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# Beneficiation of Fine Size Lignite Coal to Reduce Sulphur by Dry Sieve Technique of Matasukh Mines Nagaur, Central Rajasthan, India

**Abstract**

The sulphur is the main pollutant element for environment of lignite coal which exists as inorganic, organic and in Free State as trace element. The lignite coal of Matasukh Mines contained marginal CV=1748.84 kcal/kg with sulphur=3.34%. In the favor beneficiation the %RW=52.27and %RW/%S=24.31are detected for fine size lignite coal in present research. The ratio of %AS/%S=14.53. %VM/%S=9.65 and %FC/%S=6.04 are detected by the dry sieve technique for 100 mesh to1mm fine size of lignite coal. The value of $R^2$ =0.069 is calculated by regression study. The total sulphur is reduced %S= -1.19% and the lignite coal is transferred in to CV=+353.84 kcal/kg as value added products.

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**Keywords:** Fine size, Hard Lignite Coal, Eschka's Mixture, $R^2$

**Introduction**

The sulphur is an inorganic element which is main source of acid rain as $H_2SO_4$ in India. The lignite coal of Matasukh Mines has high %S which exist as inorganic, organic and in free state sulphur as trace[1]. Sulphur has 30 solid allotropes having different physical properties and exist in living organism in protein contains. Normally a healthy 70 kg human body contains about 140 grams of sulphur. The sulphur has 25 isotopes having different atomic mass and same atomic No. The sulphur isotope ratio ($^{34}S/^{32}S$)[2] is environmental sensing parameter for the identification of sulphur sources and the compounds of its transformations. Lignite coal is main energy source[3] in India for thermal power plants therefore the structure play important role the energy rich matter in lignite coal. The lignite coal is of high impurity having sulphur so it is also termed as hard coal[4] for thermal power plant. In the present research the sulphur is reduced by dry sieve technique as reducing size of lignite coal particle along with increasing CV .The sulphurs are in lignite coal as.

**Aim of the Study**

Up gradation of lignite coal of matasukh mines

**Inorganic sulphur**

Inorganic sulphur is present as mainly pyrite [5]($FeS_2$). The pyrite is classified as two types as formation state syngenetic stage during peat formation, and a subsequent epigenetic stage[6]. Inorganic sulphur is the major part in the high ash coal.

**Organic sulphur**

The organic sulphur in coal is covalently bound[7] into its large complex structure and is difficult to remove physically or chemically in the contrast to pyritic or inorganic sulphur. During combustion the 95% of sulphur of fuel is oxidized to $SO_2$.This $SO_2$ oxidizes with free OH and $HO_2$ radicals in the atmosphere condition and give sulphur trioxide ($SO_3$) which reacts with water drops in the clouds and change into sulphuric acid[8].This is attempt the mechanism of the acid rain.

1. **Materials**
2. This was elementary and initial step to up gradation of lignite coal to use in experimental lab. The fraction of the lignite coal as retains on a screen and picked out by a fork shovel during loading is called steam coal and the fraction that remains after steam coal has been removed from the run of mine coal was called slack coal[9]. The steam coal is more effective than slack coal for thermal power plant. The 10 kg lignite coal was collected from the Matasukh Mines of Nagaur of central Rajasthan,

India. This sample was termed by as received (AR) sample. This sample was replaced on dry place to dry in open air it was Air dried (AD) sample. This AD sample had been Brocken down in to small piece and remaining also crushed out to form uniform piece. The AD sample having in large amount was reduced by the coning and quartering method and at least 100 gm this sample was sieved by 60mesh and used for the calculation of basic value of principal parameters and CV which is tabulated in Table 1.

**Table 1**
**Basic CV Kcal/Kg Moisture=35%, Dry Sieve Size=60 Mesh.**

| S. No. | Approximate Analysis Parameters | Value |
|---|---|---|
| 01 | %FC | 7.62 |
| 02 | %VM | 22.48 |
| 03 | %AS | 34.99 |
| 04 | CV kcal/kg | 1748.84 |
| 05 | %S | 3.34 |

VM=Volatile matter, AS=Ash, FC=Fix Carbon, CV=Calorific Value.

**Sulphur Measurement Method**

Lignite coal contained high impurity with sulphur particle. The lignite coal had a large No. of inorganic impurity containing gray clay[10] as random distributes in carbonic matrix of lignite coal. The ash forming elements were present in coal and sieved by the nesting of sieve in successive order of decrease size of sieve containing 8 sieves from 50mm to 200 meshes. The reduction in size for coal samples improved the heating value. In reducing size of coal particles increased in reactivity of coal therefore smaller particle specific mass and porosity promoted faster heat and increased in fraction of available sulphur transfer[11] in thermal power plant . The Eschka's method [12] was used to determine the sulphur measurement which is a innovative and fruitful method for beneficiation of lignite coal and control the environmental pollution. In this method a mixture of 2 part MgO and1 part $Na_2CO_3$ was used which is known by the Eschka's mixture. Due to this used mixture so this process was termed as Eschka's methods. This mixture is used to supply homogenous heat for all part of lignite coal.

