JHARKHAND Rai University
RANCHI

# MINING ENGINEERING
# LAB MANUAL

## FUEL TECHNOLOGY AND MINERAL PROCESSING
## (DIPLOMA)
## SEMESTER VI

# INDEX

## EXPERIMENT NO-1

**AIM:** To determine the proximate analysis of coal.

**THEORY:**

**PROXIMATE ANALYSIS**

The proximate analysis of coal comprises of determination of the moisture, ash, volatile matter and fixed carbon.

**Moisture**

Free water may exist in the coal as adsorbed on the surface, condensed inside fine capillary network and as bound to the coal molecule by chemisorptions and hydrogen bonding.

**Volatile Matter**

A volatile product obtained by the pyrolysis of coal in the absence of air is known as volatile matter. The product may contain hydrogen, methane, carbon monoxide, carbon dioxide, higher hydrocarbons, tar, water vapors, nitrogen, ammonia, hydrogen sulphide etc. The pyrolysis temperature of coal may lie in the range from 600-800oC. The yield of volatile can be taken as a measure of its rank. Volatile matter will be much less in coke than that of coal as pyrolysis had occurred during coking at around 1000oC. Volatile matter does not contain the moisture of coal but it contains water that is formed from the hydrogen and oxygen of coal during the decomposition.

**Ash**

Coals are associated with certain mineral or inorganic matter, which gets deposited along with vegetable matter or gets into coal by subsequent infiltration. The ash consists mainly of silica, alumina, iron oxide and lime. When heated, coal as does not melt sharply at any temperature, but begins to soften at much lower temperature than that required melting. The ash content in coke is much higher than in coal.

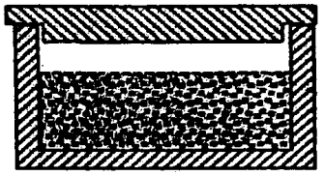
**Fixed carbon**

Fixed carbon is obtained by deducting the sum of moisture, ash and volatile matter percentage from 100.

**PROCEDURE**

**Moisture determination:**

(1) Dry the silica dish in an oven and weigh.
(2) Spread out about 1 gm of 20 mesh coal sample on the dish.
(3) Weigh the dish again to find the exact mass of the sample.
(4) Heat the dish without any cover in the oven at about 105±5oC for 1 hour.
(5) Take out the dish from the oven, cover it with the lid and cool.
(6) Weigh the dish to find the loss in weight of coal due to presence of moisture.



**Volatile matter:**

(1) Heat a clean crucible and its lid at 900±15oC for 7 minutes in muffle furnace.

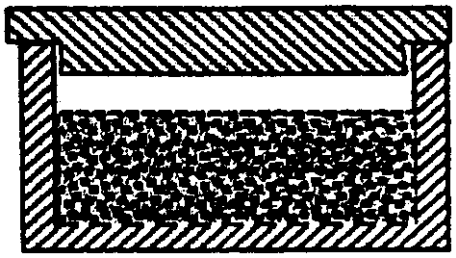
(2) Allow the crucible and lid to cool on a metal plate for a minute and in dessicator for 10 minutes.

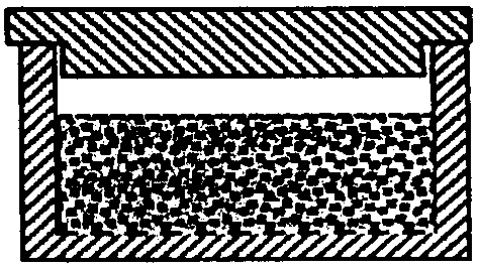
(3) Weigh the crucible and lid together.

(4) Put near 1 gm sample and weigh again to know the exact mass.

(5) Insert the crucible with the lid on it into the furnace at 900oC and keep there for a period of 7 minutes.

(6) Weigh the crucible with the lid to know the weight loss due to expulsion of volatile matter.





