done properly	Proper fitment should be done	Improper fitting	Inadequate torque applied or wrong method/ technique of assembly	Proper training of workers and supervision at concerned station if required.
			Headcover	Damaged bush or improper fitting.	Replacement of concerned bolts.
			Other	Misalignments, un identifiable error, etc.	Rework of engine, identification and elimination of error
			Part Shortage	Shortage of parts required	Management of production considering number of available parts.

1.2 PERFORMANCE TESTING

Performance testing is the testing which is performed to ascertain how the components of a system are performing under a particular given situation. Resource usage, scalability, and reliability of the product are also validated under this testing. Performance testing is the superset for both load & stress testing. Other types of testing included in performance testing are spike testing, volume testing, endurance testing and scalability testing. So, performance testing is basically a very wide term Performance Cause and effect diagram

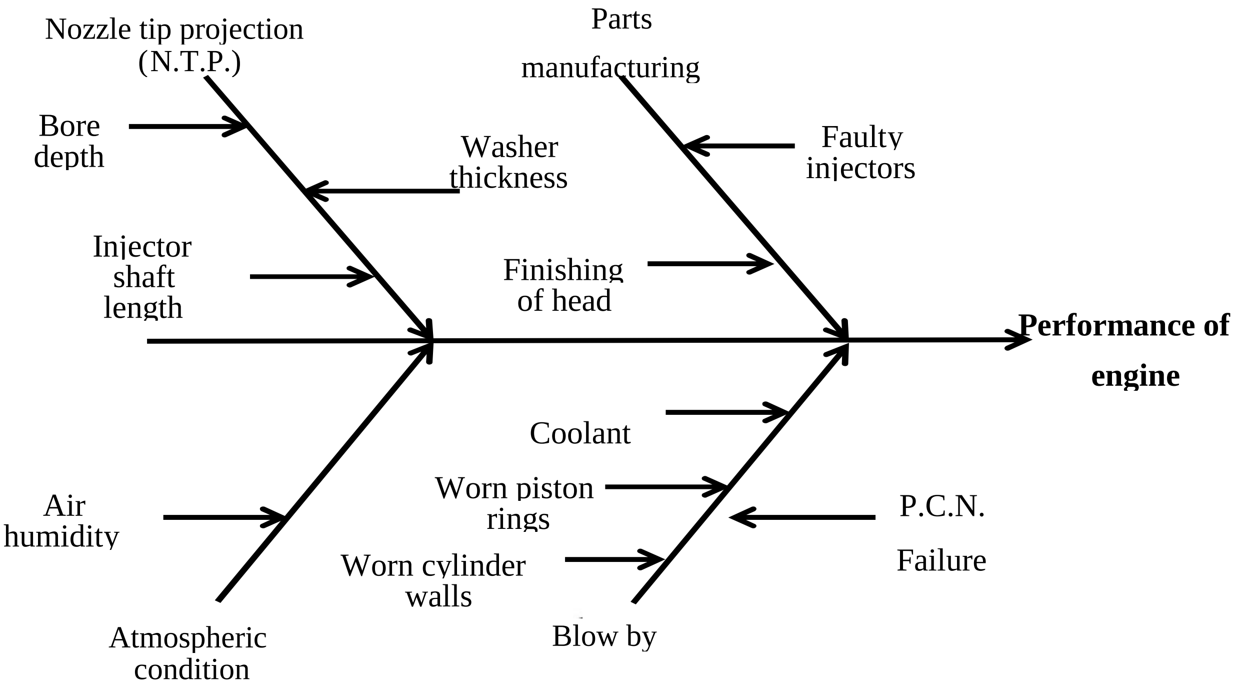

Fig 6. Performance Cause and effect diagram

Typically, the detailed design and development programme for an engine takes 3–7 years from inception to service entry. Designing 'right first time' is not practical for such a high technology product. Development comprises individual component tests followed by hundreds of hours of engine testing, based on which many design modifications are introduced. The resulting production engine standard will then comply as closely as possible with the original specification. After service entry, production acceptance or production pass off testing of each individual production engine is common practice, ensuring that it meets key acceptance criteria. This test is the final check on component manufacture and engine build quality prior to delivery to the customer.

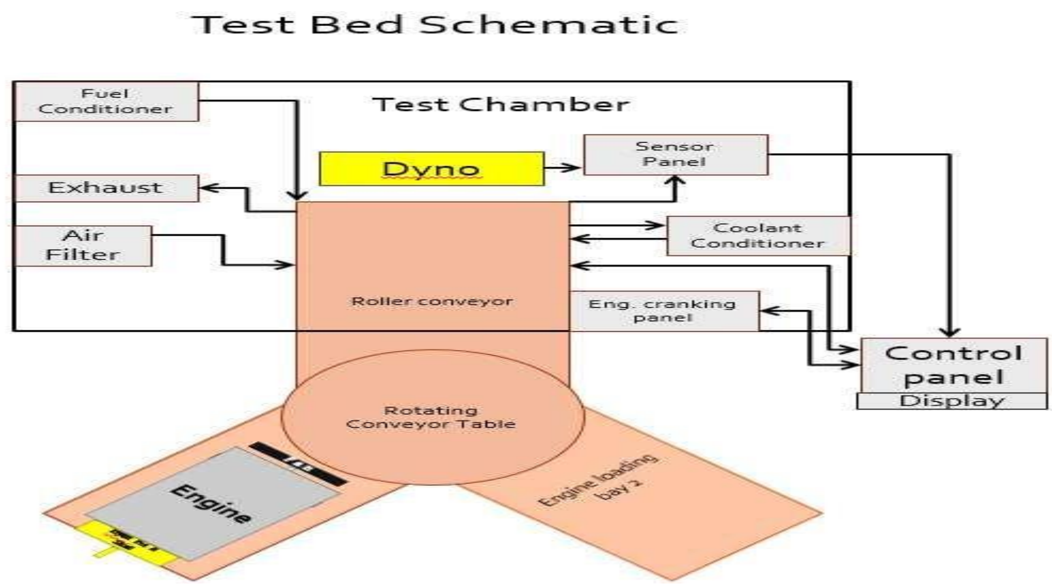

Fig 7. Test Bed Schematic

2. CONCLUSION

A comprehensive study of the newly developed engine assembly line for 3 Litre and 5 Litre CI was conducted. An extensive study of assembly line is carried for more than 700 engines in total. While audit of all engines during the period was carried for leakage testing on assembly line and performance conducted on performance bed. From this study we can conclude that,

Leakage Testing

• In 3 litre engines, there was overall rejection of 8.478% for leakage testing, of which for water ways there was about 5.2% of total rejection while for oil ways there was 94.8% of rejection rate. After taking in account the findings, necessary steps were taken resulting in reduction of overall rejection rate to 5.39%.

• In 5 litre engines, there is overall rejection of 15% for leakage testing, of which for water ways there is about 47.2% of rejection rate while for oil ways there is 52.7% of rejection rate. After taking in account the findings, necessary steps were taken resulting in reduction of overall rejection rate to 7.05%.

• Many rejections are due to human errors were eliminated by POKA-YOKE.

Nozzle Tip Projection

• Performance of engine depends on Nozzle Tip Projection which is dependent on bore depth of engine head block and shaft length of injector.

• However, no relation was found between FSN and Nozzle Tip Projection.

• Standard bore depth should be 17.1mm to 17.4mm.

Blow by

• Coolant flow is the major factor affecting blow by.

• Piston cooling nozzle working affects the blow by of the engine. Working pressure of
2.8 bar is required for proper cooling of the engine

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