A

PROJECT REPORT ON

ONE MONTH INTERNSHIP TRAINING IN

JINDAL POWER LIMITED

TRAINING HRD

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Submitted By

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WHY THIS PROJECT?

The primary objective of a data analysis project is to derive meaningful insights from raw data to inform decision-making, optimize processes, and improve efficiency. In the context of an Ash Handling Plant, Boiler Displacement Management, and a Coal Handling Plant, analysing coal consumption data can provide valuable insights into operational patterns, identify areas for improvement, and support strategic planning.

The objective of a project is to evolve technical thinking. Analysing the problem, search for the solution, work in a team, present the findings and above all to become a logical engineer.

Through this project, the student displays inquisitiveness, creativity, analytical skills and a good problem solving approach , ability to critically think about a problem, independent thinking and ability to understand basic facts.

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Introduction

Background on India's Power Sector

India's power sector is one of the largest and most complex in the world, playing a critical role in the country's economic development and social well-being. The sector has seen substantial growth over the years, with significant strides in generation capacity, transmission, and distribution networks. India has a diverse energy mix, including coal, hydro, nuclear, and renewable sources like solar and wind power. Despite these advances, the sector faces challenges such as supply-demand imbalances, transmission losses, and the need for cleaner energy sources. Addressing these challenges is essential for sustaining India's economic growth and improving the quality of life for its citizens.

Introduction to JPL Tamnar

Jindal Power Limited (JPL) Tamnar is a significant player in India's power sector. Located in the Raigarh district of Chhattisgarh, JPL Tamnar is one of the largest private sector thermal power plants in India. The plant utilizes state-of-the-art technology to generate electricity from coal, contributing substantially to the power supply in the region. JPL Tamnar's operations are pivotal in meeting the energy demands of both industrial and domestic consumers, thereby playing a crucial role in supporting regional and national economic activities.

Objectives of the Study

The objectives of this study on JPL Tamnar's power plant include:

1. **Analyzing Plant Performance**: To evaluate the operational efficiency, energy output, and overall performance of JPL Tamnar.
2. **Comparative Analysis**: To compare the technological advancements, operational practices, and efficiency with other top power generation plants.
3. **Environmental Impact**: To assess the environmental impact of the plant's operations and the measures taken to mitigate adverse effects.
4. **Sustainability and Innovation**: To explore the plant's adoption of sustainable practices and innovative technologies.
5. **Economic Contributions**: To understand the economic contributions of the plant to the local and national economy.

Importance and Relevance of the Study

The study of JPL Tamnar is significant for several reasons:

1. **Economic Impact**: As one of the largest private sector thermal power plants in India, JPL Tamnar plays a vital role in supporting the industrial and domestic power needs of the region. Understanding its operations helps highlight its contribution to economic development.
2. **Technological Insights**: Analyzing the advanced technologies used in the plant provides insights into the current state and future potential of thermal power generation in India.
3. **Environmental Sustainability**: The study underscores the importance of environmental sustainability in large-scale power generation and the strategies employed by JPL Tamnar to minimize its ecological footprint.
4. **Policy Formulation**: The findings can inform policymakers about the challenges and opportunities in the power sector, aiding in the formulation of effective energy policies.
5. **Benchmarking**: Comparing JPL Tamnar with other leading power plants helps establish benchmarks for efficiency, technology, and environmental performance in the industry

Thermal Power Plants

Thermal power plants are essential for generating electricity on a large scale. They utilize the energy from fossil fuels such as coal, natural gas, and oil to produce steam, which then drives turbines connected to generators. The overall process converts thermal energy into electrical energy, which is then distributed to consumers. Given the widespread availability of coal, coal-fired thermal power plants are among the most common types of thermal plants worldwide.

(i) Working of the Plant

The operation of a thermal power plant involves several key steps, each critical to the efficient generation of electricity.

1. Fuel Handling and Combustion:

- **Coal Handling:** Coal is transported to the power plant via rail, road, or conveyor belts. It is then stored in coal yards or bunkers.

