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ASSESSMENT OF COAL THROUGH ANALYSIS OF VARIOUS PROPERTIES OF COAL SAMPLE AND PROGNOSIS OF CALORIFIC VALUE BY ARTIFICIAL NEURAL NETWORK.

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Abstract - *The lab experiment illustrate the use of thermogravimetric analysis (TGA) to perform proximate analysis on series of coal samples of different rank. Peat and coke are examined. A total of four exercises are described. The weight percent moisture, volatile matter, fixed carbon, and ash content are determined for each sample and comparsions are made The GCV of the coal sample by proximate analysis and by analysised value of Bombcalorimeter are compared. Proximate analysis is performed on coal samples of various mines in study area for local electric utility. These can be analysis by matlab tool i.e ANN module to find the fit Regression value of i.e R^2 = 0.9 and the error between Analysised value and predicted value.*

Key Words: **Thermogravimeteric analysis, Proximate analysis, Bomb calorimeter, Artificial Neural Network, Regression .**

1. INTRODUCTION

India is the third largest producer and consumer of coal in the world. Coal finds wide usage in many industries as main fuel for the process. Thermal plants are the major users of coal. Coal is an extremely complex material and exhibits a wide range of physical property and chemical properties. The rapidly expanding use of variety of coal at present made it necessary to devise acceptable method for coal analysis. As part of the coal evaluation, methods/correlations are continuously developed to increase the accuracy, reduce the time of analysis and cost. In order to achieve better control on the boilers and thereby to achieve better performance, accurate computation of elemental composition is required. In this article, we suggest a method to compute the analysis based on the proximate analysis information using Artificial Neural Network model (ANN). Around 15 lab analysis data-points on coal for which proximate information is available had been used to train and test the ANN model. Composition of proximate analysis is represented by %Ash, %Fixed Carbon, %Moisture and % Volatile Material.

1.1 Coal

The coal by its nature occurs the most valuable mineral. It's a world trade that creates a economic contribution to the worldwide economy. Coal is deep-mined commercially in additional than fifty countries and employed in over seventy. The Annual rate of production as obtain the world coal consumption is regarding five, The occurrence of valuable tonnage of 800 million tons, of that regarding seventy five is employed for electricity production. This consumption is projected to just about double by the year 2030 to fulfill the challenge of property development and a growing demand for energy. The International Energy Agency predicts that world energy demand can grow around sixtieth over the following thirty years, most of it in developing countries. China and India are terribly giant countries in terms of each population and land mass, and each has substantial quantities of coal reserves.

Hot worth is that the quantity of warmth evolved by their complete combustion and through an experiment it's determined by bomb, This methodology of determination price and needs subtle instrumentality and additionally trained chemist equally final analysis of coal also wants terribly pricey equipment and trained analyst, where as Moisture(M), ash(A),Volatile matter(VM), and Fixed carbon(FC) are proximate analysis of coal by exploitation easy muffle chamber and it's comparatively cheaper than the bomb and moderately trained chemist are often performed. Energy demand of the whole world is increasing recently and are principally remunerated by the fossil based mostly fuels like fossil fuel, fuel and coal. Coal is extremely crucial energy sources for several countries, among the fossil fuels, that manufacture heat and power by distinct technologies to meet our lifestyle needs.

1.2 Artificial neural network (ANN)

ANN empirical modeling tool, Galvanized by behavior of biological neural structures. ANN builds the process the behavior change of different objective goods and components. The occurrence of the substance mean while done by the selection of outputs and inputs. The nature may be decides. Neural networks are powerful tools that have skills to spot underlying extremely advanced relationships and connections from input output information. Artificial neural network model developed

mistreatment forty nine samples and ten samples use for validation. Artificial Intelligence tools have been in use for years in a number of mining related applications. Expert and knowledge based systems, probably the most popular AI tools, have found their way into a number of computer-based applications supporting everyday mining operations as well as production of mining equipment. In recent years, AI has provided tools for optimizing operations and equipment selection, problems involving large amounts of information that humans cannot easily cope with in the process of decision-making

2. METHODS AND MATERIAL

2.1 Method of sampling.

The method of sampling and if the sample is still too bulky for convenient handling it is again quartered down. The material finally remaining is spread into a circular mass about 2 inches deep on the cloth, and the sampling-scoop is used to fill the sample can compactly with portions from opposite quarters. The entire operation described above, from the cutting of the sample to the sealing of the can, should be done in the mine so as not to expose the coal to the outside atmosphere.

2.2 Pulverising

1) Primary Crushing: The gross sample collected is feed to primary crusher and the coal size is reduced to 12.5mm size with heap of mechanical crushing.

2) After Primary crushing of coal sample, one portion (one fourth of the gross sample) called Part-1 will be used for determination of total moisture and the other portion (three fourth of the gross sample) called Part-2 will be used for Testing and analysis.