In order to operate this methods at first 1.0 gm lignite coal sample was weighed and mixed with 3 gm of Eschka's mixture (2 part MgO and1 part $Na_2CO_3$) in a porcelain crucible .This uncovered crucible containing mixture was heated in electrical muffle furnace for 2 hour at incineration. Here mean was of incineration absence of black particle in residue. At this condition the mixture was cooled down and replaced in a 250 ml beaker containing hot water to dissolve it. The all contents was diluted by hot water at 150 ml and added 10 ml bromine water and replaced it in water bath for an hour to oxidize sulphur into sulphate compound . The sufficient HCl was added and boiled up to remove bromine and again the solution was neutralized by adding $NH_4OH$ by using methyl orange as indicator. After complete neutralization of solution it run in to 10 ml solution of 10% barium solution and boiled up to 4 hour at white ppt of $BaSO_4$. It was washed 10time by hot water gradually to remove excess of bromine and Heated in electric muffle furnace at dull red to dry up and cooled down and weighted it for calculation as.

A. **%Sulphur Calculation (Gravimetric Analysis)**

$$\%s = \frac{\text{Wt 2 of BaSO 4 contained in coal} * 32}{\text{Wt 1 of coal sample taken in bomb} * 233} * 100 \quad (1)$$

$Wt_1$ =weight of coal sample,

$Wt_2$=weight of $BaSO_4$ ppt**.**

$BaSO_4$ ppt is non water soluble so it can be easily removed from solution by normal filtration.

**Retained Weight in Dry Sieve Technique**

The quantitative success of dry sieve technique is measured by the % retained weight. The retained weight is denoted by the % RW physical parameters. The retained weight is the measurement of dry sieve efficiency.

**Table 2**
**Retained Weights in Dry Sieve TechniqueTotal Weight=10 Kg. Moisture=35%, Nesting of Sieve=+50mm To 200 Mesh(8)**

| S. No. | Size mm | Average size | RW gm | %RW |
|---|---|---|---|---|
| 01 | +50mm | +50mm | 5330 | 53.30 |
| 02 | 20 to 50mm | 35mm | 2340 | 50.10 |
| 03 | 10 to 20mm | 15mm | 930 | 39.91 |
| 04 | 4.75 to 10mm | 7.37mm | 520 | 37.14 |
| 05 | 1 to 4.75mm | 2.87mm | 440 | 50.00 |
| 06 | 100 mesh to 1mm | 0.57mm | 230 | 52.27 |
| 07 | 100 mesh to 200 mesh | 0.223mm | 143 | 68.09 |
| 08 | -200 mesh | 0.298mm | 67 | 100 |

RW= Retained Weight

**Ultimate Analysis for Sulphur**

By American Society for Testing and Materials (ASTM) D 388, the analysis of lignite coal in which constituents contains is analyzed (apart from associated mineral matter (mm)) as chemical element in mass percentage is termed as ultimate analysis .in this analysis carbon, hydrogen, sulphur, nitrogen as well as oxygen chemical elements are detected by various methods from dry mineral matter free sample of lignite coal and other impurity among carbon matrix in coal lumps which directly effects the CV of lignite coal and produce pollutants. At burning there is good need to analysis of lignite coal to up gradation of CV of lignite sample and remove pollutants.

**Table 3**
**Ultimate Analysis For Sulphur%S= Sulphur in Sieved Coal,**

| S. No. | Size | Average size | % S | CV kcal/kg. |
|---|---|---|---|---|
| 1 | +50mm | +50mm | 3.65 | 1592.32 |
| 2 | 20 to 50mm | 35mm | 3.24 | 1666.88 |
| 3 | 10 to 20mm | 15mm | 3.69 | 1694.16 |
| 4 | 4.75 to 10mm | 7.37mm | 3.50 | 1727.58 |
| 5 | 1 to 4.75mm | 2.87mm | 3.75 | 2032.54 |
| 6 | 100 mesh to 1mm | 0.57mm | 2.15 | 2102.68 |
| 7 | 100 mesh to 200 mesh | 0.223mm | 3.71 | 2067.48 |
| 8 | -200 mesh | 0.298mm | 4.36 | 1379.88 |

