**International Journal of Environmental Science: Development and Monitoring (IJESDM)**
**ISSN No. 2231-1289, Volume 4 No. 2 (2013)**

# Utilization of vast quantity of ash produced by Thermal power plants

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## ABSTRACT

**When Coal is burnt it changes into ash which proved to be a fatal substance for our environment. From various test such as flame test it was found that coal ash contains the impurities of calcium and sodium salts on burning coal this impurities changes into oxide and after adding tap water it changes into hydroxide. Hydroxide whose Ph value was nearly 9 ionize in water due to ionization electric pressure created on electrodes and cause movement of ions and electromotive force is to be set up. Now the paste**
**was left for 2 to 3 days it was observed that some amount of water along with dissolved sodium sulphide comes on the surface which was filtered out. After analyzing, the raw materials are proportioned, ground to fine powder and bleaded and it was stored as slurry. now the raw materials, clay, some quantity of limestone and shale was kept in furnace at 1700C flame, a chemical reaction transform them into clinker. Finally pulverizing the clinker produced by calcening to incipient fusion a mixture of argillaceous and calcereous material. It was ground together with gypsum and ferrous chloride and later sample was obtained at room temperature in an alkaline environment. In this way the present work fulfils three basic aims firstly of making coal ash usable and getting rid of pollution caused by ash and also to fill the void created between the production and demand of cement.**

***Keywords- Argillaceous, Bleaded Clinker, Incipient Fusion.***

## 1. INTRODUCTION

Gainful and sustainable ash utilization is one of the key concern at N.T.P.C. The ash **utilization division set up in 1991, strives to derive maximum usage from the vast** quantities of ash produced at its coal based station. The division proactively formulates policies, plans and programs for ash utilization. It further monitors the progress, in these activities and works for developing new segments of ash utilization. The various segments of ash utilization currently includes cement, asbestos-cement product and concrete manufacturing industries, land developments, road embankments construction, Ash dyke raising, building products such as bricks/blocks/tires, reclamation of coal mine and as a soil amender and source of micro-nutrients in agriculture. Use of fly ash in the manufacture of pre-stressed railway concrete slippers demonstrated in association with IIT, Kanpur research studies also have been taken to explore use of ash is SDPE and poly propylene products.The quality of ash produced at a NTPC’s stations is extremely good with respect to fineness, low unburnt carbon and has high pozzolanic activity and confirms to the requirements of IS 3812-2003-Pulverized fuel ash for use as Pozzolana in cement, cement mortar and concrete. The fly ash generated at NTPC station is ideal for use in manufacturing of cement, concrete, concrete-products, cellular concrete products.

**Table 1.** *Area wise break-up of utilization for the year 2009-10 is as under:*

| Area Of Utilization | Quantity (In million tons) |
|---|---|
| Land Development | 7.73 |
| Cement Manufacturing | 7.20 |
| Ready Mix concrete and asbestos cement products | 0.40 |
| Road Embankments | 1.34 |
| Ash Dyke Raising | 3.51 |
| Bricks and other building products | 2.04 |

| | |
|---|---|
| Mine Filling | 1.13 |
| Export | 0.90 |
| Others | 0.37 |
| **TOTAL** | **27.61** |

## 2. OBJECTIVE

To convert the chemical energy of coal ash into electrical energy and then transforming the waste which is left after production of electricity into complete damp proof cementious like substance.

## 3. EXPERIMENTAL PROCEDURE AND RESULT

As coal ash contains alkali and metallic oxide like Aluminium oxide ($Al_2 O_3$), Iron Oxide ($Fe_2 O_3$), Sodium Oxide ($Na_2 O$), Calcium Oxide (CaO) etc. Thus on adding water these oxide changes into hydroxide of respective oxides. The hydroxide whose Ph value was nearly 9 ionize in water. Due to ionization electric pressure is maintained on electrodes and due to movement of ions electromotive force (emf) current is to be set up, and due to movement of ions electromotive force (emf) or current is to be set up.

$$\mathbf{Ca(OH)2 + H_2O \Rightarrow Ca^{++} + 2OH^-}$$
$$\mathbf{NaOH \Rightarrow Na^+ + OH^-}$$

