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Reliability Analysis of Boilers

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ABSTRACT

The reliability analysis on the boiler operation was conducted in this study. The demand of the steam in process industries is increasing rapidly, and this demand can be met by increasing the capacity utilization of steam boilers. The analysis shows that the boiler is a complex and challenging system with complicated structures, including various subsystems like feedwater tank, feedwater pump, return water temperature, and fusible plug, blow off cock, ash pit, fire tubes, etc. Those are examined for failure that can lead to its maintenance forecast and performance and to analyse the reliability of the boiler operation with respect to its failure rate. In this analysis the mean time between failures, mean time to repair, failure rate, repair rate and availability indices were determined. This paper describes the application of reliability-centered maintenance methodology to the development of maintenance plan for a steam-process plant. The main objective of reliability-centered maintenance is the cost-Effective Maintenance of The Plant Components Inherent Reliability Value. Sudden failures of any power plant boiler component lead to, loss of production and high maintenance cost due to unplanned and irregular maintenance.

Keywords: Steam boilers, Reliability, Reliability Centered Maintenance(RCM), analysis, boiler, operation, failure, Critical components of boiler, Expert judgment approach, Best fit failure model.

INTRODUCTION

In India textile industries plays a vital role. India is the third biggest textile exporter in the world. The textile sector consists of many processes like spinning, weaving, knitting, dyeing, printing, finishing etc. Wet processing in textile consumes the highest thermal energy (steam power) in the plant. In process industries, generally, steam is used as a heat transfer medium. However, in most of the textile process industries, steam boilers plays a vital role. There are many failures because of the complexity of the boiler system. These lifetime distributions can be obtained from field failure data. To describe the lifetime distribution of the system, knowledge of the experts about the failures of the components and subsystems can be recorded. When experts give their opinions in decision-making, this will become expert judgment. The expert judgment method can be used to resolve the problem of the unavailability of the failure data. The index is deterministic and can only be used for maintenance efficiency management. In order to improve maintenance efficiency and to reduce maintenance costs. This paper presents a system reliability-based method to identify the most critical components of the boiler. Some of the failure modes of boiler is

1. Fire tubes are damaged due to high temperature of hot gases, corrosion due to water flows from the tubes

2. Damage of fusible plug

LITERATURE REVIEW:

One of the most significant systems in the textile sector, the steam boiler is essential to the generation and distribution of steam. Because there is a constant need for steam, PM is crucial to the efficient operation of the textile industry. Excessive PM duties might result in higher maintenance expenses, but this can be avoided with appropriate work scheduling and planning. Consequently, the steam boiler system utilized in the Indian textile sector is optimized and cost-effective maintenance and replacement decisions are made using the created RCM model. The primary goal of the suggested model is to reduce the likelihood of steam boiler component and subsystem failures while leaving the operating environment and maintenance expenses unaffected.

1.SYSTEMS SELECTION:

The preparation for a system study involves several tasks, including functional failure analysis, system description, system selection, and boundary condition definition. With numerous subsystems and components, the steam boiler system is a crucial and intricate system. The steam boiler makes sure that there is always steam available for the textile industry. Numerous boiler breakdowns can cause delays in production and cost consequences. As a result, a boiler system is chosen for examination. The preparation for a system study involves several tasks, including functional failure analysis, system description, system selection, and boundary condition definition. With numerous subsystems and components, the steam boiler system is a crucial and intricate system. The textile business is guaranteed to have a steam boiler.

2.DEFINING SYSTEM BOUNDRY CONDITIONS :

Following system selection, the various subsystems and system components were defined to study the boundary conditions. To pinpoint the key parts and subsystems that contribute to significant failures and maintenance expenses, it is critical to establish clear system boundaries. As a result, the boiler system is broken down into nine distinct subsystems and approximately 45 components for analysis.

3.FAILURE AND REPAIR DATA:

Maintenance history cards, life tests, and expert opinion methods can be used to gather field failure and repair data for equipment importance analysis. The lack of maintenance history cards in many businesses meant that actual failure and repair data was not easily accessible. There was constant communication with maintenance staff to gather the required data. Lastly, to gather as much failure data as feasible, the expert judgment approach was employed.

4.SYSTEM DESCRIPTION AND FUNCTIONAL ANALYSIS :

Studying every component's function, how it operates, and all other operational and environmental factors is crucial at this point. All the steam boiler system's subsystems and parts have had their functionality examined. In a similar vein, the boiler system's functional failure analysis is conducted by determining the failure modes and their causes.