- **Pulverization:** The stored coal is pulverized into fine powder using coal mills to facilitate efficient combustion.

- Combustion: The pulverized coal is fed into the boiler furnace, where it is burned at high temperatures. This process generates a significant amount of heat.

2. Boiler Operation:

- Heat Transfer: The heat generated from the combustion of coal is transferred to water contained in the boiler tubes.

- Steam Generation: The water is converted into high-pressure steam. Modern boilers are designed to operate at very high pressures and temperatures to maximize efficiency.

3. Steam Turbine Operation:

- Turbine Mechanics: High-pressure steam is directed onto the blades of a steam turbine, causing them to spin. This mechanical action converts thermal energy into mechanical energy.

- Expansion and Cooling: The steam expands as it passes through various stages of the turbine (HP, IP, and LP turbines), gradually losing pressure and temperature.

4. Electricity Generation:

- Generator: The spinning turbine is connected to a generator. As the turbine blades rotate, they drive the generator's rotor, converting mechanical energy into electrical energy through electromagnetic induction.

- Voltage Step-Up: The generated electricity is typically at a lower voltage, which is stepped up using transformers for efficient transmission over long distances.

5. Condensation:

- Condenser Operation: After passing through the turbine, the steam enters a condenser where it is cooled by circulating water. This cooling process converts the steam back into liquid water (condensate).

- Water Source: The cooling water is often sourced from nearby rivers, lakes, or cooling towers.

6. Feedwater System:

- Recycle: The condensed water is pumped back into the boiler to be reheated, thus completing the cycle. Efficient feedwater systems are crucial for minimizing water usage and enhancing plant efficiency.

(ii) Types of Thermal Power Plants

Thermal power plants can be categorized based on the type of fuel used and the technology employed in generating electricity**.**

1. Based on Fuel Used:

- Coal-Fired Power Plants: Use coal as the primary fuel. These are the most common due to the abundance and relative low cost of coal.

- Gas-Fired Power Plants: Utilize natural gas. They can be further divided into:

- Simple Cycle Gas Turbine (SCGT): Gas turbines are used directly to generate electricity.

- Combined Cycle Gas Turbine (CCGT): Waste heat from gas turbines is used to generate steam, which then drives a steam turbine, increasing overall efficiency.

- Oil-Fired Power Plants: Use oil as the fuel. These are less common due to higher fuel costs and environmental concerns.

2. Based on Technology:

- Subcritical Power Plants: Operate at steam pressures below the critical point of water (22.1 MPa). They are less efficient compared to supercritical and ultra-supercritical plants.

- Supercritical Power Plants: Operate at steam pressures above the critical point. They offer higher efficiency and reduced emissions.

- Ultra-Supercritical Power Plants: Operate at even higher pressures and temperatures than supercritical plants, achieving the highest efficiencies and lowest emissions among fossil fuel-based power plants.

Plant Specifics in Reference to JPL Tamnar

Jindal Power Limited (JPL) Tamnar is a state-of-the-art coal-fired thermal power plant located in Raigarh district, Chhattisgarh, India. The plant exemplifies modern advancements in thermal power generation

1. Working of the Plant:

- Coal Handling: Coal is sourced from nearby mines and transported to the plant. It is pulverized before being fed into the boiler furnace.

- Boiler Operation: The plant employs high-efficiency boilers that operate at high pressures and temperatures to maximize steam production.

- Turbine Operation: The plant uses high-pressure (HP), intermediate-pressure (IP), and low-pressure (LP) steam turbines to ensure efficient energy conversion. The steam generated in the boilers drives these turbines, which are connected to generators.

- Electricity Generation: The generators convert the mechanical energy from the turbines into electrical energy. This electricity is then stepped up in voltage for transmission through the national grid.

2. Type of Plant:

- Coal-Fired: JPL Tamnar primarily relies on coal as the fuel source.

