The electric power need is increased due to vast industrialization and urbanization across the globe. Though the fuel sources are more, the cheapest and popular fuel is coal due to its vast availability. The utility boiler is a closed device used to process the coal to produce steam by supplying proper proportion of heat energy to water. A multidisciplinary effort was carried out to define and analyse the operational aspects that reside in the complex boiler system. The impacts of each factor affecting the boiler performance were determined and their values are estimated for the user specified load. This aspect supports to derive the major inferences and control strategies to maintain stable steam generation process. The proposed effort reduces the complexities emerged due to the significant growth of global electric demand.

The effective deployment of derived strategies results in preventing the heat losses that occur in various thermal components. The optimized solution prevents the boiler system from abnormal behaviour through the determination of the root causes which deviates the plant performance. The intended effort leads to reduce the fuel consumption, usage of resources, production and maintenance cost. It helps to attain expected level of operational practices and eliminate the slowdown deviations that occur in boiler performance. The required industrial data needed for computing the essential values from multiple sources were obtained for various boiler loads and coal grades. The steam generation process of coal fired boiler is analysed. Further a formal / mathematical model of the entire plant was developed. The implementation process enriches the understandable level of steam generation process. Employing the formal model, the steam generation process for different grades of coal was evaluated with predicted performance data. This evaluation is to ensure the plant efficiency.
The modelling includes all the sequential activities associated with the integrated thermal components. It provides the base values which are related to various inlet and outlet absorption of each boiler elements. A synthetic data set of boiler steam generation was derived with the base operational values. To derive the optimal boiler design values, the base values deduced from the formal model were used. In the data prediction process, different degrees of polynomial equations are formulated. The equations are analysed and their stableness were verified.

The data driven methodologies were used to measure the correlation between the operational data and thermal components. Data mining based clustering method and neural network based clustering method were used to extract the required knowledge from thermal data in order to reduce information deficiencies. The information deficiency always results in uncertainty and complicates the process of identifying corrective measures whenever performance deviation arises. Through the extracted knowledge the power plant performance can be guaranteed by minimizing the level of uncertainties. The knowledge gained from the clustered pattern leads to define optimal set points. The optimal design values will provide the plant absorption design to learn the crucial characteristics and trends of fuel with its associated operational parameters.

The influencing parameter of steam formation is estimated by using the steam properties like temperature, heat absorption pattern and pressure. Among the huge amount of parameter pool, it is identified that burner tilt and coal flow are the major efficiency influencing parameter. Hence, the estimation of these parameters become mandatory based on the load and grades of coal. A simple neural network model was designed and trained with the optimal design values obtained through clustering process. By using the estimated values, the trend from 250MW to 550MW were drawn for both
these parameters which act as a boundary limit to evaluate the usual steam generation process. The estimated values are useful in predicting the required number of mills and other operational parameters like the amount of steam produced at a certain period of time to compute temperature, pressure, dryness of steam and utilized quantity of heat. It is essential to acquire the knowledge about weight of the coal burnt and calorific value to compute the supplied heat. The calorific value is calculated by knowing the information about the volume of different constituents of the fuel. The optimization model simulates all the control strategies and guidelines to attain the boiler efficiency from 85% to 90%. It includes the effect of every influencing parameter that helps to minimize heat losses in all the stages of boiler steam generation.

To prove the correctness of analytical model, the prediction of unknown parameters from known parameter was also carried out by using the regression model. The regression method results in representing the correlation exist with predicted value, targeted value and error rate which are visualized independently for all the interrelated boiler components. The deviation in the predicted error rate as supposed to the target error rate was found negligible. This ascertains the accuracy of the analytical model. Irrespective of coal grade, the heat absorption pattern of all thermal components should remain unchanged. The HAP analysis was performed in different aspects, which derives the key boiler operational inferences. An exclusive HAP analysis was also performed to gain informative strategies. As a result various key inferences of performance influencing factors were identified. Various inference operational parameters and its resulting consequences that will increase the boiler efficiency were formulated.