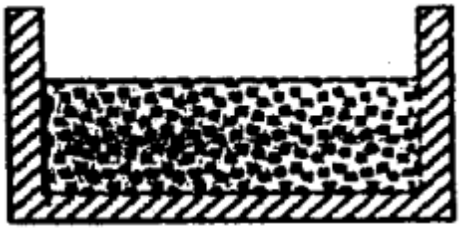
**Ash determination:**

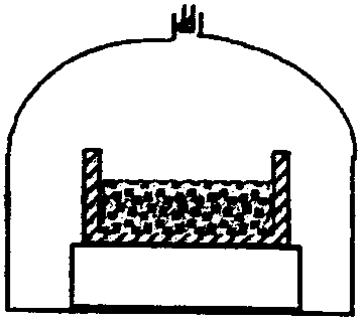
(1) Follow the steps 1 to 3 of moisture determination.

(2) Insert the open dish in the furnace at 815oC for an hour.

(3) Remove the dish; allow it to cool for 10 minutes on the slab and 15 minutes in the dessicator.

(4) Weigh the dish to find the mass left which is the ash content of the coal.





**<u>RESULT:</u>**

(1) Determine the moisture content (wt.%) in coal samples, as received basis.

(2) Determine the ash content, V.M. and fixed carbon in percentages in both samples, dry basis and put all the results and data in the tabular form.

**Proximate analysis of coal samples**

| Experiment | Temperature | Time(min) | Dish Weight | Dish+ Sample Weight | Dish+ Residue Weight |
|---|---|---|---|---|---|
| Moisture | | | | | |
| Volatile Matter | | | | | |
| Ash | | | | | |

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## EXPERIMENT NO-2

**AIM:**

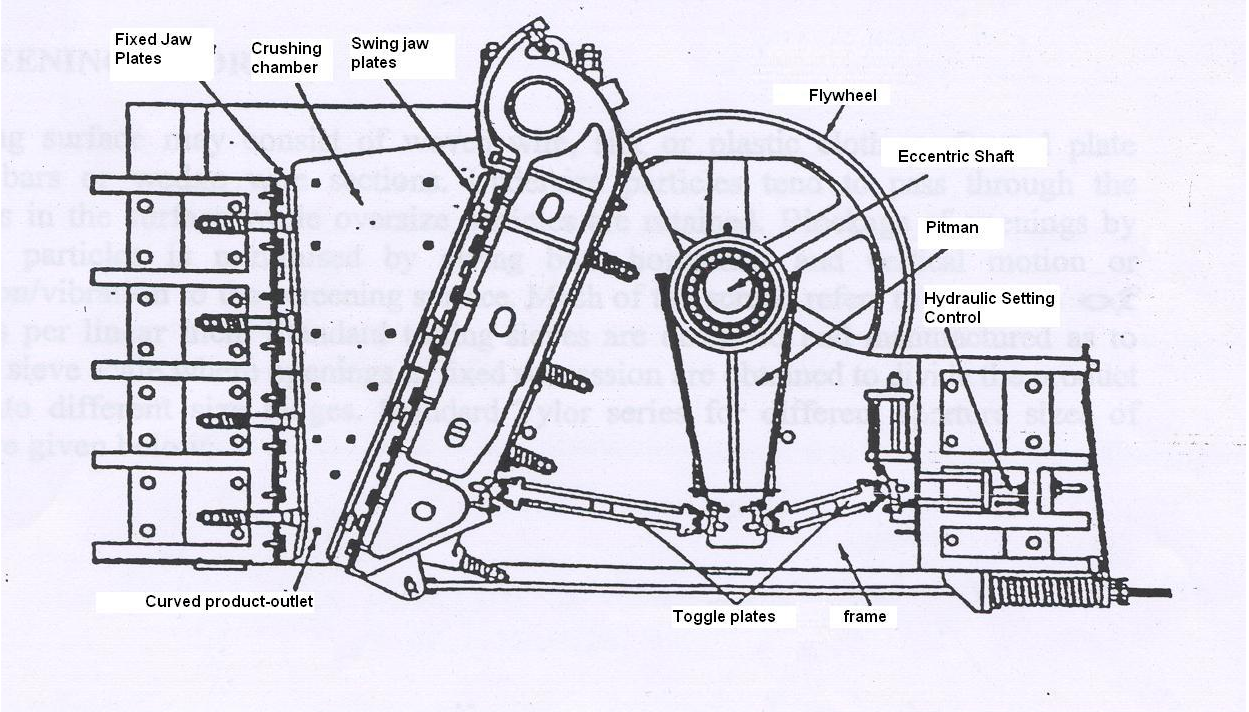
To Study the Crushing by Jaw roll crusher.