On Anode (Cu- plate)

$$\mathbf{OH- + 1\,e- \Rightarrow OH}$$
$$\mathbf{4OH \Rightarrow 2H_2O + O_2}$$

On cathode (Zn– plate).

$$\mathbf{Ca^{++} + 2e- \Rightarrow Ca\,.}$$
$$\mathbf{Na^{++} + 1\,e- \Rightarrow Na\,.}$$

It was observed that when the two plates namely Copper and Zinc are dipped in the solution of ash and water. It contain 300 gram of ash and 200 ml of water, potential difference obtained nearly 0.9 volt and current of 30 mA

From these observations we can say that current and potential difference depends upon following factors:

*1.Number of plates taken (n):*

If more and more number of plates are taken then current and potential difference both increases simultaneously as shown in the table 2:

This observation was done when the quantity of ash was taken as 500 gm and closeness of the plates was 5 cm and that much quantity of water was added till it became paste like solution.

**Table 2.**

| S.No. | No. of plates(n) | Potential difference(v) | Current(mA) |
|---|---|---|---|
| 01. | 2 | 1 | 40 |
| 02. | 4 | 1.3 | 60 |
| 03. | 6 | 2.7 | 80 |

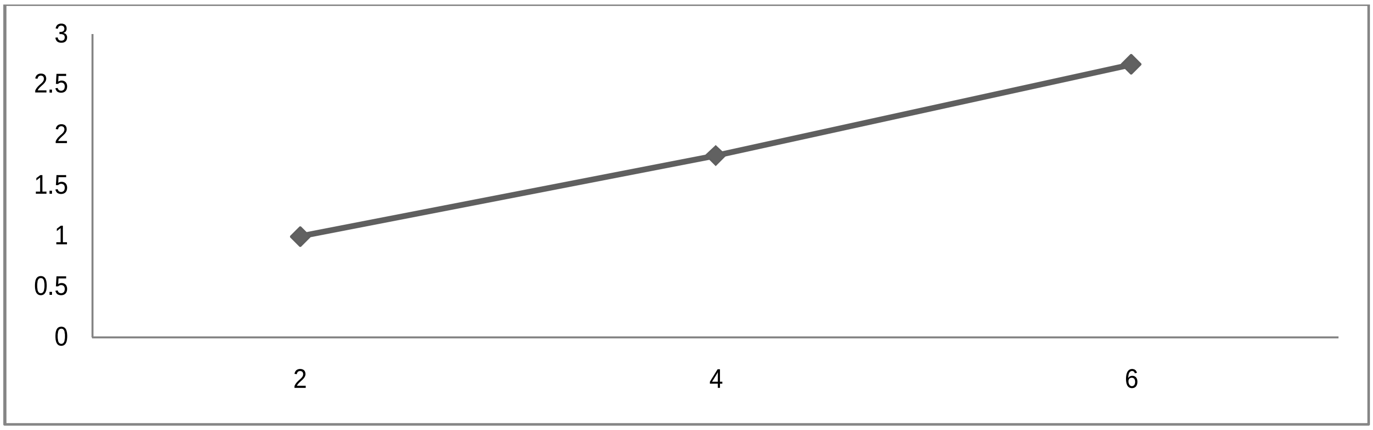


*Fig.1. Graph between number of plates (x-axis) and potential difference (y-axis)*

***General Equation: (for Potential difference)***

$$V = 0.13333 + 0.425\ n$$

Value of co-relation coefficient (For P.d.)

$$R = 0.99942$$

Where R is the value of Co-relation coefficient.

