International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 05 Issue: 05 | May-2018 www.irjet.net p-ISSN: 2395-0072

Research on Failure mode and effect analysis of Diesel Engine

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ABSTRACT:

Fault tree analysis is a top down, deductive failure analysis in which an undesired state of a system is analysed using Boolean logic to combine series of lower level events. This method is mainly used in fields of safety engineering and reliable engineering to understand how system can fail , to identify the best ways to reduce risk or determine the event rates of safety accident or particular system level failure .

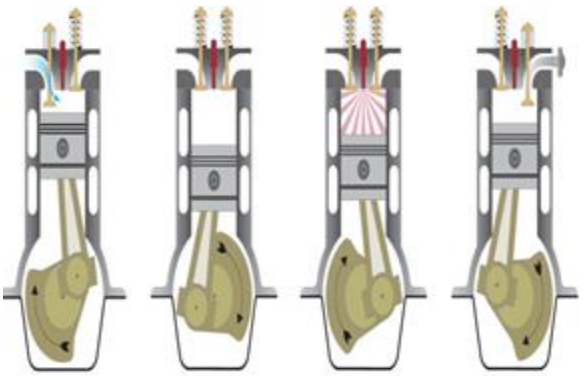
Failure mode and effect analysis is a step by step approach for identifying all possible failures in a design , a manufacturing or assembly process or a product or service . By the use of this tool we are able to identify the critical part of the system , causes of its failures . It is use to find out risk priority number and reduce the failure and increase reliability of the system . In this paper FMEA of diesel engine is done and find out the fail or critical part of the system and engine brought into operating condition.

Keywords FTA, FMEA

INTRODUCTION

Basically the diesel engine is use in various industry as well as automobiles due to its simple and economically easy to handle . Diesel engine works on four stroke cycle it consists of air intake or we can say that suction , compression , expansion and exhaust .In suction process the fresh air is intake and then compress upto its desired compression ratio so that we can get maximum power with high efficiency , as we know that the compression ratio of diesel is mainly lies between 16 to 20 and provide good efficiency .

As we can earlier discuss the use of diesel engine and due to its high efficiency it is very much required to provide good maintenance and find out the critical part of system so that use engine as long as possible with minimum cost acquired . In this paper uses two methods for evaluating the failure or critical part of the system which is known as FTA and failure mode and effect analysis that is FMEA.



a. Intake air b. Compression c. Power d. Exhaust

Figure 1. Single cylinder diesel engine

FTA

FTA is a top down analysis having a series of steps through which the causes of event are established . It provides a visual representation of how an equipment failure human error and other factors have to lead accident or event .FTA provides an effective method for evaluating risk at system level by making use various tool like probabilistic risk assessment , system reliability assessment and safety engineering which helps for quantitative determination of probability of a safety hazard . Many people and corporations are using this method on a regular basis to ensure the safety and reliability .

FMEA

The FMEA is a design tool used to systematically analyze postulated component failures and identify the resultant effects on system operations. The analysis is sometimes characterized as consisting of two sub-analyses, the first being the failure modes and effects analysis (FMEA), and the second, the criticality analysis (CA).Successful development of an FMEA requires that the analyst include all significant failure modes for each contributing element or part in the system. FMEAs can be performed at the system, subsystem, assembly, subassembly or part level.

In addition to the FMEAs done on systems to evaluate the impact lower level failures have on system operation, several other FMEAs are done. Special attention is paid to interfaces between systems and in fact at all functional interfaces. The purpose of these FMEAs is to assure that irreversible physical and/or functional damage is not propagated across the interface as a result of failures in one of the interfacing units. These analyses are done to the piece part level for the circuits that directly interface with the other units.