## INTRODUCTION

Crushing and grinding refer to bringing about size reduction in the ore so that valuable minerals are liberated from the gangue. It is the first step in any mineral beneficiation by methods such as Tabling, Jigging, Magnetic Separation, Electrostatic Separation, Floatation etc. Crushing devices include jaw crushers, gyratory crushers and roll crusher. Grinding refers size reduction of the material to much finer size of less than 0.1mm. Grinding is normally carried out in tumbling mills which are rotated on horizontal axis. Mills are commonly charged with a grinding medium made of forged steel, cast steel or cast iron having Brinnel hardness value of 300 to 370. The load to the mill may vary from 20 to 50%. The present experiment is aimed at studying the design, construction and action of the laboratory models of jaw crusher, roll crusher and ball mill.

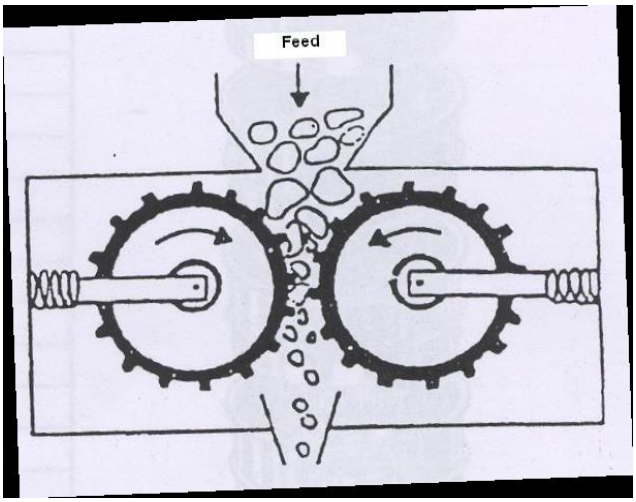
### A. JAW CRUSHER

1. Note the action of components of Jaw Crusher by turning the fly wheel by hand.
2. Note the movement of different components by idle running of the jaw crusher.
3. Measure the operational dimensions such as gape, mouth, throat, open and closed set.
4. Select large pieces of the rock and feed them singly into the crusher.
5. Study the product and measure the dimensions of the largest particle in the product.
6. Take 2 kg of rock sample in the size range of 25 to 50 mm by hand picking.
7. Feed the material to the crusher without choking the crushing zone of the machine.
8. Carry out the screening of the product by shaking the sieves for about 5 minutes.
9. Retain the product for use as feed to Roll Crusher.
10. Clean the crusher, sieves and the floor with the compressed air hose.




**B. ROLL CRUSHER**

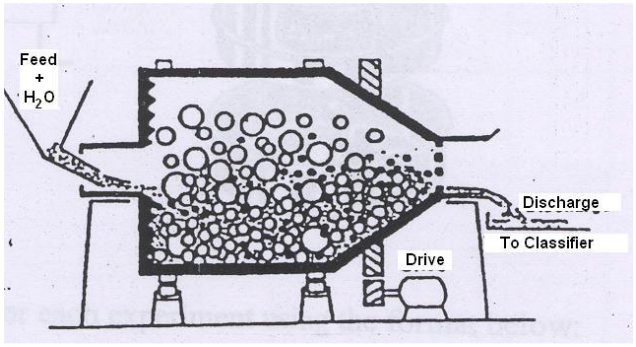
1. Measure the diameter of the Rolls and the speed of the crusher by idle running
2. Set the crusher to 4 or 6 mm gap between the two rolls
3. Feed about 1 kg of the product of Jaw Crusher starting with the smallest size and note the suitability of treating different sizes of the feed to the machine.
4. Carry out the size analysis of the product of the roll crusher as explained before.
5. Clean the crusher, sieves and the floor with the compressed air hose.




**C. BALL MILL**

1. Note down the dimension of the grinding mill and find its volume.
2. Estimate the weight of grinding media being used and the volume.
3. Add about 200g of the crushed material in the size range of 3 to 14mm.

4. Run the mill for 10 min.
5. Take out the product completely and weigh.
6. Carry out the size analysis using sieves.
7. Repeat steps 3 to 6 by running the mill for 20 minutes.