3) Secondary Crushing: After primary crushing of coal, Part-2 of the coal sample is sent to secondary crusher, coning and quartering of coal sample is carried out at secondary crusher and the sample is further reduced to 3.35 mm of size.

4) Pulveriser: Coning and quartering of coal sample is done and pulveriser will reduce the coal sample to powdered form and the top size of 212 Micron is attained. Precaution will be taken so that further sieving and pulverising is not needed at the time of testing.

Fig -1 pulversing crusher

2.3 Moisture

About 1 g of finely powered air-dried coal sample is weighed in a crucible. The crucible is placed inside an electric hot air-oven, maintained at 105-110°C. The crucible is allowed to remain in oven for 1 hour and then taken out, cooled in desiccators and weighed. The loss in weight is reported as moisture (on percentage basis).

$$\text{Moisture (\%)} = \frac{\text{Loss in weight}}{\text{wt.of coal taken}} \times 100$$

2.4 Volatile matter

The dried sample of coal left in the crucible in (1) is then covered with a lid and placed in an electric furnace (muffle furnace), maintained at 925°± 20°C. The crucible is taken out of the oven after 7 minutes of heating. The crucible is cooled first in the air, then inside a desiccator and weighed again. The loss in weight is reported as a volatile matter on percentage-basis.

$$\text{Volatile matter (\%)} = \frac{\text{Loss in weight due to removal of volatile matter}}{\text{wt.of coal sample taken}} \times 100$$

2.5 Ash

The residual coal in the crucible in a volatile matter is then heated without a lid in a muffle furnace at 700 ± 50° C for half an hour. The crucible is then taken out, cooled first in the air, then in desiccators and weighed. Heating, cooling, and weighing are repeated, till a constant weight is obtained. The residue is reported as ash on percentage-basis.

$$\text{Ash (\%)} = \frac{\text{wt.of ash left}}{\text{wt.of coal taken}} \times 100$$

2.6. Fixed carbon

Fixed carbon (%) = 100 - percentage of (moisture + volatile matter + ash).

Table-1 Results of Proximate analysis

Sample Code	Moisture (%)	Ash Content (%)	Volatile Matter (%)	Fixed Carbon (%)
1	5.72	34.18	21.85	38.25
2	5.48	37.26	22.50	34.76
3	6.17	26.39	20.42	47.02
4	5.91	30.48	26.21	37.40
5	5.39	38.74	22.54	33.33
6	6.74	40.38	19.84	33.04
7	6.31	45.60	23.56	24.53
8	6.42	47.05	22.89	23.64
9	6.11	42.17	24.18	27.54
10	6.29	41.36	21.23	31.12
11	5.94	30.33	25.12	38.61
12	5.90	30.95	22.84	40.31
13	6.26	24.56	26.12	43.06
14	6.06	28.03	25.41	40.50
15	5.82	32.08	19.84	42.26

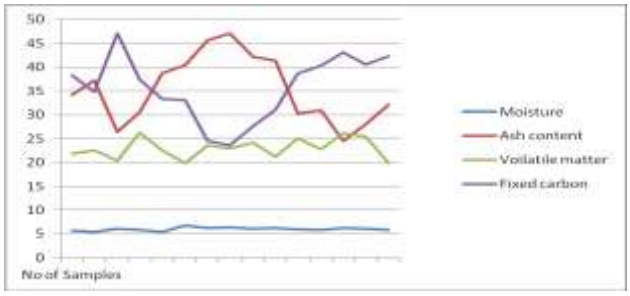

Fig 2 Graph of various parameters

2.7 Bomb Calorimeter

On the other side of the cover, there are two bent rods connected to two ends. The bent rods have small holes through which two fuse wires are connected. There is the provision for putting the crucible containing the pellet tied to the fuse wire by means of a cotton thread.

Procedure:

1g of air dried coal sample is taken by weighing in a balance of - 212 micron (-72 mesh BSS). A pellet is made with the coal and weighed. The calorimeter cover is taken and about 10 ml/min of distilled water is poured into it. The pellet in the crucible is brought in contact with the fuse wire by means of a thread. The cover is then tightened. Oxygen is then admitted into the calorimeter at a pressure of about 300 - 400 psi atmospheres. Then 2L of water is put into the bigger vessel. Necessary electrical connections are made and stirrer is adjusted in the adjusted position. The stirring is do softly for 5 minutes. The initial temperature reading is then taken. A sparking and combustion of coal has taken place in the calorimeter after the fire of bomb. The maximum reached temperature is then noticed. The bomb is removed and the pressure exhausted. The bomb internal is examined for unburnt or sooty deposits. If such material is found, then the test is discarded. The calorific value of coal is calculated by:

Calorific value = $(T_2 - T_1)$ * Water equivalent / Weight of the pellet

T_1 – Initial temperature,
T_2 – Final Temperature,

3. OBJECTIVES OF REGRESSION ANALYSIS.

The determination of explicit form of regression equation is the ultimate objective of regression analysis. It is finally a good and valid relationship between study variable and explanatory variables. Such regression equation can be used for several purposes. For example, to determine the role of any explanatory variable in the joint relationship in any policy formulation, to forecast the values of response variable for given set of values of explanatory variables. The regression equation helps as understanding the interrelationships of variables among them. ANN-based models for GCV estimation After the ANNs model development, predicted GCV values were compared with the experimental GCV. It was observed that correlation coefficient value of experimental GCV and predicted GCV by ANN model is 0.972 that it is good correlation between experimental and predicted GCV by neural network.

