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Waste Slag Management with help of Air Blaster in CFBC Boiler

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Abstract: ***This research paper addresses the issue of excess ash content in CFBC boilers when lower quality fuel, such as the lower or upper layer of lignite, is supplied. The increase in ash content leads to the continuous draining of bed ash and often results in the restriction of bed material flow in the furnace inlet pipe to the slag cooler. While this may not have a significant impact on the required load in normal conditions, it can severely affect the unit's load capacity in the case of poor-quality coal. The paper proposes a solution for waste slag management using air blasters in 135 MW CFBC boiler, which can effectively prevent the choking of inlet pipes and ensure uninterrupted operation at the required load capacity. The implementation of this solution has the potential to significantly improve the operational efficiency and reliability of CFBC boilers, particularly when using lower quality fuels.***

Keywords**:** ***CFBC Boiler, Waste Management, Air Blaster, Slag, Bed Material Draining.***

I. INTRODUCTION

The utilization of low-quality fuel sources such as lignite in circulating fluidized bed combustion (CFBC) boilers has become increasingly common due to the depletion of conventional high-quality fuel sources. However, the use of such fuels often results in the production of a higher quantity of ash, which can create operational challenges for CFBC boilers. One of the significant challenges faced by these boilers is the choking of the inlet pipe from the furnace to the slag cooler due to the formation of excess ash content. This can cause a reduction in load capacity, leading to significant economic losses.

This research paper addresses the issue of waste slag management in CFBC boilers and proposes a solution to prevent the choking of the inlet pipe using air blasters. The proposed solution aims to improve the operational efficiency and reliability of CFBC boilers while utilizing low-quality fuel sources. The study highlights the operational challenges faced by CFBC boilers when lower quality fuels are utilized. Also discussed impact on the unit's to run at required load capacity. In this article, studied a significant implication of the power generation industry. This study will be very useful to improve the efficiency and reliability of CFBC boilers, particularly when using low-quality fuels.

II. LITERATURE REVIEW

Circulating fluidized bed combustion (CFBC) boilers have emerged as a promising technology for power generation due to their high fuel flexibility and lower emissions compared to conventional boilers. However, the utilization of low-quality fuel sources such as lignite, which is abundant in many regions, has posed challenges for the efficient and reliable operation of CFBC boilers. The production of excess ash content during the combustion of low-quality fuels can lead to operational challenges, including the choking of the inlet pipe from the furnace to the slag cooler.

Numerous studies have been conducted to investigate the impact of low-quality fuels on the performance of CFBC boilers. A study by Basu *et al.* (2015) found that the utilization of lower quality fuels such as lignite can result in higher ash content and fouling in the boiler. The study also highlights the importance of proper waste management strategies to prevent fouling and improve operational efficiency. Whereas, Gupta *et al.* (2019) investigated the operational challenges faced by CFBC boilers when using high-ash fuels and proposed solutions to prevent slag buildup.

Air blasters have been proposed as a solution for preventing the choking of the inlet pipe in CFBC boilers. A study by Pabon *et al.* (2019) investigated the use of air blasters for waste management in CFBC boilers and found that it effectively prevented slag buildup and improved operational efficiency. The study suggests that air blasters can be a cost-effective solution for managing waste in CFBC boilers, particularly when using low-quality fuels.

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In addition, the utilization of advanced technologies such as fluidized bed combustion with hot gas filtration and gasification can also improve the operational efficiency of CFBC boilers when using low-quality fuels (Gupta *et al*., 2019). These technologies will be helpful in reducing the formation of ash and fouling in the boilers, which may be lead to improved efficiency and reliability.

Overall, the literature highlights the challenges posed by low-quality fuels on the operational efficiency and reliability of CFBC boilers and the importance of waste management strategies to prevent fouling and improve efficiency. The proposed solution of using air blasters can be an effective and cost-efficient way to manage waste in CFBC boilers, particularly when using low-quality fuels. The utilization of advanced technologies can also aid in improving the efficiency and reliability of CFBC boilers when using low-quality fuels.

III. SLAG COOLER

Here, authors will not provide a detailed description of the present slag management system in the CFBC boiler for the sack of brevity. Although, it was mentioned that in the present system, the excess ash content is drained out continuously from the bed and sent to the water-cooled slag cooler for solidification. The cooled slag is then discharged and transported to the designated disposal site. The slag cooler consists of a series of tubes as shown in fig. 1. through which water flows to cool the slag, and then the water is circulated to a cooling tower for heat dissipation.



Fig. 1. Water Cooled Slag Cooler of CFBC Boiler

IV. AIR BLASTER

An air blaster is a device used for cleaning or dislodging materials that may have become stuck or accumulated in pipes, vessels, or other equipment. It operates by creating a high-pressure air pulse that is directed towards the material to be cleaned, dislodging it and allowing it to flow out of the equipment.