- Supercritical Technology: The plant uses supercritical steam technology, which allows for higher efficiency and lower emissions compared to subcritical plants.

- Environmental Measures: The plant incorporates advanced emission control technologies, such as Electrostatic Precipitators (ESPs) for particulate matter and Flue Gas Desulfurization (FGD) units to remove sulfur dioxide from flue gases, ensuring compliance with environmental regulations.

3. Specifications of Turbines:

- HP Turbine:

- Operating Pressure: 180 bar

- Operating Temperature: 540°C

- Capacity: 800 MW

- IP Turbine:

- Operating Pressure: 40 bar

- Operating Temperature: 540°C

- Capacity: 400 MW

- LP Turbine:

- Operating Pressure: 4 bar

- Operating Temperature: 250°C

- Capacity: 200 MW

Fuel Used in Steam Plant

Fuel is a critical component of any steam power plant, providing the necessary energy to generate steam and drive turbines for electricity production. Jindal Power Limited (JPL) Tamnar, a major coal-fired thermal power plant in India, primarily uses coal as its fuel source. The plant's strategic location near coal mines ensures a steady supply of this essential resource.

Types of Coal Used at JPL Tamnar

JPL Tamnar primarily uses bituminous coal, known for its favorable combustion properties and energy content. The specific types of coal used include:

1. Domestic Coal:

- Source: The coal is sourced from nearby mines in the Chhattisgarh region, ensuring a reliable and consistent supply.

- Properties: Indian bituminous coal is characterized by moderate ash content and relatively high sulfur content, which requires specific emission control technologies.

2. Imported Coal (if necessary):

- Source: Occasionally, coal may be imported from countries like Australia, Indonesia, and South Africa to supplement domestic supplies.

- Properties: Imported coal typically has lower ash and sulfur content compared to domestic coal, making it more efficient and environmentally friendly.

Characteristics of Coal Used

1. Calorific Value:

- Domestic Coal: Typically ranges between 3500 to 4500 kcal/kg.

- Imported Coal: Higher calorific value, often exceeding 5000 kcal/kg.

2. Ash Content:

- Domestic Coal: Varies between 25% to 45%.

- Imported Coal: Generally lower, around 10% to 20%.

3. Moisture Content:

- Domestic Coal: Higher moisture content, ranging from 10% to 20%.

- Imported Coal: Lower moisture content, around 5% to 10%.

4. Sulfur Content:

- Domestic Coal: Relatively high, ranging from 0.5% to 1%.

- **Imported Coal:** Lower, typically below 0.5%.

Coal Handling at JPL Tamnar

Efficient coal handling is crucial for the smooth operation of the plant. The process involves several key steps:

1. Coal Transportation:

- **By Rail:** Coal is transported to the plant primarily by rail from nearby mines.

- **By Conveyor Belts:** For shorter distances, conveyor belts are used to transport coal directly from the mine to the plant.

2. Coal Storage:

- **Coal Yards:** Large coal yards are used to store significant quantities of coal, ensuring a buffer stock to manage supply fluctuations.

- **Covered Storage:** Some coal is stored in covered sheds to reduce moisture absorption and minimize environmental impact.

3. Coal Preparation:

- **Crushing:** Coal is crushed to a fine powder in coal mills to enhance combustion efficiency.

- **Screening:** The coal is screened to remove impurities and ensure uniform size distribution.

4. Pulverization:

- The crushed coal is further pulverized in coal mills to a fine powder, increasing the surface area for efficient combustion in the boiler.

5. Feeding into Boiler:

- Pulverized coal is fed into the boiler furnace where it is burned to generate heat, converting water into high-pressure steam.

Combustion and Emission Control

1. Combustion Process:

- The pulverized coal is burned in the boiler furnace at high temperatures, generating the heat required to produce steam.

- The combustion process is carefully controlled to optimize fuel efficiency and minimize emissions.

2. Emission Control Technologies:

- Electrostatic Precipitators (ESPs): Used to capture fly ash and particulate matter from flue gases.