4. RESULTS

Table 2 Results of Proximate GCV and Bomb calorimetric GCV

Sample Code	GCV of proximate Analysis	GCV of Bomb Calorimeter
1	4540	4551
2	4308	4344
3	5132	5177
4	4671	4743
5	4144	4183
6	3726	3718
7	3410	3404
8	3234	3229
9	3608	3606
10	3755	3750
11	4759	4807
12	4706	4767
13	5191	5247
14	4934	5010
15	4643	4709

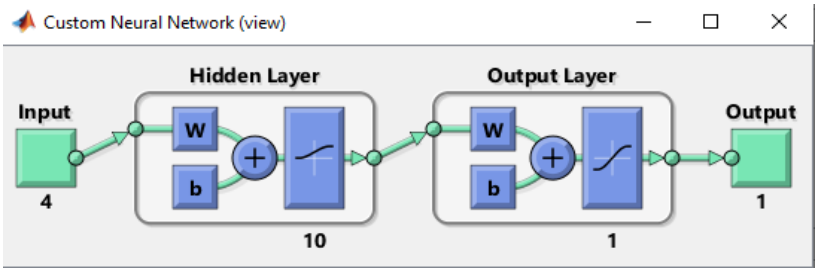

Fig- 3 Neural Network model Development

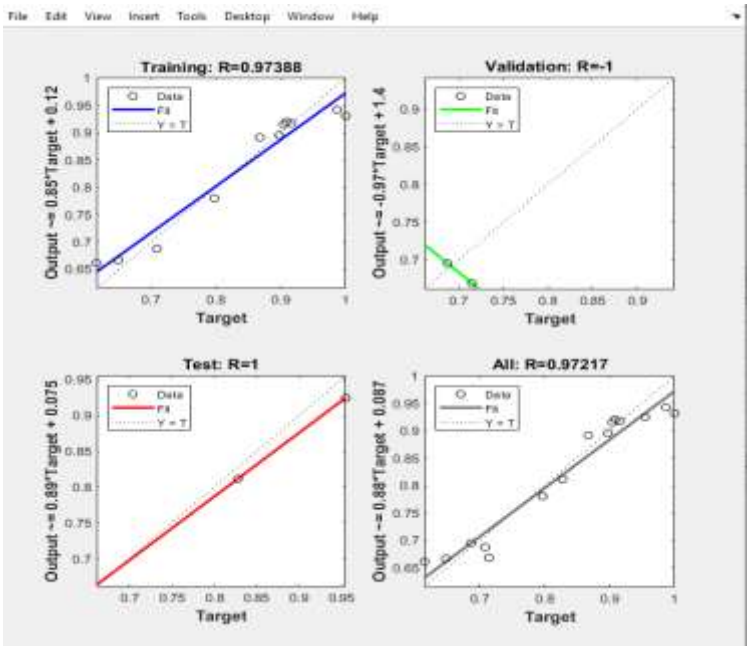

Fig -4 Moisture, Ash, Volatile matter, Fixed carbon and GCV

Table - 3 Error difference between Analysised value and predicted values

Analysised value	Predicted value	Difference
0.8279	0.8116	0.0163
0.9867	0.9423	0.0444
0.9039	0.9153	-0.0113
0.7972	0.7801	0.0171
0.7086	0.6877	0.0209
0.6488	0.6668	-0.0180
0.6154	0.6612	-0.0458
0.6872	0.6948	-0.0076
0.7147	0.6682	0.0465
0.9161	0.9175	-0.0013
0.9085	0.9202	-0.0117
1.0000	0.9310	0.0690
0.9548	0.9246	0.0302
0.8975	0.8956	0.0019

5. CONCLUSIONS

The determination R^2 of the multiple correlation model is ninety seven. This worth is sweet and identifies the valid model. This result reveals the quality of a multiple regression toward the mean model within the prediction of hot worth. These models are call manufacturers that examine coal deposit parameters, like hot worth, ash content, and wetness content, so as to manage the coal deposit. The developed correlation involves the results of all the main variables affecting the gross worth of coals. Validation with a group of knowledge at affordable accuracy establishes the overall acceptableness of the developed correlation.

The very small difference Between Analysised GCV and Predicted GCV values makes as to understand that the samples from various mines as mostly similar nature and properties and useful for industrial purpose.

The efficiency of boiler can be known by the selective way of sampling test of proximate analysis predicted by ANN.

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