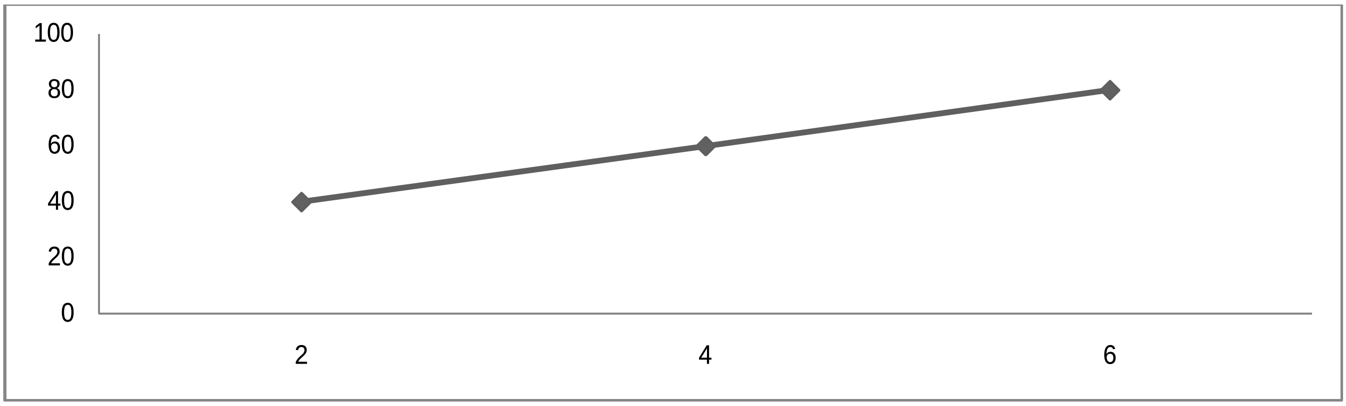


*Fig.2. Graph between number of plates (x-axis) and current (y-axis)*

**General Equation (for current) :**

$$I = 20 + 10\ n$$

Value of Co-relation Coefficient for current

$$R = 1$$

*2. Quantity of Ash taken:*

When the number of paste kept 2 and closeness between them is nearly equal to 5 cm and quantity and quantity of ash was increased from 50 gm to 1 kg. It was observed that potential difference remains constant but current increases from 10 mA to 60 mA as shown in graph.

**Table 3.**

| S.No. | Quantity of Ash taken (grams) | Current (mA) |
|---|---|---|
| 01. | 50 | 10 |
| 02. | 100 | 10 |
| 03. | 150 | 10 |
| 04. | 200 | 16 |

| | | |
|---|---|---|
| 05. | 250 | 20 |
| 06. | 300 | 20 |
| 07. | 350 | 20 |
| 08. | 400 | 24 |
| 09. | 450 | 24 |
| 10. | 500 | 30 |
| 11. | 550 | 30 |
| 12. | 600 | 35 |
| 13. | 650 | 40 |
| 14. | 700 | 40 |
| 15. | 750 | 42 |
| 16. | 800 | 44 |
| 17. | 850 | 49 |
| 18. | 900 | 54 |

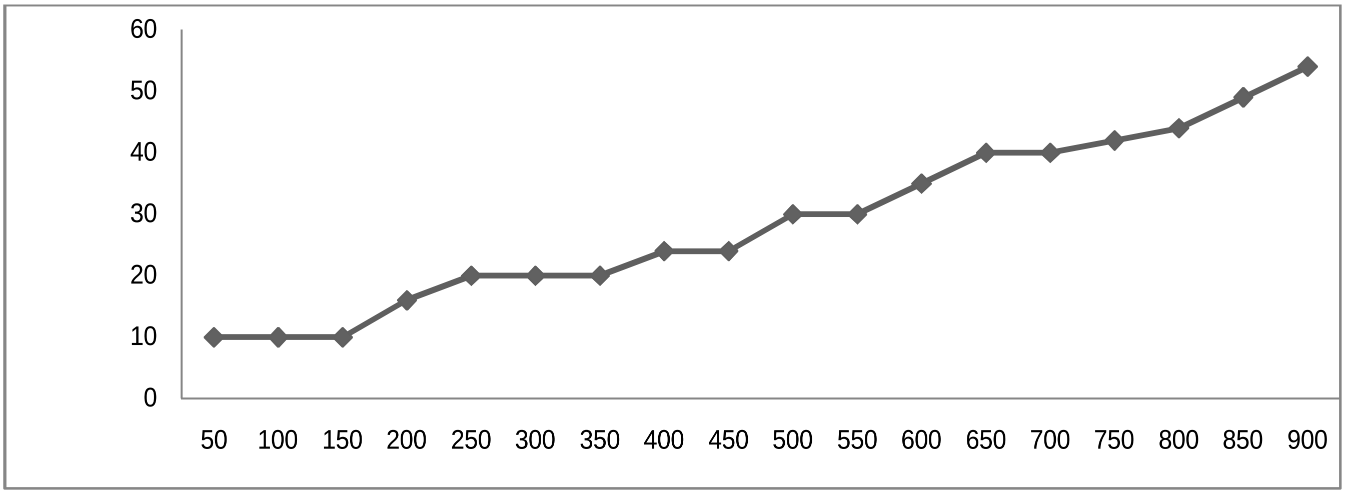


*Fig.3. Graph between quantity of ash taken (x-axis) (in grams) and current (y-axis) (in mA)*