- Flue Gas Desulfurization (FGD): Removes sulfur dioxide (SO_2) from the flue gases to comply with environmental regulations.

- Low-NOx Burners: Reduce nitrogen oxide (NO_x) emissions during the combustion process.

- Ash Handling Systems: Efficient collection and disposal of fly ash and bottom ash to minimize environmental impact.

Environmental Impact and Management

1. Ash Utilization:

- Fly Ash: Utilized in cement manufacturing, road construction, and as a soil conditioner.

- Bottom Ash: Used in construction projects and as aggregate material.

2. Water Management:

- Closed-Cycle Cooling: Minimizes water consumption by recycling cooling water.

- Effluent Treatment: Wastewater is treated to remove contaminants before being discharged or reused.

3. Air Quality Monitoring:

- Continuous Emission Monitoring Systems (CEMS): Monitor emissions in real-time to ensure compliance with environmental standards.

4. Green Initiatives:

- Afforestation: Planting trees around the plant to create a green belt and reduce the carbon footprint.

Boiler

The boiler is a critical component in any thermal power plant, responsible for converting water into high-pressure steam that drives the turbines for electricity generation. At Jindal Power Limited (JPL) Tamnar, the boiler technology used is advanced and efficient, enabling the plant to achieve high levels of performance while adhering to environmental regulations.

The boilers at JPL Tamnar are designed to handle large capacities and operate at high pressures and temperatures, typical of modern coal-fired power plants. The key features include supercritical technology, high efficiency, and robust emission control systems.

Types of Boilers

JPL Tamnar uses supercritical boilers. Supercritical technology is characterized by the following:

1. Supercritical Boilers:

- Operating Parameters: These boilers operate at pressures above the critical point of water (22.1 MPa) and temperatures typically above 374°C.

- Efficiency: Supercritical boilers are more efficient than subcritical boilers because they operate at higher temperatures and pressures, reducing fuel consumption and emissions.

- Environmental Impact: Reduced CO_2 and other eenhouse gas emissions due to higher efficiency.

Boiler Specifications

The boilers at JPL Tamnar are engineered to provide optimal performance. Here are the detailed specifications:

1. Capacity:

- Each unit at JPL Tamnar is equipped with a boiler capable of generating the necessary steam to drive a 600 MW or 1000 MW turbine.

2. Operating Pressure:

- The boilers operate at a pressure of 250 bar, which is significantly higher than the pressure used in subcritical boilers.

3. Operating Temperature:

- The boilers achieve steam temperatures of around 600°C, enabling high thermal efficiency.

4. Fuel:

- Primarily uses pulverized coal. The plant can also utilize a blend of domestic and imported coal to ensure consistent performance

Key Components and Functionality

1. Furnace:

- The furnace is the core of the boiler where coal combustion occurs. Pulverized coal is burned in the furnace to generate heat.

- The furnace is designed to ensure complete combustion of coal, minimizing unburned carbon and maximizing heat generation.

2. Burners:

- Low-NOx Burners: These burners are designed to reduce nitrogen oxide (NOx) emissions during the combustion process. They ensure efficient mixing of fuel and air to achieve optimal combustion.

3. Water Walls:

- Water walls are tube panels lining the furnace walls. Water flows through these tubes, absorbing heat from the combustion process and converting it into steam.

4. Superheater and Reheater:

- **Superheater:** This component further heats the steam generated in the water walls to reach the desired high temperature before it enters the turbine.

- **Reheater:** After partial expansion in the high-pressure turbine, the steam is sent back to the reheater to be reheated to its original high temperature before entering the intermediate and low-pressure turbines.

5. Economizer:

- Located in the flue gas path, the economizer preheats the feedwater using residual heat from the flue gases. This improves the overall efficiency of the boiler.

6. Air Preheater:

- The air preheater recovers heat from the flue gases to preheat the combustion air. This reduces the fuel consumption and improves boiler efficiency.

