

International Journal of Education and Science Research

Review

December- 2016

E-ISSN 2348-6457 P-ISSN 2348-1817 Email- editor@ijesrr.org

APPEARANCE ACTIONS FOR FOUR CYLINDER DIESEL ENGINE BY EMPLOYING ALGEBRA OF LOGICS

Shobhit Sharma	Dr. S.B. Gupta
Research Scholar	Supervisor
Mewar University	Mewar University
Rajastan	Rajasthan

ABSTRACT: Dependability reliability as such is not new; engineers have always striven to operate systems that are relatively free from failures. Generally reliability has been achieved from the subjective and qualitative experience of design and operation. The skeptics of modern reliability evaluation techniques often reject to this method of assessing the reliability of a system as engineering judgment. It is fallacy; however, to suggest that engineering judgment is displaced by quantitative reliability evaluation since as much engineering judgment is required in its use. In addition to provide a set of numerical indices, reliability evaluation can be used to indicate how a system may fail, the consequences of failures and also to provide information to enable engineers and managers to relate the quality of their system to economics and capital investment. In doing so, it can lead to better and more economics designs and a much improved knowledge of the operation and behavior of a system.

KEYWORDS: Information, economics, reliability

INTRODUCTION

An unreliable system has higher probability of failure as and when any item of the associated equipment is damaged or destroyed due to some causes. Consequently, the unreliability of the system may result into wastage of cost, time of personal as well as national security. Thus, in conclusion, a high degree of reliability is prime requirement in various practical fields e.g., nuclear power plant, space systems and defense systems etc. So, it is necessary to evaluate reliability and other performance measures in advance to avoid above mentioned losses. The previous methods of obtaining reliability have tedious calculations and are so typical. So, in this paper, the author has evaluated reliability of four cylinder diesel engine by employing the Boolean function technique which is easier in comparison of old techniques.

Fuel system, discussed here, helps to transfer the fuel from the fuel tank to the engine and regulate its flow into the cylinders depending on speed and local requirements. Here, a multi-component fuel system in diesel engine, comprising of four subsystems in series, has considered. In this system the fuel is injected into the cylinders using an injection pump and injectors. The diesel fuel from the tank is pumped to the fuel injection device. This device consists of small plunger pump operating to push the fuel through the injectors (nozzles) into the cylinders and one can operates one pump from the fuel injection pumps at the appropriate time i.e., towards the end of the compression stroke the fuel is pushed through the small hole in the injector and is atomized as it enters into the cylinder. The author, in this model, has considered a parallel redundant fuel injective device to improve the system's performance. The whole system can fail due to failure of at least one component of all the routes of flow.

Boolean function technique has used to formulate and solve the mathematical model. Reliability and M.T.T.F. of the considered diesel engine have been obtained to connect the model with physical situations. A numerical example and its graphical representation have been appended at last to highlight important results.

ASSUMPTIONS

Following assumptions have been considered in this paper:

- Initially, all components of the system are good.
- All the states of different components are statistically independent.
- Reliability of each component of the system is known in advance.

International Journal of Education and Science Research Review E-ISSN 2348-6457

www.ijesrr.org Volume-3, Issue-6 December- 2016 Email- editor@ijesrr.org P-ISSN 2348-1817

- The diesel engine as a whole can fail, if at least one component in all the routes of flow fails.
- Transition from one component to other is hundred percent reliable.
- Each component of the system remains either in good or in bad state.
- There is no repair facility available.
- Failure times of all the components of the system are arbitrary.

FORMULATION OF MATHEMATICAL MODEL

Using Boolean function technique, the conditions of capability of the successful operation of the diesel engine in terms of logical matrix are expressed as:

$$D(x_1, x_2 - -, x_8) = \begin{vmatrix} x_1 & x_2 & x_3 & x_5 \\ x_1 & x_2 & x_3 & x_6 \\ x_1 & x_2 & x_3 & x_7 \\ x_1 & x_2 & x_3 & x_8 \\ x_1 & x_2 & x_4 & x_5 \\ x_1 & x_2 & x_4 & x_6 \\ x_1 & x_2 & x_4 & x_7 \\ x_1 & x_2 & x_4 & x_8 \end{vmatrix} \dots (1)$$

