International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 08, August - 2017

Wet Coal Drying System

Shubham S. Fawade
(DME, B.Tech Automobile)
Automobile Department
K.E. Society's Rajarambapu Institute of Technology (An Autonomous Institute)
Walwa, Sangli, India

***Abstract*— Coal is the world's most important source of energy fueling around 40% of the power stations. Coal moisture has a large negative effect on boiler efficiency, station service power and is responsible for higher coal flow rate, higher flue gas flow rate, increased operating and maintenance cost. Commonly used dryers are fluidized bed, vibrated bed, flash dryers and rotary dryers are high temperatures dryers. Such high temperatures should not be used for coal drying as it is susceptible to spontaneous ignition. Hence to overcome this entire problem, we have designed a system which will not require one separate unit. Also this system uses waste heat from chimney which was going waste to atmosphere. In this system, we are using forced convection. Firstly atmospheric air is blown by blower through chimney where counter flow heat exchange takes place and atmospheric air gets heated up to 42°c which is sufficient to remove percent of moisture from coal. This heated air from chimney is taken through pipe line up to conveyer belt and it is sprayed over running conveyer belt. Hence it does not require one separate unit. Running cost in this system is to run blower only.**

Keywords— Moisture; Dryers; Chimney; Ignition; Conveyer; Convection

I. INTRODUCTION

Coal is the world's most important source of energy fueling. 40% of the power stations around the world use it as a starting material for many chemical syntheses. It is commonly agreed that coal pits will be mined more intensively and in more numbers in the coming years and that lignite and hard coals will be the major energy suppliers until 2100.

The major part of the global coal reserves, about 45%, consists of Low Rank Coal (LRC, also known as Brown Coal.). LRCs can have moisture content from 25% to as high as 66% in some of the Victorian Coals. LRCs can be used to replace more expensive bituminous coals, either as blending components with high rank coal in existing boilers, or in new boilers designed with flexibility to use LRC. But the high amount of moisture in LRC leads higher energy requirements during combustion, high amount of stack gas flow, lower plant efficiency, high transportation cost and potential safety hazards during transportation and storage etc. It is not cost-effective to process LRC if it is transported to industrial site without drying though the mining cost is low. The presence of moisture causes reduction in friability of coal, difficulty in blending and pneumatic transportation.

II. METHODOLOGY

In this system, we are using blower which will force the atmospheric air (temperature of air in rainy season average 28°c) through chimney. Inside chimney the atmospheric air is carried by pipe. This pipe will have 375 numbers of turns and each turn will have diameter of 0.25 m. After heat exchange between atmospheric air and chimney draught, atmospheric air will get heated up to 50°c.

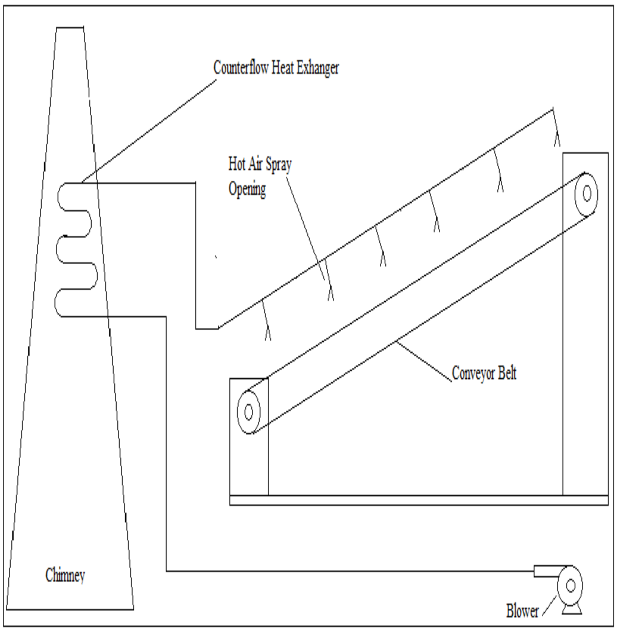

Fig.1 Schematic Diagram of Coal Drying System


Fig.2 Setup of the Coal Drying System

This heated air is then carried by pipe up to conveyer belt. On conveyer belt this heated air is blown through opening to separate the lump of coal.

A. Design

1. Calculation for finding number of turns required to heat atmospheric air up to a desired temperature for drying coal

The atmospheric air is blown by blower through a chimney. Inside the chimney, air is carried by number of

turns. While carrying the air inside chimney, heat exchange takes place between hot flue gases and atmospheric air. Thus after exchanging heat, the atmospheric air gets heated to desired temperature to heat the wet coal.
The flow of flue gases and atmospheric air is counter flow.

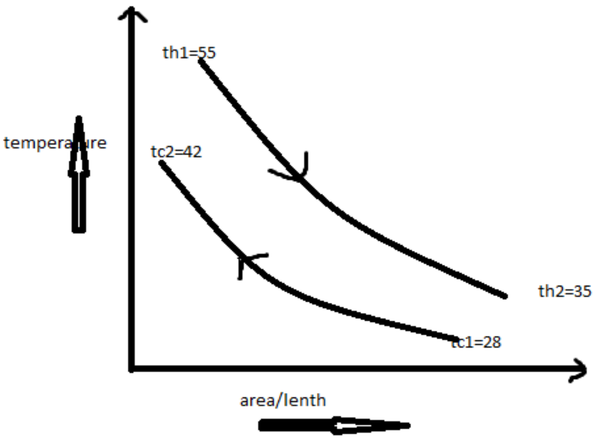

Fig.2 Counter flow between flue gases and atm. air

Where,
55° c =temperature of chimney draught
35°c = temperature of flue gases after exchanging heat
28° c = atmospheric temperature in rainy season
42° c = temperature of atmospheric air after exchanging heat