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## EXPERIMENT NO-3

**AIM:** To study the Floating of coal fines.

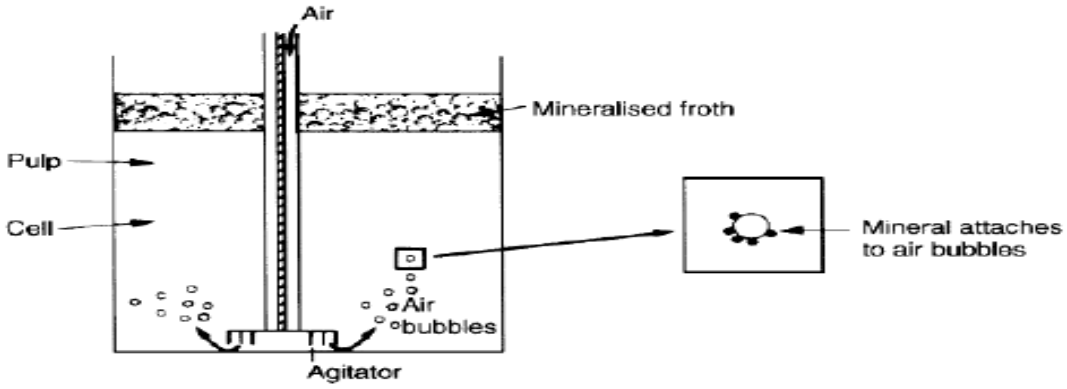
**MATERIALS / APPARATUS REQUIRED:**

1. Ore / coal
2. Different sieve screens of ASTM size
3. Froth Floatation Cell
4. Weight balance
5. Water
6. Pine oil

**THEORY:**

**Froth Flotation Process:**

 Flotation is the most widely used method of wet concentration of ores for separating the valuable constituent of the ore from the worthless gangue. The process is primarily a surface phenomenon based on the adhesion of some mineral particles to air, and simultaneous adhesion of other particles to water in the pulp.



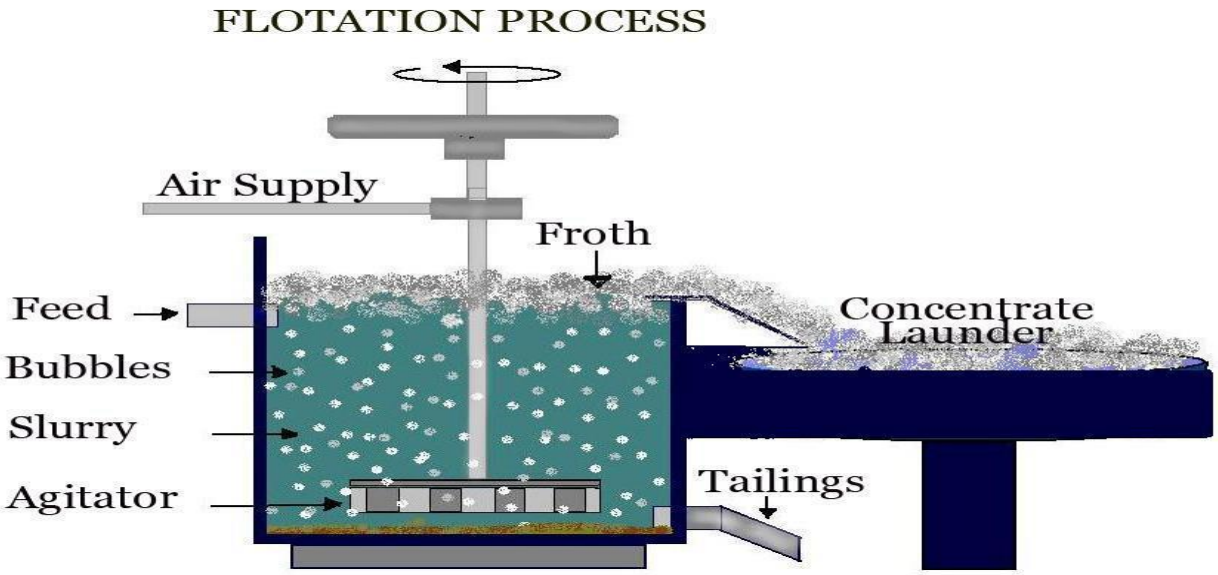

 Flotation process is the most efficient, but is the most complex of all ore beneficiation processes. In this process adhesion is made between air bubbles and small mineral particles in such a way that they rise in that pulp. The floating mineralized froth is then skimmed off while the other minerals are retained in the pulp. This fact is well-known flotation proper.