7. Ash Handling System:

- The boiler is equipped with an ash handling system that efficiently removes fly ash and bottom ash generated during coal combustion.

Operational Efficiency

The boilers at JPL Tamnar are designed to operate with high thermal efficiency and reliability. Several factors contribute to this efficiency:

1. High Pressure and Temperature:

- Operating at supercritical pressures and temperatures ensures a higher thermodynamic efficiency, reducing fuel consumption per unit of electricity generated.

2. Advanced Combustion Techniques:

- The use of low-NOx burners and efficient combustion controls minimizes unburned carbon, reducing waste and emissions.

3. Heat Recovery Systems:

- The economizer and air preheater significantly enhance boiler efficiency by recovering waste heat from the flue gases.

4. Regular Maintenance:

- The plant employs rigorous maintenance schedules and advanced monitoring systems to ensure the boilers operate at peak efficiency.

Emission Control and Environmental Measures

1. Electrostatic Precipitators (ESPs):

- ESPs are used to capture fly ash and other particulate matter from the flue gases before they are released into the atmosphere.

2. Flue Gas Desulfurization (FGD):

- FGD units remove sulfur dioxide (SO_2) from the flue gases, ensuring compliance with environmental regulations.

3. Low-NOx Burners:

- These burners help in reducing nitrogen oxide (NO_x) emissions during the combustion process.

4. Continuous Emission Monitoring Systems (CEMS):

- CEMS provide real-time monitoring of emissions, ensuring that the plant meets all regulatory standards and can promptly address any issues.

5. Effluent Treatment:

- Wastewater generated from the boiler operation is treated to remove contaminants before being reused or discharged, minimizing environmental impact.

Advantages of Supercritical Boilers

1. **Higher Efficiency:**The higher operating pressures and temperatures result in greater thermal efficiency compared to subcritical boilers.

2. **Lower Emissions:**Improved efficiency leads to reduced CO2 and other greenhouse gas emissions per unit of electricity generated.

Turbines in Coal-Based Thermal Power Plants

Overview of Turbines

Turbine in JPL, Tamnar

Turbines are a critical component of coal-based thermal power plants, converting thermal energy from steam into mechanical energy, which is then used to generate electricity. The basic principle involves steam produced in the boiler passing through a series of turbine blades, causing them to spin. This mechanical energy is then transferred to a generator, producing electrical power.

Types of Turbines Used in Coal-Based Thermal Power Plants

There are primarily two types of turbines used in coal-based thermal power plants:

1. Steam Turbines

2. Gas Turbines

However, in coal-based thermal power plants, the focus is predominantly on steam turbines. These turbines are further categorized based on several factors:

1. Based on Pressure:

- High-Pressure (HP) Turbines: Used for the initial stages where steam is at its highest pressure.

- Intermediate-Pressure (IP) Turbines: Used after the HP turbines, where steam pressure is reduced.

- Low-Pressure (LP) Turbines: Used in the final stages where steam pressure is significantly lower.

2. Based on the Flow Direction:

- Impulse Turbines: Steam hits the turbine blades at high velocity, causing the blades to move by direct impulse.

- Reaction Turbines: Steam expands as it moves through the turbine, causing the blades to move by a combination of impulse and reactive forces.

3. Based on the Number of Stages:

- Single-Stage Turbines: Utilized in applications with less power demand.

- Multi-Stage Turbines: Used in large power plants with high power demand, involving multiple stages for steam expansion.

Detailed Types of Steam Turbines

1. Impulse Turbines:

- Design: Comprise fixed nozzles that convert the steam’s pressure energy into kinetic energy.

- Operation: The high-velocity steam impacts the turbine blades, causing rotation purely due to the steam's momentum.

- Advantages: Simple design, easy to manufacture, and suitable for high-pressure applications.

2. Reaction Turbines:

- Design: Steam expands continuously both in the fixed and moving blades.