SOLUTION OF THE MODEL

By making use of algebra of logic, we may rewrite equation (1) as: $D(x_1, x_2 - -, x_8) = |x_1 \ x_2 \wedge d(x_1, x_2 - - - x_8)|$...(2) where,

$d(x_{1}, x_{2} x_{8}) = \begin{vmatrix} x_{3} \\ x_{3} \\ x_{3} \\ x_{4} \\ x_{4} \\ x_{4} \\ x_{4} \\ x_{4} \end{vmatrix}$	x_3	x_5		
	<i>x</i> ₃	x_6		
	<i>x</i> ₃	x_7		
	<i>x</i> ₃	x_8		(3)
	$-x_4$	x_5		
	<i>x</i> ₄	x_6		
	<i>x</i> ₄	x_7		
	x_8			
Substituting				
$A_1 = \begin{vmatrix} x_3 & x_5 \end{vmatrix}$				(4)
$A_2 = \begin{vmatrix} x_3 & x_6 \end{vmatrix}$				(5)
$A_3 = \begin{vmatrix} x_3 & x_7 \end{vmatrix}$				(6)
$A_4 = \begin{vmatrix} x_3 & x_8 \end{vmatrix}$				(7)
$A_5 = \begin{vmatrix} x_4 & x_5 \end{vmatrix}$				(8)
$A_6 = \begin{vmatrix} x_4 & x_6 \end{vmatrix}$				(9)
$A_7 = \begin{vmatrix} x_4 & x_7 \end{vmatrix}$				(10)
and $A_8 = x_4 \ x_8 $				(11)

Copyright@ijesrr.org

International Journal of Education and Science Research ReviewE-ISSN 2348-6457www.ijesrr.orgVolume-3, Issue-6December- 2016Email- editor@ijesrr.orgP-ISSN 2348-1817these values in equation (3), one obtains:

$$d(x_1, x_2, -----x_8) = \begin{vmatrix} A_1 \\ A_2 \\ A_3 \\ A_4 \\ A_5 \\ A_6 \\ A_7 \\ A_8 \end{vmatrix} \qquad \dots (12)$$

Using orthogonalisation algorithm, equation (12) may be written as:

$$d(x_{1}, x_{2}, ----x_{8}) = \begin{vmatrix} A_{1} & A_{2} & A_{3} \\ A_{1}' & A_{2}' & A_{3} & A_{4} \\ A_{1}' & A_{2}' & A_{3}' & A_{4} & A_{5} \\ A_{1}' & A_{2}' & A_{3}' & A_{4}' & A_{5} & A_{6} \\ A_{1}' & A_{2}' & A_{3}' & A_{4}' & A_{5}' & A_{6} \\ A_{1}' & A_{2}' & A_{3}' & A_{4}' & A_{5}' & A_{6}' & A_{7} \\ A_{1}' & A_{2}' & A_{3}' & A_{4}' & A_{5}' & A_{6}' & A_{7} \\ A_{1}' & A_{2}' & A_{3}' & A_{4}' & A_{5}' & A_{6}' & A_{7}' & A_{8} \end{vmatrix}$$
 ...(13)

Now, we have

$$A'_{i} = \begin{vmatrix} x'_{3} \\ x_{3} & x'_{i+4} \end{vmatrix} ; i=1,2,3 \text{ and } 4 \qquad \dots(14)$$
$$A'_{i} = \begin{vmatrix} x'_{4} \\ x'_{4} \end{vmatrix} ; j=5,6,7 \text{ and } 8 \qquad \dots(15)$$

$$A_{j} = \begin{vmatrix} x_{4} & x_{j}' \end{vmatrix}$$
; $j = 3, 0, 7$ and 8

Using algebra of logic, one can obtain the following results:

$$A_1' A_2 = \begin{vmatrix} x_3' \\ x_3 & x_5 \end{vmatrix} \wedge \begin{vmatrix} x_3 & x_6 \end{vmatrix} = \begin{vmatrix} x_3 & x_5' & x_6 \end{vmatrix} \qquad \dots (16)$$