In the context of CFBC boilers, air blasters can be used for waste management to prevent slag buildup and choking of the inlet pipe from the furnace to the slag cooler. The air blasters are installed at strategic locations in the boiler and are programmed to discharge high-pressure air pulses at regular intervals to prevent the accumulation of slag. The high-pressure air pulse dislodges the slag and prevents it from accumulating in the inlet pipe, thereby improving the efficiency and reliability of the boiler.

The use of air blasters for waste management in CFBC boilers has been found to be effective in preventing slag buildup and reducing the frequency of bed ash draining. It is also a cost-effective solution compared to other waste management strategies such as manual cleaning or the installation of additional equipment.

V. METHODOLOGY

A. Construction

Schematic representation of air blaster through line diagram is shown in **Fig. 2**, an air blaster was installed at 9 M elevation from the ground floor in a CFBC Boiler unit, while the slag cooler was located at 5 M elevation. The air blaster consisted of a cylindrical vessel as shown in fig. 3 with a diameter of 450 mm and a height of 550 mm. The vessel was equipped with a pressure gauge and a pressure-relieving valve, with a maximum design pressure of 10 MPa and a maximum working pressure of 7 MPa.

To supply air to the air blaster, two lines were taken, one from the service air header and the other from the instrument air header. The air blaster was programmed to discharge high-pressure air pulses at regular intervals to prevent the accumulation of slag in the CFBC boiler.

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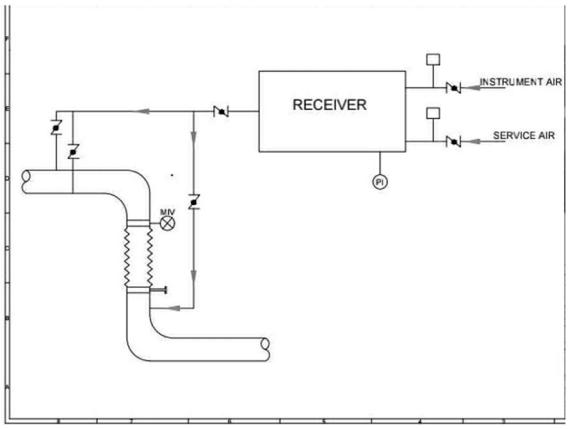


Fig. 2. Line Diagram of Air Blaster


Fig. 3. Air storage Vessel

B. Working Principal

The air feeding process of the air blaster can be divided into three phases. In the first phase, air is supplied from the Instrument header/service air header as per required operating pressure then stored pressurised air passes through a solenoid valve feed, in the inlet pipe there were multiple point where there is a higher chance of bed material getting dusty as presented in **Fig 2**. As per requirement operating command given by desk engineer from DCS.

In the second phase, a waiting period is initiated to create an air pressure equilibrium between the air circuit, triggering mechanism, and pressure vessel. In the third phase, upon activation, the solenoid valve opens, allowing pressurized air to enter the inlet pipe, resulting in a sudden blast of air from the pressure vessel. This phase is typically measured in milliseconds.

The cycle then repeats again at Phase 1, allowing for continuous slag management and preventing build-up in the CFBC boiler.

C. Cost Analysis

Table 1. Air Blaster Component cost analysis

Air Blaster Component cost analysis in INR			
Component	Price per piece	Quantity	Total Cost
Vessel	1800 INR	1	1800
Solenoid Valve	300 INR/Piece	4	1200
Manually operated valve (MIV)	200INR	5	1000
SS Pipe 0.5 inch and 2 inch	205 INR/kg	6 kg	1230
Electrical Cabel	40 INR/ m	60 meter	2400
Total			7630 INR

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D. Benefits of Air Blaster

The use of air blasters in slag management has proven to be a safer and more effective solution than the traditional method of poking by fitters. In the traditional method, fitters are required to manually poke the inlet pipe of the slag cooler, which can be unsafe due to the high temperatures and the risk of contact with the slag as shown in fig. 4.



Fig. 4. Slag Leakage in Inlet Pipe

In contrast, the air blaster system is fully automated and eliminates the need for manual poking. This reduces the risk of injury to personnel and ensures a safer working environment. Additionally, the air blaster system can be remotely controlled, further enhancing safety by keeping personnel at a safe distance from the equipment.

E. Result

The implementation of the air blaster for waste slag management in the CFBC Boiler was found to be effective in reducing the frequency of bed material flow restrictions caused by excess ash content. The air blaster was able to dislodge the clogging materials in the inlet pipe of the furnace to the slag cooler, preventing a reduction in load capacity and avoiding the need for manual cleaning methods that pose safety risks. Additionally, the use of the air blaster was found to be a more efficient and cost-effective (Shown in Table 1.) alternative to traditional cleaning methods, contributing to the overall optimization of the unit's performance.