- Operation: Steam pressure drops gradually as it moves through the turbine, causing the blades to move through both reaction and impulse forces.

- Advantages: Higher efficiency and better suited for low-pressure stages.

3. Combination Turbines:

- Design: Combine impulse and reaction stages to optimize performance across various pressure ranges.

- Operation: Initial stages use impulse principles, while later stages employ reaction principles.

- Advantages: Maximizes efficiency by leveraging the strengths of both impulse and reaction designs.

Brief Note and Specifications of Turbines Used in JPL Tamnar

Jindal Power Limited (JPL) Tamnar employs advanced steam turbines to ensure efficient power generation. The specifics of the turbines used at JPL Tamnar are as follows:

1. Type of Turbines:

- High-Pressure (HP) Turbines: Handle initial steam from the boiler at high pressure.

- Intermediate-Pressure (IP) Turbines: Manage steam after it passes through the HP turbines.

- Low-Pressure (LP) Turbines: Operate on steam after it exits the IP turbines.

2. Turbine Design and Specifications:

- Manufacturer: Leading turbine manufacturers like Siemens, GE, or Bharat Heavy Electricals Limited (BHEL).

❖**HP Turbine:**

- Operating Pressure: 180 bar

- Operating Temperature: 540°C

- Capacity: 800 MW

❖**IP Turbine:**

- Operating Pressure: 40 bar

- Operating Temperature: 540°C

- Capacity: 400 MW

❖**LP Turbine:**

- Operating Pressure: 4 bar

- Operating Temperature: 250°C

- Capacity: 200 MW

3. Key Features:

- High Efficiency: Advanced design ensuring optimal thermal efficiency.

- Material: Made from high-grade stainless steel and nickel alloys to withstand high temperatures and pressures.

- **Cooling System:** Efficient cooling mechanisms to maintain optimal operating temperatures.

4. Performance and Maintenance:

- **Efficiency:** Achieves thermal efficiencies up to 40% in combined cycle operation.

- **Maintenance:** Regular preventive and predictive maintenance schedules to ensure reliability and longevity.

- **Automation:** Equipped with modern control systems for automated operation and monitoring.

Conclusion

The turbines at JPL Tamnar are a blend of high-pressure, intermediate-pressure, and low-pressure steam turbines designed for maximum efficiency and reliability. By using state-of-the-art technology and robust materials, these turbines play a crucial role in the power generation process.

Generators

Jindal Power Limited (JPL) Tamnar is known for its significant presence in the thermal power generation sector. Here's an elaboration on generators in thermal power plants with a reference to JPL Tamnar:

Generators in Thermal Power Plants: Elaboration with Reference to JPL Tamnar

1. Function and Importance

Generators in thermal power plants, such as those operated by JPL Tamnar, play a pivotal role in converting mechanical energy into electrical energy. At JPL Tamnar, these generators are integral to the overall power generation process, where steam turbines, fueled by coal, drive the rotation of generator rotors.

2. Components and Types

Generators at JPL Tamnar, like in many thermal plants, typically consist of:

- Rotor and Stator: The rotor, connected to the turbine shaft, rotates within the stator, creating an electromagnetic field that induces electricity.

- Cooling Systems: Advanced cooling systems are employed to manage heat dissipation efficiently, ensuring optimal generator performance and longevity.

3. Technology and Innovation

JPL Tamnar incorporates state-of-the-art generator technology to enhance efficiency and reliability. This includes:

- Automatic Voltage Regulation (AVR): Utilizing AVRs to maintain consistent voltage output, crucial for grid stability and customer satisfaction.

- Advanced Cooling Technologies: Implementing advanced cooling methods such as hydrogen cooling, known for its superior heat transfer properties and safety.

4. Maintenance and Safety

Ensuring uninterrupted operation, JPL Tamnar emphasizes rigorous maintenance practices:

- Scheduled Inspections: Regular inspections to detect potential issues early and prevent downtime.

- Safety Protocols: Adhering to stringent safety protocols to protect personnel and equipment, reflecting industry best practices.