Similarly, we get

$$A'_{1} A'_{2} A_{3} = \begin{vmatrix} x_{3} & x'_{5} & x'_{6} & x_{7} \end{vmatrix}$$
 ...(17)

$$A'_{1} A'_{2} A'_{3} A_{4} = \begin{vmatrix} x_{3} & x'_{5} & x'_{6} & x'_{7} & x_{8} \end{vmatrix}$$
 ...(18)

$$A_1' A_2' A_3' A_4' A_5 = \begin{vmatrix} x_3' & x_4 & x_5 \end{vmatrix} \qquad \dots (19)$$

$$A_1' A_2' A_3' A_4' A_5' A_6 = \begin{vmatrix} x_3' & x_4 & x_5' & x_6 \end{vmatrix} \qquad \dots (20)$$

$$A_1' A_2' A_3' A_4' A_5' A_6' A_7 = \begin{vmatrix} x_3' & x_4 & x_5' & x_6' & x_7 \end{vmatrix} \qquad \dots (21)$$

$$A_{1}' A_{2}' A_{3}' A_{4}' A_{5}' A_{6}' A_{7}' A_{8} = \begin{vmatrix} x_{3}' & x_{4} & x_{5}' & x_{6}' & x_{7}' & x_{8} \end{vmatrix} \qquad \dots (22)$$

Using the equations (16) through (22), equation (13) becomes

$$d(x_{1}, x_{2}, ---, x_{8}) = \begin{vmatrix} x_{3} & x_{5} & x_{6} \\ x_{3} & x_{5}' & x_{6} & x_{7} \\ x_{3} & x_{5}' & x_{6}' & x_{7} \\ x_{3} & x_{4}' & x_{5} & x_{6} \\ x_{3}' & x_{4} & x_{5}' & x_{6} \\ x_{3}' & x_{4} & x_{5}' & x_{6}' & x_{7} \\ x_{3}' & x_{4} & x_{5}' & x_{6}' & x_{7} \\ x_{3}' & x_{4} & x_{5}' & x_{6}' & x_{7}' & x_{8} \end{vmatrix} \qquad \dots (23)$$

By making use of equation (23) equation (2) gives:

$$D(x_{1}, x_{2}, ---, x_{8}) = \begin{vmatrix} x_{1} & x_{2} & x_{3} & x_{5} & x_{6} & x_{7} \\ x_{1} & x_{2} & x_{3} & x_{5}' & x_{6}' & x_{7} & x_{8} \\ x_{1} & x_{2} & x_{3} & x_{5}' & x_{6}' & x_{7}' & x_{8} \\ x_{1} & x_{2} & x_{3}' & x_{4} & x_{5}' & x_{6} & x_{7} & x_{8} \\ x_{1} & x_{2} & x_{3}' & x_{4} & x_{5}' & x_{6} & x_{7} & x_{8} \\ x_{1} & x_{2} & x_{3}' & x_{4} & x_{5}' & x_{6} & x_{7} & x_{8} \\ x_{1} & x_{2} & x_{3}' & x_{4} & x_{5}' & x_{6} & x_{7} & x_{8} \\ x_{1} & x_{2} & x_{3}' & x_{4} & x_{5}' & x_{6} & x_{7} & x_{8} \end{vmatrix} \qquad \dots (24)$$

Since, R.H.S. of equation (24) is disjunction of pair-wise disjoint conjunctions, therefore, reliability of considered diesel engine will be:

$$R_{s} = P_{r} \{D(x_{1}, x_{2}, ---x_{8}) = 1\}$$

$$= R_{1}R_{2}[R_{3}R_{5} + Q_{5}R_{3}R_{6} + Q_{5}Q_{6}R_{3}R_{7} + Q_{5}Q_{6}Q_{7}R_{3}R_{8} + Q_{3}R_{4}R_{5} + Q_{3}Q_{5}R_{4}R_{6}$$

$$+ Q_{3}Q_{5}Q_{6}R_{4}R_{7} + Q_{3}Q_{5}Q_{6}Q_{7}R_{4}R_{8}$$

$$= R_{1}R_{2}[R_{3}R_{5} + R_{3}R_{6} + R_{3}R_{7} + R_{3}R_{5}R_{6}R_{7} + R_{3}R_{8} + R_{3}R_{5}R_{6}R_{8} + R_{3}R_{6}R_{7}R_{8}$$