Benefits

Major benefits derived from a properly implemented FMEA effort are as follows:

1. It provides a documented method for selecting a design with a high probability of successful operation and safety.
2. A documented uniform method of assessing potential failure mechanisms, failure modes and their impact on system operation, resulting in a list of failure modes ranked according to the seriousness of their system impact and likelihood of occurrence.
3. Early identification of single failure points and system interface problems, which may be critical to mission success and/or safety. They also provide a method of verifying that switching between redundant elements is not jeopardized by postulated single failures.
4. An effective method for evaluating the effect of proposed changes to the design and/or operational procedures on mission success and safety.
5. A basis for in-flight troubleshooting procedures and for locating performance monitoring and fault-detection devices.
6. Criteria for early planning of tests.

History

Initially used by the U.S military after World War II as a process tool, FMEA gradually spread into industry. It became widely known within the quality community as a total quality management tool in the 1980s and as a Six Sigma tool in the 1990s. A team should apply FMEA to perform risk assessment to see what the customer will experience if a key process input (X) were to fail. The team should then take action to Minimise risk and document processes and improvement activities. FMEA is living document that should be reviewed and updated whenever the process is changed (Jogger, 2002). It can be used in the define phase of the define, measure, analyse improve and control strategy as a voice of the customer input, but is more commonly created in the measure phase, updated in the analyse and improve phases and is a vital element of the control phase. FMEA is one of the most efficient low-risk tools for prevention of problems and for identification of more efficacious solutions, in cost terms, in order to prevent such problems.

To develop the FMEA, initially was done a survey on the functions of each component, as well as on its failure modes and effects. Were been used, as support for the analysis, the system textual description, contained in the technical operation instructions, the fault registers in the abnormality cards (service orders for maintenance) of the plant, the maintenance plans currently used and the instrumentation descriptions of the equipment and components. It was also performed a brainstorming in a join into the plant operators, so that it was possible to get with more details about the description of the possible failures of each component.

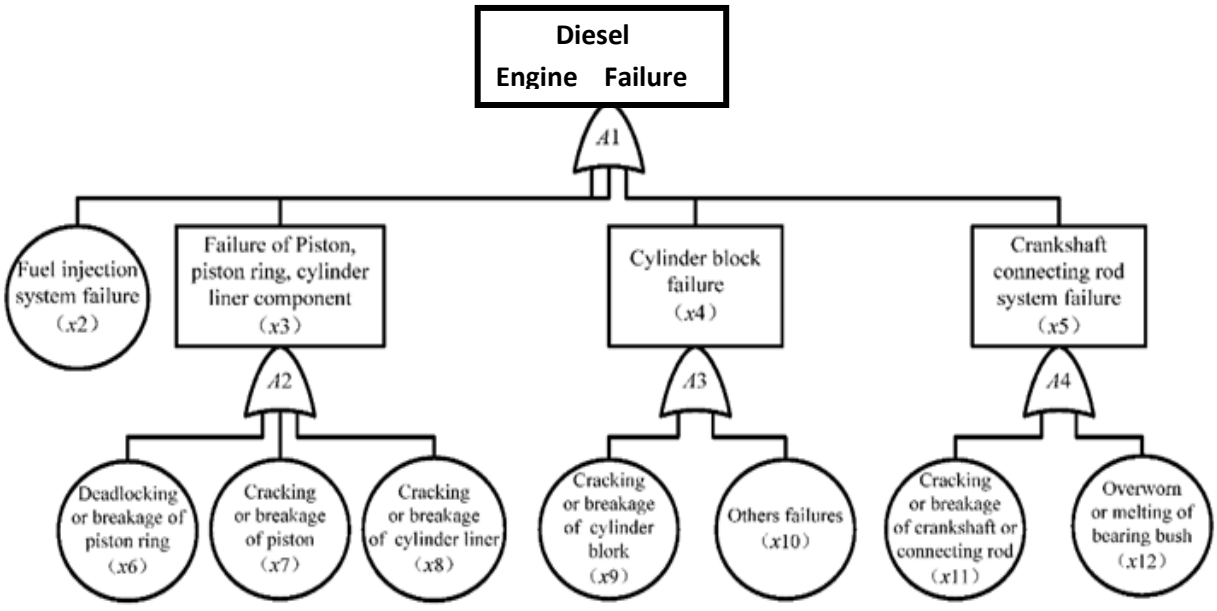
METHODOLOGY

The methodology of maintenance of diesel engine by the use of fault tree analysis and failure mode and effect analysis find out the critical part of the system and inspect the failure part of the engine **.**