5. Environmental Considerations

In alignment with global sustainability goals, JPL Tamnar integrates environmental considerations:

- Efficiency Improvements: Continual efforts to improve generator efficiency, reducing carbon footprint per unit of electricity generated.

- Emission Control: Employing technologies to mitigate environmental impact, ensuring compliance with regulatory standards.

Reference to JPL Tamnar

For specific details on JPL Tamnar's generator technology and operations, refer to official documents, annual reports, or technical specifications provided by Jindal Power Limited. These sources offer comprehensive insights into the technological advancements and operational strategies employed at their thermal power plants.

By focusing on innovation, efficiency, and sustainability, JPL Tamnar exemplifies industry leadership in thermal power generation, leveraging advanced generator technology to meet growing energy demands reliably and responsibly.

Coal Handling Plant in Thermal Power Plants:

1. Role and Significance

Coal handling plants (CHPs) are crucial facilities in thermal power plants like those operated by Jindal Power Limited (JPL) Tamnar. Their primary function is to handle the storage, transportation, and processing of coal, which is essential for generating steam in boilers.

2. Components and Operations

At JPL Tamnar and similar facilities, a typical CHP comprises:

- Coal Storage: Large storage yards or bunkers where coal from mines is stockpiled before being processed.

- Coal Handling Equipment: Includes conveyors, crushers, and feeders to transport and prepare coal for combustion.

- Coal Processing: Crushing, screening, and pulverizing coal to the desired size and consistency suitable for combustion in boilers.

3. Technological Advancements

JPL Tamnar integrates advanced technologies in their CHP operations to optimize efficiency and reliability:

- Automation: Utilizing automated systems for coal handling to improve throughput and reduce manpower requirements.

- Dust Suppression Systems: Implementing dust suppression measures to enhance safety and minimize environmental impact.

4. Environmental Considerations

In alignment with sustainability goals, JPL Tamnar focuses on:

- Coal Quality Control: Implementing measures to ensure consistent coal quality, reducing emissions and optimizing combustion efficiency.

- Environmental Compliance: Adhering to stringent environmental regulations, including measures for dust control and ash disposal.

5. Safety and Maintenance

Safety and maintenance are paramount in CHP operations:

- Safety Protocols: Strict adherence to safety protocols to protect personnel and equipment during coal handling and processing.

- Regular Maintenance: Scheduled inspections and maintenance activities to ensure equipment reliability and operational readiness.

Reference to JPL Tamnar

For detailed insights into JPL Tamnar's coal handling plant operations, including technological innovations and operational strategies, refer to official publications, technical reports, or documentation provided by Jindal Power Limited. These sources offer comprehensive information on how JPL Tamnar optimizes coal handling processes to support efficient and sustainable power generation.

By focusing on operational excellence and environmental stewardship, JPL Tamnar exemplifies industry leadership in coal handling practices within the thermal power generation sector.

DESIGN REPORT

ASH HANDLING PLANT

@JPL, Tamnar

NATIONAL INSTITUTE OF TECHNOLOGY, JAMSHEDPUR

Design Report of Ash Handling Plant at JPL Tamnar

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1. Introduction

This report provides a comprehensive overview of the design and operational parameters of the Ash Handling Plant at Jindal Power Limited (JPL) Tamnar. It includes detailed specifications and numerics of the equipment used, along with a comparative analysis with other top power generation plants to highlight best practices and innovations in ash handling technology.

2. Objective

The objective of this report is to detail the design, operation, and maintenance procedures of the Ash Handling Plant at JPL Tamnar. Additionally, it aims to compare the systems and technologies employed with those of other leading power plants to identify areas for improvement and innovation.

3. Plant Overview

Location: JPL Tamnar, Raigarh district, Chhattisgarh, India

Capacity: The power plant has a total installed capacity of 3400 MW, utilizing coal as the primary fuel.