General Equation for current

$$I = 0.5266m + 3.93451$$

Where m is the quantity of Ash taken

Value of Co-relation coefficient R = 0.98984

*3. Closeness of plates:*

When the number of plates was kept 2 and quantity of ash was fixed to 300 gm and closeness of plates was varied from 2 cm to 20 cm .It was observed that potential nearly remains constant (slightly varies) but current decreases from 20 mA to 5 mA.

**Table 4.**

| S.No. | Closeness of plate x (cm) | Current (mA) |
|---|---|---|
| 01. | 2 | 22 |
| 02. | 4 | 20 |

| | | |
|---|---|---|
| 03. | 6 | 18 |
| 04. | 8 | 17 |
| 05. | 10 | 14 |
| 06. | 12 | 12 |
| 07. | 14 | 9 |
| 08. | 16 | 8 |
| 09. | 18 | 7 |
| 10. | 20 | 5 |

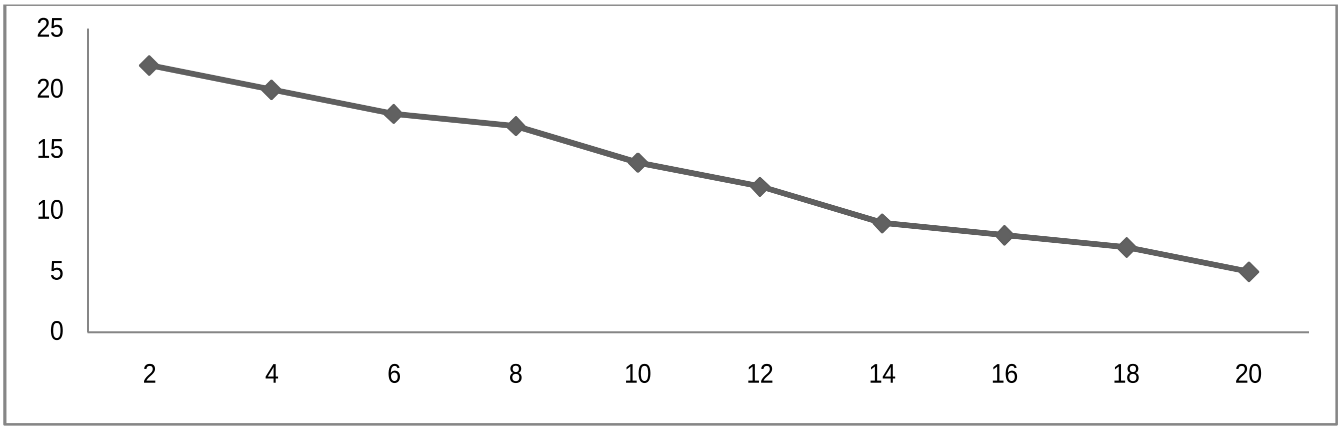


*Fig.4. Graph between closeness of plate (x-axis)(in centimeter) and current(y-axis) (in mA)*

General Equation for Current

$$I = 25.0667 - 1.05152\ x$$

Where x is plate separation

Value of co-relation coefficient

$$R = 0.98707.$$

Now the paste was left for two to three days along with electrodes. It was found that water molecules comes on the surface then the electrodes were removed and the sample was heated to nearly 350-400 degree Celsius and it was crushed into tiny powder like substance and it was named as sample A. After analysis, the raw materials which are sample A, calcium oxide and shale are ground to fine powder of nearly size $\leq 125\ \mu$ in a suitable grounder to very tiny particles and blended in moist climatic condition and it was stored and named as sample B. This sample B was heated very hardly to nearly 750 degree Celsius in a rotatory furnace.