Causes of engine failure

1. Due to the failure of piston and piston ring
2. Due to the failure of fuel injector
3. Due to the failure of crank shaft
4. Due to failure of gadget pin
5. Failure of cylinder head
6. Failure of cylinder valves

Effect of Severity



These are the basic failure of diesel engine and by the use of failure mode and effect analysis the criticality of the part is analyse .

Tool of FMEA for finding the critical part

Risk priority number (RPN) = Severity(S) * Occurance(O) * Detection (D)

Criteria for ranking severity	Effects	Rank
Failure occurs without warning	Deadly	10
Failure occurs with warning	Hazardous	9
Product inoperable with loss of function	Very serious	8
Product operable but loss of performance	Serious	7
Product operable but with loss of comfort	Moderate	6
Product operable with low effect on performance	Low	5
Noticeable effect by most customers	Very low	4
Noticeable effect by average customers	Minor	3
Noticeable effect by discriminating customers	Very minor	2
No effect	None	1

Chances of Occurrence

Occurrence	Failure rate	Criteria	Rank
Very high	Greater than 1in 2	Failure is almost ineriable	10,9
High	1 in 8	Repeated failures	8,7
Moderate	1 in 80	Occasional failures	6,5,4
Low	1 in 15000	Relatively few failures	3,2
Remote	1 in 1500000	Failure is unlikely	1

Ranks of Detection of failure mode

Chances of detection of failure mode	Rank
No known control available	10
Very remote chances of detection available	9
Remote chances of detection	8
Very low chances of detection	7
Low chances of detection	6
Moderate chances of detection	5
Moderately high chances of detection	4
High chances of detection	3
Very high chances of detection	2
Almost certain to detect	1

By the use of tool analysis the RPN of fuel injector

Parts	Failure mode	Effect	Causes	Severity	Occurrence	Detection	Risk priority number
Engine	Fuel injector	Engine is not started Or Performance is decreases	Dust present in the injector	8	6	5	240

As we can see that the risk priority number is greater than 100 that means it is dangerous and say that it is critical part of the engine so the recommended actions required.
Recommended actions are
Timely maintenance Cleaning of fuel injector
Fuel filter pump is used

After recommended actions RPN of fuel injector is

Severity	Occurrence	Detection	RPN
3	3	2	18

Now the RPN number is 18 which is below than critical limit so the engine as well as component is safe .

By the use of FMEA analysis the RPN of piston

Parts	Failure mode	Effect	Causes	Severity	Occurance	Detection	Risk priority number
Engine	Piston	Engine jam	Due to over heating of piston or Due to wear out of piston ring	8	6	4	192

As we can see that the risk priority number is greater than 100 that means it is dangerous and say that it is critical part of the engine so the recommended actions required .
Recommended actions are
Timely maintenance
Use good quality lubricant
Use coolant for removing exceeding heat

After recommended actions RPN of PISTON is

Severity	Occurrence	Detection	RPN
4	3	2	24

Now the RPN number is 24 which is below than critical limit so the engine as well as component is safe .

CONCLUSIONS

In this paper failure mode and effect analysis and fault tree analysis its history , and benefits are discussed and the failure part and the basic reason of failure and the factors of failure are discussed. By the use of FMEA , the failure part ,causes , mode , and their effect are discussed and severity rank and occurrence of failure , detection rank and risk priority number is calculated .

And after calculating the risk priority number if find out the number is greater than 100 then it is a serious problem for us so recommended the important actions which should be taken for increasing the life of the part as well as the whole engine and increase the reliability of the component.

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