**Table 4**
**Dry Sieve Technique Principal Parameter Ratio for Different Size at Moisture=35%**

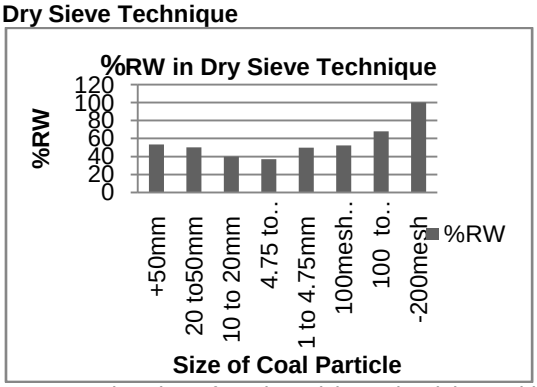
| S. No. | Size mm | %VM/ % S | %FC/%S | %A S/ % S | % S |
|---|---|---|---|---|---|
| 1 | +50mm | 4.56 | 2.53 | 10.70 | 3.65 |
| 2 | 20to50mm | 5.43 | 2.95 | 11.66 | 3.24 |
| 3 | 10mm to 20mm | 4.34 | 2.94 | 10.31 | 3.69 |
| 4 | 4.75 to 10mm | 4.98 | 2.98 | 10.60 | 3.50 |
| 5 | 1mm to 4.75m | 5.16 | 3.45 | 8.70 | 3.75 |
| 6 | 100mesh to 1mm | 9.65 | 6.04 | 14.53 | 2.15 |
| 7 | 100 mesh to 200mesh | 6.00 | 3.13 | 8.38 | 3.71 |
| 8 | -200mesh | 5.35 | o.59 | 7.72 | 4.36 |

FC=Fix Carbon, VM= Volatile, AS= Ash.

**Results and Discusions**

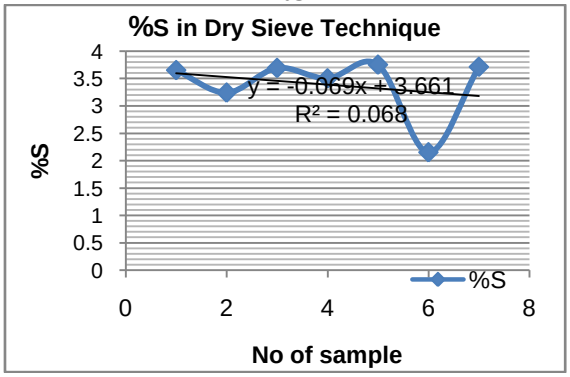
The retained weight shows the efficiency of dry sieve technique in this present research. The retained weight is detected %RW=52.27 for 100 meshes to 1mm fine size range of lignite coal particle. The %RW/%S=24.31 is determined in the dry sieve technique for size lignite coal which shows efficiency of dry sieve technique in the presence of sulphur. The results are given in Table 2 and represented in fig.1.

**Fig.1**
**The Representation of Retention Weight (%RW) in Dry Sieve Technique**




The size of coal particle and sulphur a highly correlates each other in dry sieve technique. In the dry sieve technique the %S decrease as decrease the size of coal particle.The sulphur detects as %S=2.15 at 100 mesh to 1mm fine size of coal particle. The value of sulphur decrease as %S= -1.19 decrease with fine size of coal and $R^2$ =0.068 has been calculated in regression study. The results have been tabulated in Table 3 and represented in fig.2.

**Fig. 2**
**The Relation between Fine Size of Coal Particles and %S**

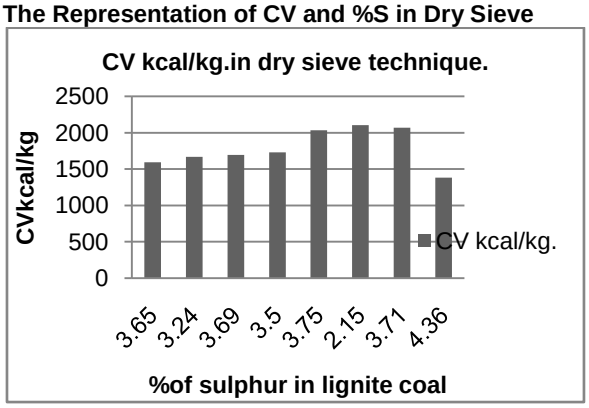



The up gradation takes place in dry sieve technique. The high value of %VM/%S=9.65and %FC/%S=6.04 are in favor of up gradation of lignite coal. The value of principal parameters with change of sulphur is pioneer study to detect the up gradation of fine size lignite coal of Matasukh Mines. The results have been tabulated in Table 4 and represented in fig.3.

**Fig.3**
**The Representation of % VM/% S,% FC/% S and % S in Dry Sieve Technique**

The CV increase with decrease sulphur and size of coal particle. The value of at least of sulphur as %S=2.15 and maximum CV=2102.68 kcal/kg have been measured by dry sieve technique for fine size of coal particles. The lignite coal is transferred in to CV=+353.84 kcal/kg as value added products. The comparative results have been given in the fig.4

**Fig. 4**
**The Representation of CV and %S in Dry Sieve**




**Conclusion**

1. The sulphur is the main pollutant element in the Matasukh Mines lignite coal. The sulphur reduction take place 2.15% at fine size 100 meshes to 1mm Matasukh lignite coal particle. The %S= -1.19 decreased with reduce of coal particle size. The $R^2$ =0.068 obtains in dry sieve technique.
2. The ash reduce %AS=-3.73 by dry sieve technique and beneficiation is expressed as %AS/%S=14.53
3. The up gradation is carried out as %VM/%S=9.65and %FC/%S=6.04 at 100mesh to 1mm fine size lignite coal particle and the lignite coal is transferred into CV=+353.84 kcal/kg as value added products.

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