**Wet Kiln Process Material and gas temperature.**

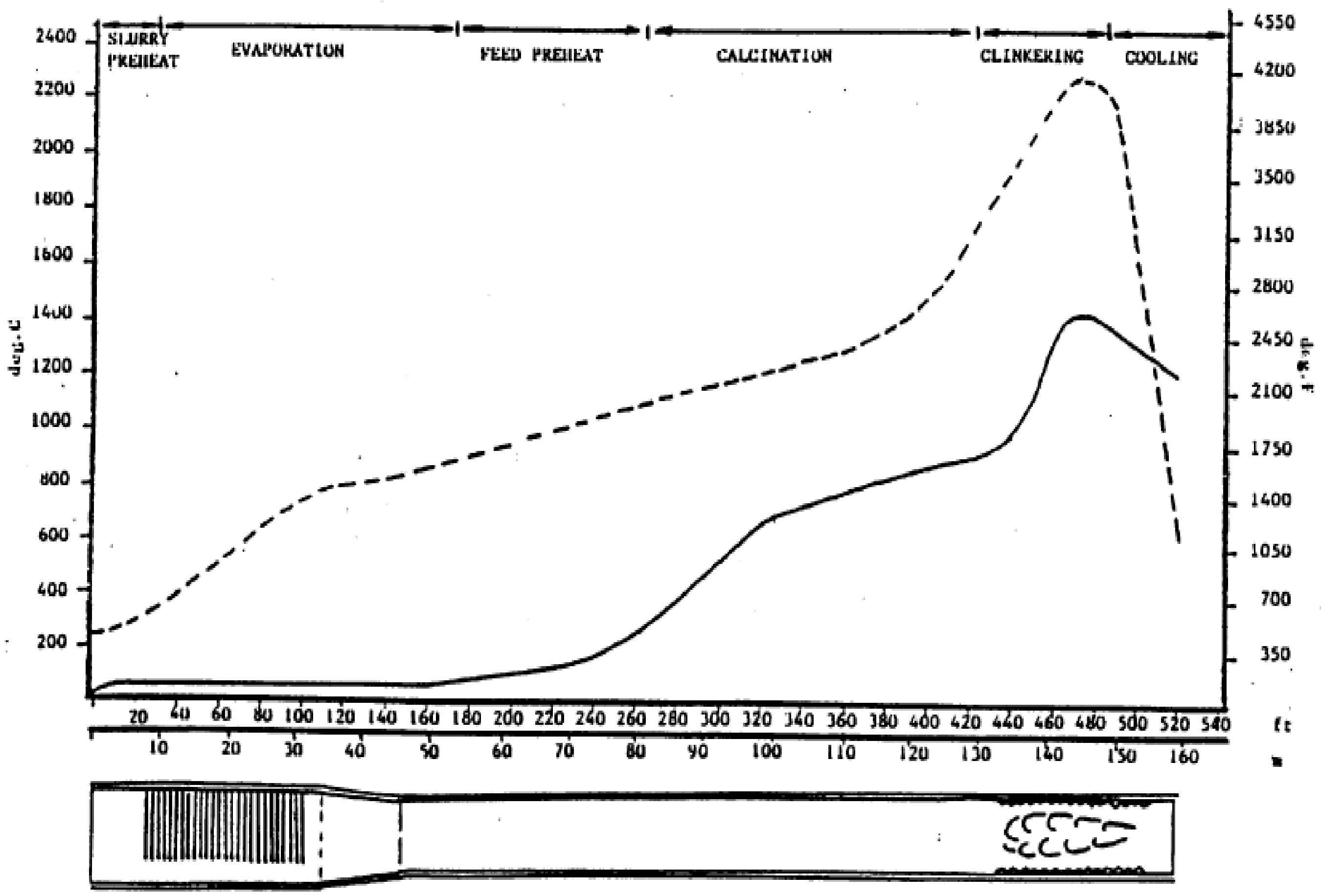


*Fig. 5 Wet Kiln Process Material and gas temperature.*

At this temperature the mixture is partially fused and sintered and chemical combinations between lime, alumina and silica resulting in the formation of calcium aluminates and silicates as such:

$2Cao + SiO_2 \rightarrow 2CaO.SiO_2$ (Di Calcium Silicates)

$3CaO + SiO_2 \rightarrow 3CaO.SiO_2$ (Tri Calcium Silicates)

$3CaO + Al_2O_3 \rightarrow 3CaO.H_2O_3$ (Tri Calcium Aluminates)

$4CaO+Al_2O_3+Fe_2O_3 \rightarrow 4Cao.Al_2O_3.Fe_2O_3$ (Tetra Calcium Aluminate Ferrite)

All the reactions are endothermic and to avoid excessive cation of mass the temperature is preferably controlled. Of the above products formed in the rotator furnace, the most important is tri-calcium silicates.

