Comparative Analysis of Two Reliability Models Consisting of Low-Pressure Boilers as Cold Standby Units

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- *Abstract*— **The progression of any industry cannot be achieved until and unless one system is compared with another system. The present paper deals with the comparative analysis of two reliability models consisting of low-pressure boilers as cold standby units. First system comprises of one high pressure boiler and a standby system of two low pressure boilers while on the other hand, the second system comprises of one high pressure boiler and a cold standby system of three low pressure boilers. The cold standby unit comprising of low-pressure boilers is being used to accommodate the job of main high-pressure boiler and in such a case, all low-pressure boilers work simultaneously under the breakdown of one high pressure boiler. The repairman is always available to repair under any breakdown and the repair is done on First-cum-First-serve basis. Various system effectiveness measures are computed and the comparative analysis is carried out using Semi Markov process and Regenerative point technique. Graphical study has also been done for the system.**

- *Index Terms* — **Standby systems; Semi Markov process; Regenerative point technique.**

I.INTRODUCTION

The power system comprises of many components, out of which boiler is a significant one. The main principle of a boiler is to bring out steam by applying heat energy to water. Standby components play a vital role for increasing reliability and efficiency of any system.

The study of standby systems has been extensively done by researchers [1-15] in the field of reliability engineering. Reliability modelling and profit analysis of industrial systems has been done by researchers considering different operational circumstances. Davis [1] discussed goodness of fit test and rate of failure with various failure distributions. Epstein and Sobel [3] analysed the field of life testing with exponential distribution. Similarly, researchers have contributed considerably in the field of reliability and life testing. In the present study, the performance of a high-pressure boiler with its cold standby unit along with three fans is being studied.

The first system comprises of one main high-pressure boiler, a cold standby unit which consists of two low pressure boilers. While on the other hand, the second system comprises of one main high-pressure boiler and a cold standby system which consists of three low pressure boilers. A single repairman is available for the repair of any of the component of the system and the repair is done on First-cum-First-serve basis. The system fails completely if any of main high-pressure boiler and any of the low-pressure boilers comes at halt. System effectiveness measures for both models have been evaluated using Semi Markov process and Regenerative point technique in reference 10 and 11.

However, no reliability model is perfect in every sense. A model may perform better in some circumstances and less in other circumstances. Therefore, there is a dire need to study the comparative analysis in order to understand which model performs better under a situation.

II.COMPARATIVE ANALYSIS OF MODELS DISCUSSED IN REFERENCE 10 AND REFERENCE 11

The comparative analysis has been carried out for the same particular cases discussed in referred papers for the concerned models. For the economic comparison of these two models, graphical study has been done and valid conclusions have also been drawn to arrive at a decision when to use which model.

Let $P_{3.1}$ be the profit of model 1 and $P_{3.2}$ be the profit of model 2, and the difference between the models thus denoted by ($P_{3.1}$-$P_{3.2}$). Table 1 shows the profit $P_{3.1}$ of model 1, Table 2 shows the profit $P_{3.2}$ of model 2 and the difference of profits ($P_{3.1}$-$P_{3.2}$) with respect to rate of failure of high-pressure boiler i.e. Main unit (λ) for different values of rate of failure of one low pressure boiler i.e. 1st standby unit (λ_1) has been shown by Table 3 and the corresponding graphical study is shown by Fig.1.

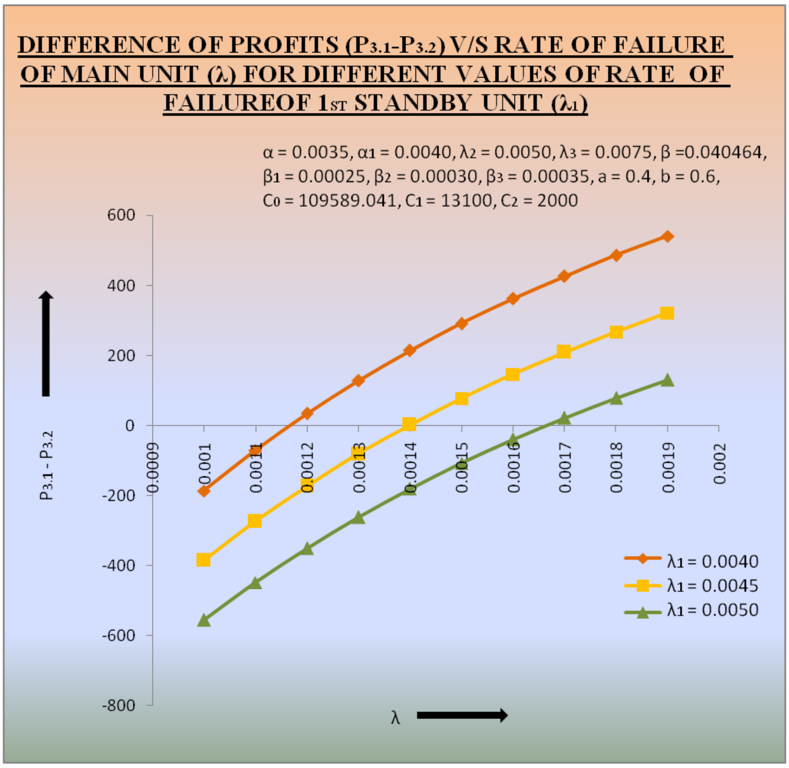

Fig 1

From the Fig. 1, it can be concluded that:
(i) The difference between Profits ($P_{3.1} - P_{3.2}$) rises as the rate of failure of high-pressure boiler (λ) increases. However, the difference decreases with rise in failure rate of 1st standby low-pressure boiler (λ_1).

