

# Literature Review on the Effects of Wet Coal on Power Generation

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**Abstract:** A number of studies had been conducted on thermal power plant's operations & performance improvement. These studies depended on certain limited factors like equipment & machinery. The factors such as coal quality & coal handling & their effects on power generation hasn't been dealt & considered widely. The moisture in coal is present naturally and therefore there is nothing much that can be done on wet coal factor has been the ideologies of researchers. A change in approach is need of the hour. Moisture in coal plays a very significant role in operation & performance of thermal power plant. It also affects the economics & environmental impacts of power generation. This leads us to consider the issue of wet coal as a matter of serious concern. This paper attempts to review the available literature & highlight the effects of wet coal on power generation.

**Keywords:** Wet Coal, Thermal Power Plant, Moisture in Coal.

## INTRODUCTION

The understanding of the properties and the handling characteristics of liquids and gases is an essential requirement for most of the practicing engineers. Over the years there has been a remarkable amount of development and literature dealing with the fundamentals of liquid flow, fluid mechanics, hydraulics and related topics. But there has been no parallel development of the 'Bulk Solids Handling'. Bulk material handling is based on the design of equipment used for the transportation of materials such as 'coal' and consists of machinery like conveyors, chutes, hoppers, stacker and reclaimer, called as coal handling plant or CHP. While handling the coal in coal handling plant, lot of problems have been faced. One of the major problems faced during the rainy season is, 'wet coal receipt and it's unloading'. Due to receipt of wet, sticky

and muddy coal, the coal handling plant system collapsed frequently.

The efficiencies of power plant is in the range of 30 % to 50 %, this means that there is a loss of 50 to 70 % in power generation. The losses occur due to various reasons like incomplete combustion of coal, poor coal handling, improper working of machinery (turbine, compressor, fans, combustion chamber, etc.)The moisture content in coal is one of the main reasons behind losses. Therefore a lot depends upon the quality of coal being utilized. Quality of coal affects the physical, thermal, economical & environmental factors of a power plant.

## COAL WETNESS

It concludes from the coal formation process that coal is a product of number of natural elements like plant remains, animal remains, sand, minerals, etc. The carbon percentage in coal is related to the concentration of these elements. The amount of these elements determines the quality of coal. The coal is ranked on its moisture content, volatile content & carbon content. Excessive total moisture typically results from excessive rain and uncontrollably high surface water content in the raw coal. Coal from the mines, whether open cast or underground mining, is stored on stockpiles from where it is reclaimed for power station use. Wet coal poses more problems for open cast mining operations as it affects the whole operation of mining, removal of over burden, coal and transportation of coal to the coal stock yard operations.

## LITERATURE SURVEY

There is no any specific literature available on the studies related with the effect of excessive wet coal on electricity & remedial measures for it, but the subject has been emerged up through some news magazines and some reports. Some of them are collected and put here.

In the report by Govt. of India [12], it is stated that, Energy losses due to partial unavailability was above national average in the Western & Eastern Regions

mainly due to shortage of coal, coal handling problems, poor quality/wet coal and other miscellaneous problems and was minimum in the Southern Region.

M.R.Shelar [13] discussed the challenges before MGCO under which the wet coal problem is highlighted in the paragraph of 'Constraints during the Rainy Season'. In this paragraph, he discussed the issues of wet & sticky coal received in thermal power stations of MGCO, inability of LCW to avoid the supply of wet & sticky coal, constraints of MGCO to unload such wet & sticky coal and the efforts taking by MGCO to find the solutions.

In an inspection report of OTATPS [14] the coal quality related problems are studied & the solutions for unloading the wet, muddy & sticky coal are suggested. Results focused only on manual unloading of coal wagons in case of receipt of wet, muddy & sticky coal.

In the Facts & Figures Sheet From 'Escom'[15], the effect of excessively wet coal on production of electricity is discussed. It gives information on why the coal is wet? & how the power station faces problems in transportation of this wet coal up to the coal mills by chocking the transfer chutes, feeders and crusher and coal mills also. But, no solutions are suggested to handle this wet coal.