 Floatation Cell Function of aeration element is based on step diffuser design. Acceleration in the aeration tube generates a vacuum, which sucks the necessary process air, which forms bubbles in the stock. Bubbles remove the particles from the stock suspension.

 Floatation Cell Dirt laden bubbles rise to the top of the cell, forming a foam layer. The foam layer gets skimmed off into the foam collecting chamber.

 Froth flotation is employed widely in metallurgical industries and coal.

 In the pneumatic flotation cells compressed air is directly blown into the pulp while in the sub-aeration cell a rotating impeller serves as a pump, which draws in air through the hollow shaft of the impeller and distributes the same into the pulp to produce the froth. In the laboratory, usually a rotating, hollow impeller type sub-aeration cell is used.




**PROCEDURE:**

 Take 45gm weight of finely ground coal, and 5gm weight of sand. Mix it thoroughly.

 Add 5 ltr of water to the cell and start the unipellets. Then, add 2/3 drops of pine oil (floating agent collector), and a pinch of detergent to create a stable froth.

 Now, add the coal & sand mixture into the flotation cell, Skim off the froth, and collect the same through the reservoir.

 Then, dry the collected froth, and find out the separation efficiency.

**OBSERVATION & CALCULATION:**

Measure the following parameters

 Weight of initial coal taken (W1)

 Weight of sand taken (W2)

 Weight of sand dried froth taken (W3)

 Weight of filter paper

 Total weight of filter, and coal

 Weight of the dried coal (W4)

So, using the above data, we can calculate the separation efficiency using the following formula

**Separation efficiency (in %) = [$W4/W2 \times 100$]**

**RESULT:**

Hence, we have studied about froth flotation cell, and the efficiency of the machine was found out.

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## EXPERIMENT NO-4

**AIM :** Determination of caking power of coal.

**THEORY:**

**COKING COAL**-Coking coal, also known as metallurgical coal, is used to create coke, one of the key irreplaceable inputs for the production of steel. There are many varieties of coal in the world, ranging from brown coal or lignite to anthracite. The property that really sets coking coals apart from other coals is its caking ability, which is the specific property required in order to make coke suitable for steel making. Coke quality is largely influenced by coal rank, composition, mineral content and the ability to soften when heated, become plastic, and resolidifies into a coherent mass. Bituminous class coals of high, medium, and low volatile rank that possess these properties are called “coking” coals.

Highly swelling coals, the Gray-King coke type is defined by the minimum amount of electrode carbon required to produce a strong hard coke residue of the same volume as the original coal and electrode carbon mixture.

**PRODEDURE:-**

a) Raise the temperature of the furnace until it is steady at 325°C.

b) Weigh on a scoop 20g of the sample and transfer it to the retort tube held in such a manner that the coal cannot enter the side arm.
c) Complete the transfer with a soft brush and allow the coal to fall to the far end of the retort tube. Hold the tube horizontally, insert the distance rod so that the face of the disk is 150 mm from the closed end of the retort tube and spread the coal into a layer of uniform depth by shaking and turning.
d) Withdraw the distance rod and insert a flattened pad of asbestos wool or a notched asbestos disk to retain the coal in position.

e) Without disturbing the position of the coal, close the open end of the retort tube with a heat-resisting stopper. Connect the receiver to the side arm and insert the retort tube in position in the furnace so that the centre of the coal layer coincides with the centre of the furnace.
f) Raise the energy input to the furnace in such a manner that the temperature of 325°C is regained in 3 to 7 min and maintain a uniform rate of rise of 5°C/min thereafter until a temperature of 590°C is reached. At this point, regulate the energy input to the furnace so that a temperature of 600°C is reached, and maintain this temperature for 15 min.

**RESULT:**

For coals giving a coke type with an index greater than $G_Z$, the subscript defines the minimum number of grams of electrode carbon added to produce a standard G type coke residue. In our experiment, about 5g of electrode carbon was added to make a G type Grey Coking Coal.

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