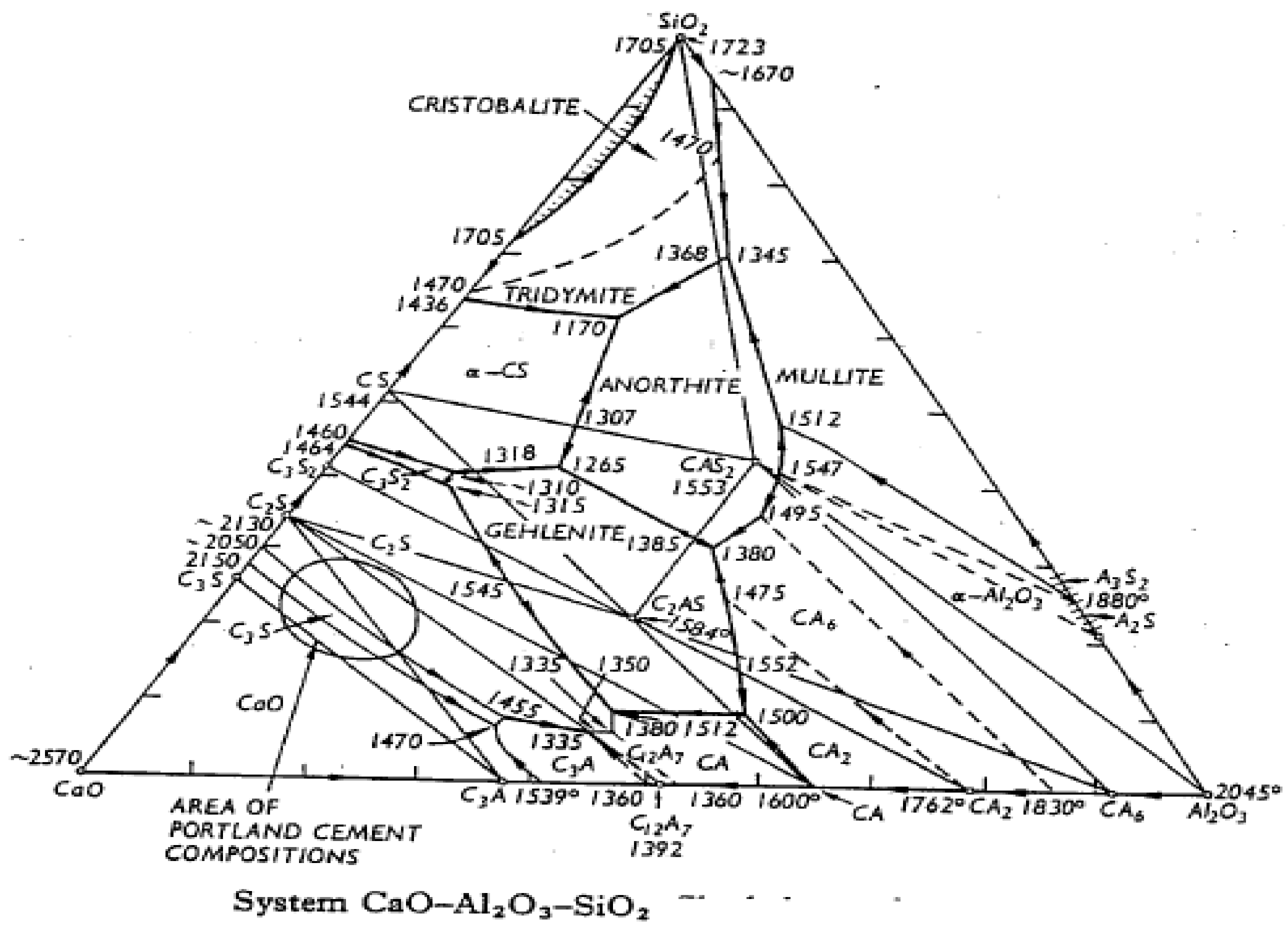


Fig.6.Phase diagram

The substance has the property of setting quickly and developing considerable strength within the few days. Tri-calcium aluminate sets immediately in the presence of water. The internal strength acquired by cement is mainly due to setting of tri-calcium aluminate. The product which comes out of the rotating furnace is named as sample C.