(ii) For $\lambda_1 = 0.0040$, ($P_{3.1} - P_{3.2}$) > or = or < 0 according as λ > or = or < 0.012. Therefore, 1st Model is better or worse than the 2nd Model if λ > or < 0.012. Both the models are equivalent at $\lambda = 0.012$.

(iii) For $\lambda_1 = 0.0045$, ($P_{3.1} - P_{3.2}$) > or = or < 0 according as λ > or = or < 0.012. Therefore, 1st Model is better or worse than the 2nd Model if λ > or < 0.014. Both the models are equivalent at $\lambda = 0.014$.

(iv) For $\lambda_1 = 0.0050$, ($P_{3.1} - P_{3.2}$) > or = or < 0 according as λ > or = or < 0.012. Therefore, 1st Model is better or worse than the 2nd Model if λ > or < 0.017. Both the models are equivalent at $\lambda = 0.017$.

Another comparative study has been shown by Fig. 2 which reveals the Difference of Profits ($P_{3.1}$-$P_{3.2}$) with respect to Revenue per unit uptime of the system (C_0) for varying values of failure rate of high-pressure boiler (λ).

From the Fig. 1, it can be concluded that:
(i) The difference between Profits ($P_{3.1} - P_{3.2}$) falls as the Revenue per unit uptime of the system (C_0) rises. However, the difference rises with increase in failure rate of main high-pressure boiler (λ).

(ii) For $\lambda = 0.0001$, ($P_{3.1} - P_{3.2}$) < or = or > 0 accordingly as C_0 < or = or > INR 36,000. Therefore,1st Model is better or worse than the 2nd Model whenever C_0 < or > INR 36,000. Both the models are equivalent at C_0 = INR 36,000.

(iii) For $\lambda = 0.0003$, ($P_{3.1} - P_{3.2}$) < or = or > 0 accordingly as C_0 < or = or > INR 46,588. Therefore,1st Model is better or worse than the 2nd Model whenever C_0 < or > INR 46,588. Both the models are equivalent at C_0 = INR 36,000.

(iv) For $\lambda = 0.0005$, ($P_{3.1} - P_{3.2}$) < or = or > 0 accordingly as C_0 < or = or > INR 62,367. Therefore,1st Model is better or worse than the 2nd Model whenever C_0 < or > INR 62,367. Both the models are equivalent at C_0 = INR 36,000.

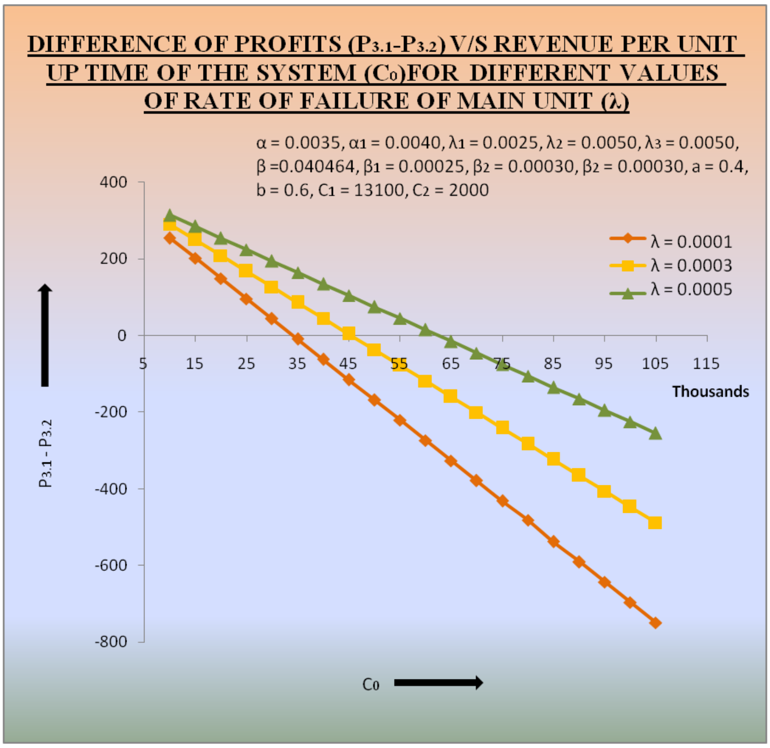

Fig 2.

III.CONCLUSION

Comparative analysis for two industrial systems has been done in the present paper. In any industrial system, cost remains a very crucial factor and in order to bring more profitable system, such analysis help to come at the conclusion that under a particular circumstance, which system can be used. The cut-off points using regenerative point technique have been evaluated and other factors can also be calculated by the users of the system in the similar way.

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