$$+ R_{3}R_{5}R_{7}R_{8} + R_{4}R_{5} + R_{4}R_{6} + R_{3}R_{4}R_{5}R_{6} + R_{4}R_{7} + R_{3}R_{4}R_{5}R_{7} + R_{4}R_{5}R_{6}R_{7}$$

$$+ R_{3}R_{4}R_{6}R_{7} + R_{4}R_{8} + R_{3}R_{4}R_{5}R_{6}R_{7}R_{8} + R_{3}R_{4}R_{5}R_{8} + R_{3}R_{4}R_{5}R_{6}R_{7} + R_{4}R_{8}R_{7}R_{8} + R_{4}R_{5}R_{6}R_{7}R_{8} + R_{3}R_{4}R_{5}R_{8} + R_{3}R_{4}R_{6}R_{8} + R_{3}R_{4}R_{7}R_{8} + R_{4}R_{5}R_{6}R_{8} + R_{4}R_{5}R_{6}R_{7}R_{8} + R_{4}R_{5}R_{7}R_{8} - R_{3}R_{5}R_{6} - R_{3}R_{5}R_{7} - R_{3}R_{6}R_{7} - R_{3}R_{5}R_{8} - R_{3}R_{6}R_{8} - R_{3}R_{7}R_{8}$$

$$- R_{3}R_{5}R_{6}R_{7}R_{8} - R_{3}R_{4}R_{5} - R_{3}R_{4}R_{6} - R_{3}R_{5}R_{6} - R_{3}R_{4}R_{7} - R_{4}R_{5}R_{7} - R_{4}R_{6}R_{7} - R_{3}R_{4}R_{5}R_{6}R_{7}$$

$$- R_{3}R_{4}R_{8} - R_{4}R_{5}R_{8} - R_{4}R_{6}R_{8} - R_{4}R_{7}R_{8} - R_{3}R_{4}R_{5}R_{6}R_{8} - R_{3}R_{4}R_{6}R_{7}R_{8}$$

$$- R_{3}R_{4}R_{5}R_{7}R_{8} - R_{4}R_{5}R_{6}R_{7}R_{8}] \qquad \dots (25)$$
where, $R_{i}(i = 1, 2, -8)$ and $Q_{i}(i = 1, 2, -8)$ are reliability and unreliability of the componentiability and unreliability of the componentiability of the componentiability of the componentiability of the componentiability and unreliability of the componentiability of the componentiability of the componentiability and unreliability of the componentiability of the componentiability of the componentiability of the componentiability and unreliability of the componentiability and unreliability of the componentiability of the componentiability and unreliability of the componentiability and unreliability of the componentiability and

where, R_i (i = 1, 2 - -8) and Q_i (i = 1, 2 - -8) are reliability and unreliability of the components of diesel engine corresponding to the states x_i (i = 1, 2 - -8), respectively.

CONCLUSION

The author's idea is to taking one parallel redundant fuel injective device to improve system's performance. Reliability of the whole system has been computed in three different cases. M.T.T.F. for the system has been obtained in case failures follow exponential time distribution. A numerical example together with its graphical illustration has also been appended at the last to highlight important results of the study.

International Journal of Education and Science Research Review E-ISSN 2348-6457

www.ijesrr.org Volume-3, Issue-6 December- 2016 Email- editor@ijesrr.org P-ISSN 2348-1817

REFERENCES

- 1. Aminto, R.; Allan, R.: "Reliability evaluation of engineering systems: Concepts and techniques", Springer publication, (2011).
- 2. Capasso, V.; Bakstein, D.: "An introduction to continuous-time stochastic processes: Theory, models and applications", Birkhauser publication, (2013).
- 3. Wing, B.S.: "Quality control, reliability and engineering design", Marcel Dekker, (2007).
- 4. Billinton, R.; Allan, R.: "Reliability evaluation of power systems", Springer publication, (2009).
- 5. Yang, S.D.: "Reliability in computer system design", Intellect Books, (2011).
- 6. Dhillon, B.S.: "Reliability, Quality and safety engineers", Taylor & Francis, (2012).
- 7. Degarmo, E.; Black, J.T; Ronald, A.: "Materials and Processes in manufacturing", Prentice Hall of India (2010).