In a report [16], the complaints received from the consumers, regarding the receipt of excessive wet, sticky & muddy coal in some rakes are listed. Action taken by authority in this regard is mentioned in the report "Referred to concerned area for corrective action." But as per the report it was observed that even after the instructions to concerned area, the things were repeated in the succeeding month also. That means authority had shown their inability to solve the problem of sending wet, muddy & sticky coal to the power stations during the rainy season.

In airport on Performance Review of Thermal Power Stations by CEA [17], Coal quality Issues were discussed. Report on receipt of wet & sticky coal by some power stations is mentioned in this paragraph. But no solutions are recommended.

In the report of the Committee Constituted by CEA [18] the receipt of wet and sticky coal in the form of slurry during monsoon season is discussed. But again, solutions to solve this problem were not discussed.

Rod Hatt [18] discusses various reasons of wetness in coal. The effect of wet coal on heat rate and flow ability is also discussed. He suggests the use of high molecular weight polypropylene plastic chute liners to improve the flow ability of coal chutes. But the high molecular weight polypropylene plastic chute liners might create the problem when it gets detached from the chutes/ bunkers by choking the coal path.

The author had taken the example of one plant regarding the wet coal problem. One of the plant struggled for days with wet coal problems, while the coal yard processed the coal through hammer mills (coal crushers) as usual. When these crushers were by-passed, the plant situation improved considerably. He has not mentioned, how the crushers were by-passed, but ultimately the problem was solved after by-passing the crushers. This means that when the wet coal is received in the plant, the best solution is to not allow this coal to go through the crushers in order to run the coal handling plant smoothly.

Chittatosh Bhattachary, Nilotpl Banerjee, Hari Sadhan Sarkar, studied the economics of moisture in coal in power plants. They tabulated the analysis which is presented in the following table 1. [6]

Table 1  
Cost effects of moisture in coal

Reference coal	MCL coal	LCW coal	ECL coal
Coal rank	Non-coking gr. F	Non-coking gr. D	Non-coking gr. E
Recd" HHV (MJ/kg)	10.878	19.526	20.398
Coal price unit	Rs. ("07)	Rs. ("07)	Rs. ("07)
Coal price / MT	440.00	1210.00	1360.00
As received coal moisture (wt %)	15.00	19.50	1.95
Ref case : 2% decrease in "as fired" coal moisture			
As fired coal moisture (wt %)	13.00	17.50	0.0
As fired" LHV with 2% less moisture[wt%(AR)] in coal (MJ/kg)	10.404	18.889	20.111
Waste heat recovery savings in equivalent "as received" coal quantity in MTPD	139.45	85.79	212.38

**EFFECT OF WET COAL ON POWER PLANT:**

The effects of moisture can be classified into three categories, physical, chemical & cost:

**Physical effects [1,2,3,4]**

- Blocks transfer chutes
- Hang ups in bunkers
- Hindrance to free flow of coal.
- Clogging.
- Capacity reduction in tipplers, conveyors, crushers, bunkers and mills.
- Difficult to handle.
- Difficulty in grinding, milling and flowing coals
- Formation of rat-holes.
- Difficult to pulverize
- More mill power is required.
- Incomplete drying of coal.
- Increase in coal flow rate.
- Increased need for boiler maintenance.
- Increase in fan & mill power.
- Units may trip
- Load hunting.

**Chemical effects [5,6,7,8]**

- The amount of heat energy required to evaporate the moisture is greater than the boiler design allows.
- Lesser amount of coal fired into the boiler.
- Lesser amount of electricity generated.
- Decreases the gross calorific value of coal.
- Ash content in boiler increases.
- Flame temperature is lower.
- Decrease in boiler efficiency.
- Increase in air, flue gases flow rate.
- Increase in CO<sub>2</sub> & SO<sub>2</sub> mass emissions.

**Cost effects [9,10,11]**

- Increase in operation cost.
- Increase in maintenance costs.
- Decrease in coal purchase cost.
- The boiler efficiency decreases.
- Unit heat rate increases.
- Increased cost of generation

different technologies for coal drying purposes. It was observed that although dry coal is desirable, the cost of drying coal acts as a discouraging factor.

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**CONCLUSION**

The moisture content of coal plays a predominant role to differentiate grades of coal. The moisture content of coal has been the centre of attraction as it affects boiler efficiency, overall efficiency, working of machinery & operation & maintenance costs. This paper reviewed the effect of wet coal on power plant performance &