VI. CONCLUSIONS

In conclusion, the installation of an air blaster for slag management in CFBC boilers has been found to be an effective solution to prevent slag buildup and reduce the frequency of bed ash draining. The air blaster's design and installation are critical to its successful operation, including the air feeding process, which is divided into three phases: air feeding, waiting, and blasting. By understanding the air blaster's functioning and its components, engineers can develop more efficient and cost-effective solutions for waste management in CFBC boilers. The air blaster's ability to continuously blast high-pressure air pulses at regular intervals has proven to be an effective and practical solution for slag management in CFBC boilers. Further studies can explore the optimization of air blaster parameters and investigate the long-term effects of air blasting on CFBC boilers' operation and maintenance.

VII. ACKNOWLEDGEMENT

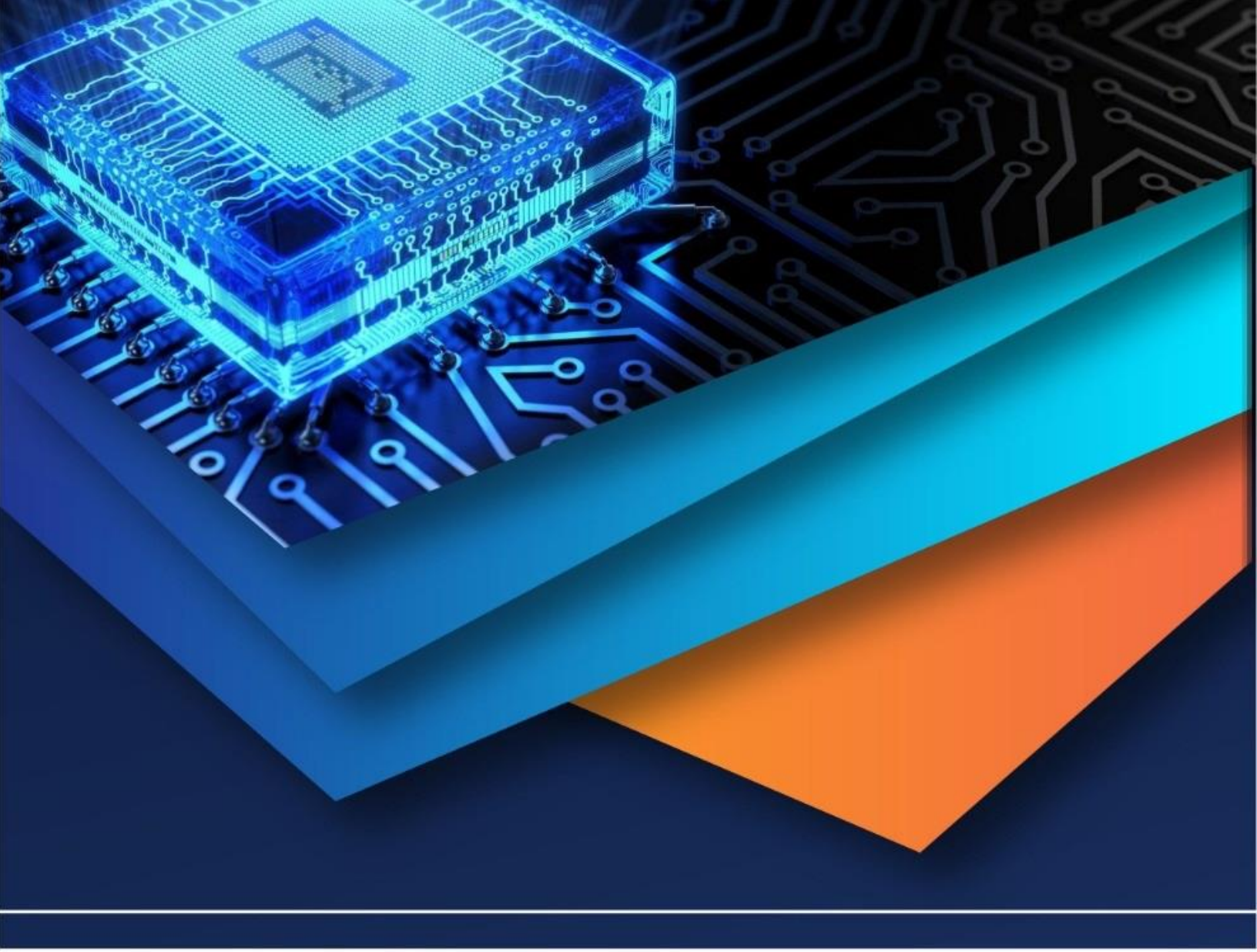
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