After cooling the sample C, it was mixed with 2 to 3 % gypsum and very few quantity of ferrous chloride and grounded to an extremely fine power and the sample was named as D. Now the sample D was taken and mixed sand and water and it was left for 10 to 11 hours, very fortunately sample sets to hard mass. The exact mechanism of the process has not being finally understood but it is known that it involves many complicated reactions. There are mainly two steps in this process:

1. The initial step which solidifies the mass.
2. Hardening in which strength is developed.

Both these steps involves reaction with water hydration and hydrolysis and it is therefore necessary that the mass we kept wet during the hardening process. Primarily the reaction involved are the hydration of calcium aluminates and calcium silicates which gives rise to the formation of their colloidal gels, at the same time some aluminum hydroxides and calcium hydroxides are formed as precipitates due to hydrolysis. Calcium Hydroxide binds the molecules of the calcium silicates together while aluminiumhydroxide fills the inside rendering the mass impersions. The various reactions involved may be represented as below:

1. Hydration of calciumaluminate to give hydrated colloidal gel.
   $3\ CaO.Al_2O_3 + 6H_2O \rightarrow 3CaO.Al_2O3.H_2O$ (Hydrated Colloidal Gel)

2. Hydrolysis of silicates to liberate free line.
   $3CaO.SiO_2+H_2O \rightarrow Ca(OH)_2 + 2CaO.SiO_2$ (Di Calcium Silicate)

3. Hydration of di calciumsilicate to give a hydrated colloidal gel.
   $2CaO.\ SiO2 + x\ H_2O \rightarrow 2CaO.SiO2.x\ H_2O$ (Hydrated Colloidal Gel) A slow process

4. Partial Hydrolysis of Aluminates to liberate free aluminiumhydroxide.
   $3CaO.Al_2O_3 + 6H_2O \rightarrow 3Ca(OH)_2 + 2Al(OH)_3$

5. Hydration of Tetra Calciumaluminaferrite to give hydrated tri calcium aluminate.
   $CaO.Al_2O_3.Fe_2O_3 \rightarrow 3CaO.Al_2O_3.6H_2O + 3CaO.Fe_2O_3$

Also gypsum combines with tri calciumaluminate to form calcium sulphoaluminate as

$$3CaO.Al_2O_3 + 3CaSo_4 + 3H_2O \rightarrow 3CaO.Al_2O_3.3CaSo_4.3H_2O$$

Also the ferrous chloride was mixed into the cement because it can form layering and cut out the oxygen and moisture supply, so that sample can behave like complete damp-proof cementious like substance.

## IV.CONCLUSION:

If national power plant gives so many fun to man by producing electricity which is indeed a very major requirement for the survival of man but it indirectly snatches the peace of human. NTPC is responsible for major air pollution in the cities. It not only pollute the air, it also pollutes the land to a large extent by generating huge amount of ash. Due to fly ash which mix-up with the air causes health hazards and also soil loose its fertility. A cement kiln is a proven technology for recycling by beneficial REUSE of solid and hazardous wastes.

The benefits are:
• Energy recovery
• Material recovery
• Economics
• Environmental preservation
• Reduction at the source
• Recycling
• Incineration
• Stabilization
• Landfill
• Allows for reuse of waste materials
• Conserves virgin fuels & raw materials
• Regulated stringently for environmental
• Solid materials are physically and chemically combined in the clinker product

In this way the present work fulfills three basic aims firstly of making coal ash usable and getting rid of pollution caused by ash and secondly to fill the void created between the production and demand of cement. Also the work focuses on the complete utilization of vast quantity of ash generated by Thermal power plant and by other big industries. It also enhances the fuel efficiency and allow for high production rates.