5.DEFINE MAINTAINANCE STRATEGIES:

The selection of specific maintenance jobs considering failure consequences is the focus of the second step of this research. A variety of maintenance jobs, including replacement, run-to-failure, condition-based, predictive, corrective, and preventive maintenance, can be chosen using a binary decision flowchart (Yes/No Answers). The most economical, dependable, and effective maintenance plan must be chosen. Several criteria, including the decrease of operating irregularities, useful life, reduction of repair costs, utilization of facilities, spare parts and tools, downtime maintenance, and repair time, should be used to evaluate the overall effectiveness of the chosen maintenance task. The suggested model is used to determine which maintenance chores are necessary for the crucial steam components and their modes of failure.

METHODOLOGY :

1.Reliability analysis of boiler by expert judgment method :

Reliability engineers use the component or system failure or life data in reliability analysis. The lifespan or time to failure of the components are examples of life data. These statistics are sometimes unavailable, but they can be found in many other places. By taking a few simple steps, the expert judgment technique may perform a reliability examination of such systems. After choosing a system for analysis, we must categorize it into different levels, including components, subassemblies, and assemblies. The first step in reliability analysis is gathering field failure data from many sources.

Criticality analysis is consequently required for the identification of critical parts once the failure data has been collected. Following criticality analysis, the distribution's parameters are estimated, and then the reliability features are discovered.

Product life data are used in reliability analysis to evaluate reliability characteristics and probability distribution parameters. Life statistics can include component failure and repair times as well as the lifespans of the items when they functioned properly. Typically, these data points correspond to certain probability distributions. They must determine which distribution fits the data the best and estimate the parameters of the distribution using statistical techniques including probability charting, least-squares analysis, and maximum likelihood estimation. However, these life data sets are frequently insufficient to apply these parameters estimate techniques. In these situations, the expert judgment-based parameter estimate method, which makes use of the experts' expertise and experience, can be used to identify the distribution parameters.

The most crucial component of the textile processing industry is the steam boiler. It has many parts and subsystems. Any part, assembly, or subsystem failure could lead to the boiler system as a whole failing. Selecting the best reliability-based maintenance plans is essential to preventing such occurrences. Therefore, reliability and maintainability analysis must be done to determine preventative maintenance schedules and to increase system availability. The boiler system is broken down into nine distinct subsystems for analytical purposes. These subsystems include the steam circulation system (SCS), fuel supply system (FSS), blow-down system (BDS), combustion and ignition system (CIS), control system (CS), electrical system (ES), and other systems. The next stage is to gather data on the system's failure and repair times. It has been noted that many process industries do not retain failure data for their boilers. For this reason, the data collection strategy adopted in this study is expert judgment based.

The user sector maintenance staff or the service engineers who handle client complaints are the specialists when it comes to boilers. These experts have access to data on boiler failure and repair spanning several years. By requesting the estimated maximum life observed, approximate average life observed, and approximate time required to repair or replace the component, the failure and repair data of every boiler system component are gathered. The mode of the reliability analysis of the distribution of the steam boiler system in this study is represented by the component's approximate average life as observed.

CONCLUSION :

The boiler system has been implemented using the best-fit failure model approach and expert judgment method. The analysis's conclusions are as follows:

(1) The expert judgment-based method is straightforward and practical, and it can be used effectively in situations where there are insufficient failure data available

(2) The expert judgment method shortens the time needed to gather field failure data

(3) The TTF and TTR data sets of every component were independent and uniformly distributed

(4) The best-fit distribution analysis reveals that the majority of the boiler's components follow the Weibull distribution

(5) The analysis reveals that the parts like the feedwater tank, feedwater pump, supply water temperature sensor, strainer, return water temperature sensor, condensate filter, MDC, coal crusher, and fusible plug etc……

RESULT :

This research project aims to do a reliability analysis of boiler operation. The Time before Failures is best described by the operating line of the boiler. Ultimately, the Pareto chart study demonstrated that leaks are the primary cause of boiler failure among the several reasons for system failure in boilers, including protection shutdown, auxiliary element failure, electric failure, and leaks. Most of the causes of the brewery's boiler failure will be resolved if more efficient steps are implemented to eradicate this.

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