2. Mass flow rate of blower

Mass flow rate of chimney draught= Mass flow rate of air blown by blower

$$m \times cp \times \Delta t = m \times cp \times \Delta t$$

$$40 \text{ kg/s} \times (55\text{-}35) = m \times (42\text{-}28)$$

Mass flow rate of blower =57.14 kg/s
Now for Surface area of heat exchanger i.e. (surface area of number of turns)
Logarithmic mean temperature difference

$$\theta m = \frac{\theta 1 - \theta 2}{\ln(\theta 1/\theta 2)}$$

where, $\theta 1 = 55\text{-}42 = 13$
$\theta 2 = 35\text{-}28 = 7$

$$\theta m = \frac{13\text{-}7}{\ln(13/7)}$$

$\theta m = 9.6°$ c
Also, we have formula
Now, $Q = U a \theta m$
Where, θm = logarithmic mean temperature difference
U = overall heat transfer co-efficient
Q = rate of heat transfer
Q = m x cp x Δt
= 40 x 4.18 x (55-35) x 10^3 w
=3344x10^3w………………..(eq. 1)

Also
Q = Uaθm
=400aθm…………………….(eq. 2)

Equate eq. 1 and 2 we get,
3344 x 10^3 = 400 x a x θ m
Surface area of heat exchanger A = 870.83 m2
Now above area is = outer area + inner area
= (π/4 x D2 x L) + (π/4 x d2 x L)
= π/4xL x (D2 + d2)= 870.83 m2..….(eq 3)
Now if we consider diameter of each pipe equal to 0.25 m and 375 turns, then we get length L= 93.75 m
Thus we get,

$$(D2 + d2) = \frac{870.83 \times 4}{\Pi \times 93.75}$$

$$= \frac{3483.32}{294.375}$$

(D2 + d2) = 11.83 m

Consider D2=1 m then we get
d2= 10.83

3. Results

Hence, to get desired temperature i.e. 42°c, there should be 350 turns of diameter 0.25 m.

B. Coal analysis

Coal used in power plant in India is low rank coal (LRC). LRC contains more amount of moisture as compared to other coal. We have done proximate analysis of coal in chemistry lab and found out percentage of moisture removed from coal after drying it at desired temperature. The procedure of proximate analysis is as follows.
Drying of coal is carried out under two conditions.
1. Ideal condition
2. Forced convection condition

1. Ideal condition

We carried out proximate analysis of coal and found percentage of moisture removed from LRC formula required for calculating percentage of moisture.

Procedure:
1. Take the weight of empty crucible=W1 gm
2. Put the coal in the crucible and weigh it=W2 gm
3. Heat the coal in the Owen for 1 hour at 50° c
4. Again weigh the crucible with the coal in 1 after heating=W3 gm

Observations:

1. W1= 15.748 gm
2. W2= 17.456 gm
3. W3=16.846 gm

Calculations:

$$\% \text{ moisture} = \frac{(W2-W3)}{(W2-W1)} \times 100$$

$$= \frac{(17.456-16.486)}{(17.456-15.7480)} \times 100$$

% moisture= 35.71 %

Results: Hence, moisture content is removed.

2. Forced convection condition

Input data:

Velocity of air=2.7 m/s
Temperature of air=48 ° c
Duration of test= 3 min
W1, weight of crucible=15.072 gm
W2, weight of coal and crucible=27.031 gm
W3, weight after drying at 48° c for 3 min=25.031 gm

Calculation:

$$\% \text{ moisture} = \frac{W2-W3}{W2-W1} \times 100$$

$$= \frac{27.031-25.031}{27.031-15.071} \times 100$$

=16.72 %

Hence, moisture content removed from coal is 16.72 %

II. ADVANTAGES

1. It doesn't require one separate unit.
2. Plant efficiency is increased.
3. Less initial cost.
4. Utilizes waste heat from power plant.
5. Power consumption to drive the conveyer belt is reduced due to reduction in weight of coal.
6. Low running cost. (Only to run the blower).
7. Long lasting solution on wet coal problems.
8. Load shading will get reduced.

III. CONCLUSION

There is a tremendous decrement of production rate due to wet coal condition in rainy season. So, by using this coal drying system, we can increase the rate of production of electricity in power plants in this season without much paying.

Ideally, there is 30-35% reduction of moisture from wet coal, but in practical model, there is reduction of 15-18% of moisture. But In actual condition in the power plant, it may reduce to about 6-7%. It is observed that from conventional dryers, by reducing 6% of moisture from coal, there is increase in 2.6-2.8% plant efficiency. So, this system will increase the plant efficiency more than that and it is more economical also.

ACKNOLEDGMENT

I would like to thank all my colleagues and dear ones who have directly and indirectly contributed me in this research work. I also express my gratitude towards my parents for their support in this research work.

REFERENCES

[1] Dr. Harun Bilirgen (Journal on Heat Transfer-ASME, Dec.2008 Vol.131).

[2] Prospect of Paras Thermal Power Plant (2*250MW), India.

[3] R. K. Rajput, "Heat & Mass Transfer", chapter- Forced Convection, Heat Exchangers, 1st Edition.

[4] Rainy season coal report, Paras Thermal Power Plant, India, 2010.

[5] R. K. Rajput, "Engg. Thermodynamics ", (chapter-13,page no.589-603).