Short Case Study

Introduction, applications and scope of predictive data analysis in boiler feed systems

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Abstract

In this rapidly advancing technological world increasingly driven by myriad amount of data, a need is generated to deal with these massive tons of information. Termed as 'Big data', this bulk of information can be really helpful in dealing with future shortcomings or present case scenarios if used in the best way. Although many methods have been developed for its processing and some are still being developed, One of the ways to tame big data is by predictive data analytics. It has found many applications at management level and IT corporations and its believed that its incorporation can be of great significance in the field of mechanical engineering too, as it not only gives a futuristic approach of handling a situation but also helps to predict the shortcomings and results in any operation. Predictive analytics often known as the future way of reducing the data. It works on various techniques including statistics to study various types of data including recent and past data and thus helps in making predictions about what might happen in future. In this study, we have analyzed a privately operated boiler feed plant its data variations and the use of 3 way decision tree model to look for prediction into a boiler plant efficiency while varying the variables. With its help we will segregate the variables based on all values of sub variables and identify that variable, which has greater significance on the final output i.e the efficiency. Currently though the use of data analytics in the field of mechanical engineering is significantly less, it looks like its use in most of mechanical engineering sector might prove to be a boon for this field making working more efficient and results more desirable.

Keywords: Scope, Predictive, Data Analysis, Boiler Feed Systems.

Introduction

Big data plays an important part in fabricating the proper design of materials, bulky equipment ,systems and products in various industries like energy and healthcare. Data science finds an ample of applications in various mechanical principles including fluid and thermal[1]. A large portion of various mechanical engineering sectors focuses on terrains such as product designing, manufacturing and energy development, which are conceivable to receive advantage from this big data and its approaches. Data analysis includes analysing the data requirement, data collection, data, processing the data, cleaning the data and finally exploring and modelling it.

Analyses of the data can be done in 3 major ways[2]: i. Predictive analyses, ii. Prescriptive analyses, iii. Descriptive analyses.

Out of these 3 techniques we have analysed the boiler feed system using Predictive analyses.

Predictive Data Analysis

Predictive models are the way by which we can utilises the recognised results to design a model that can be used for predicting values of various types of data. Modelling gives the probability of the target variable from the input group. The difference between the two approaches is that predictive analyses helps to model future events, while prescriptive analyses targets on showing how the variety of tasks and actions will affect the performance of any business and provides them the best choice. According to a survey only 3% are using prescriptive analyses as compared to 30% using predictive analyses[3]**.**

Methods of Predictive data analysis[4]

There are several methods of predictive analyses which help us to analyse the data in the best possible way, thus helping us in predicting the failure, efficiency or rate for effective working.

Some proposed methods are: i. Regression technique. ii. Time series model. iii. Decision tree model. iv. Decision analyses.

Way decision tree model

Decision Trees are used for classification and prediction target variable from various input source. In 3 way decision tree model there are 3 choices at every split. It uses "if …..Else "condition. Each way is compared to check its perfection with one another at constant time. The tree for each predictable attribute contains

information that describes how the input column that you choose affect the outcome of that particular predictable attribute[5].Each tree is headed by a node that contains the predictable attribute, followed by a series of nodes that represent the input attributes.

Application of Predictive Analysis in Boiler feed system

Boiler is most important in power plants. Its most effective utilization is done by enhancing the operation as to be performed and choosing the parameters which are optimal. Enhancing the performance of the processes give us the ability to achieve best boiler performances like improved heat rate, equivalent evaporation, better efficiency of Boiler and reduction in the emissions that are harmful for the environment.

It can be seen from the practical and experimental data related to functioning of the boiler that there are variations in the efficiency of the boiler which lead to incomplete and non-effective implementation and utilization of many major resources. A general boiler will take use of large amount of fuel as compared to that of previously planned under the case of ineffective utilization. Subsequently, an increase of few percentage in the efficiency of boiler system may result into savings of tonnes of fuel.

Modelling and validation

Power plants assemble the offline and updated data from various devices in fields at certain gap of time. The data is then present for checking and analysing, calculations and various other important purposes. Documentary functioning data about the performance of boiler system was used from the archives. Some of the essential variables which are taken into usage for our analysis are:

Primary air discharge and temperature	Rate of Heat (H.R)
Secondary air discharge and temperature	Energy (MW)
Feed Water flow and temperature	Flue gas temperature
Flow of coal and quality	Spray flow temperature

The collected data consist of two sets: i. Training and practice set (68% of the original data), ii. Testing set (32% of original data)[6].

Mining of data and Decision tree technique are taken into usage to model efficiency of boiler by figuring out the various boiler operations, processes and performance with past information on the practice set[7]. The result of the newly designed model was then measured against the earlier performances of boiler data in the testing set. The conclusion of modelling indicated that at varying loads Air to Fuel ratio is the most significant variable for improving the efficiency of boiler. The decision tree modelling indicates the scenarios in which the boiler has been successfully functioned.

Mining of data spotted certain control states which gives higher efficiency of boiler (> 81%) under variable load conditions, while the values spray flow, gas temperature and concentrations of O_2 within control limits. Modelling also gives essential knowledge on the sweet spots (where it is possible to get result in terms of our desired objective) and black holes (where the processes, though functioning within the design limits, is not producing desired results) along with the situations that must be eliminated under variable conditions of loadings[8].

Future Perspective

Although the field of predictive analysis is little known and less implemented in mechanical operations, but for sure, over the next few years or so, it is going to become their mainstream work aiding computing techniques. Some of the ways in which it will help this sector are: i. Be able to deeply look into the data pertaining to change in various factors like highly increased temperature, highly increased pressure, over stress, oscillation and vibration, corrosive action on the mechanical systems[9]. ii. Be helpful in predetermination of failures in any operation or self maintenance. iii. It is advicely fit for leveraging and analysing big data and its analytics and it has benefited various groups in a company including engineering field, manufacturing and production processes, preserving and proper complete maintenance. iv. Analytics can be useful in driving insights which may not be clearly visible while looking and viewing at the various physical aspect of the problem. Moreover, there is also a chance to automate and standardize these insights and their associated decisions which can be very important and useful to various organization with worldwide operations[10].

Conclusion

As Predictive data analysis is rising up as a promising and most advanced technology needed desperately by big organizations to manage and gain meaningful insights from their data, if proper research and initiative is taken for its incorporation in every aspect of mechanical processing, the existing mechanical efficiency can be significantly improved to tremendous levels.

Acknowledgement

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