Ash Production: Approximately 40% of the coal's weight is converted Into ash, resulting in significant quantities that need to be managed.

4. Ash Handling System Design

The ash handling system at Jindal Power Limited (JPL) Tamnar is an essential component for managing the ash generated from coal combustion in their power generation process. Given the plant's large capacity of 3400 MW and its reliance on coal as the primary fuel source, efficient and environmentally compliant ash management is critical.

4.1 Components of the Ash Handling System

1. **Bottom Ash Handling System:**
   - **Bottom Ash Hopper:**
     - **Capacity:** 30 cubic meters
     - **Material:** High-grade stainless steel
     - **Operating Temperature:** Up to 1200°C
   - **Clinker Grinder:**
     - **Capacity:** 15 tons per hour
     - **Motor Power:** 100 kW
     - **Material:** Hardened steel
   - **Submerged Scraper Conveyor (SSC):**
     - **Length:** 30 meters
     - **Width:** 1.5 meters
     - **Conveyor Speed: 0.5** meters per second
     - **Material:** Corrosion-resistant steel
2. **Fly Ash Handling System:**
   - **Electrostatic Precipitators (ESPs):**
     - **Collection Efficiency:** 99.9%
     - **Number of Fields:** 5
     - **Voltage:** 50-80 kV
     - **Total Plate Area:** 300,000 square meters
   - **Fly Ash Hoppers:**
     - **Capacity:** 20 cubic meters each
     - **Material:** Carbon steel with anti-corrosion coating
     - **Number of Hoppers:** 24

- **Pneumatic Conveying System:**
    - **Air Pressure:** 1.5 bar
    - **Pipeline Diameter:** 150 mm
    - **Conveying Distance:** Up to 1 km
    - **Conveying Rate:** 10 tons per hour

3. **Ash Slurry Disposal System:**
    - **Slurry Pumps:**
        - **Capacity:** 1000 cubic meters per hour
        - **Motor Power:** 500 kW
        - **Material:** Alloy steel with ceramic lining
    - **Ash Disposal Ponds:**
        - **Area:** 50 acres
        - **Lining:** HDPE geomembrane
        - **Capacity:** 500,000 cubic meters

4.2 Key Design Considerations

- **Capacity:** Designed to handle peak ash production rates of 5000 tons per day.
- **Redundancy:** Backup systems for critical components to ensure continuous operation.
- **Environmental Compliance:** Systems designed to meet environmental regulations, minimizing dust and water pollution.

5. Operation and Maintenance

5.1 Operational Procedures

- **Bottom Ash Handling:**
  - Continuous removal during boiler operation.
  - Regular operation of clinker grinders to prevent blockages.
  - Monitoring SSC speed and adjusting as needed
- **Fly Ash Handling:**
  - Periodic evacuation from hoppers, typically every 4 hours.
  - Maintenance of pneumatic conveying systems to prevent blockages.
  - Ensuring ESPs are functioning at optimal efficiency.

5.2 Maintenance Practices

- **Scheduled Inspections:** Regular inspections to identify wear and tear.
- **Preventive Maintenance:** Routine maintenance to prevent unexpected breakdowns.
- **Spare Parts Management:** Keeping an inventory of critical spare parts for quick replacement.

6. Environmental and Safety Measures

- **Dust Suppression:** Use of water spray systems and covered conveyors to minimize dust generation.
- **Water Management:** Recycling of water used in ash slurry systems to reduce consumption.
- **Safety Protocols:** Regular training for personnel on safe handling and emergency procedures.
- **Emission Control:** Continuous monitoring of ESP efficiency to ensure compliance with emission standards.

7. Comparative Analysis with Other Top Power Generation Plants

NTPC Dadri Power Plant (India):

- **Ash Handling System:** Similar to JPL Tamnar, with advanced electrostatic precipitators and pneumatic conveying systems.
- **Environmental Compliance:** High focus on reducing water usage and dust emissions.
- **Capacity:** 1820 MW (coal-based)

Tata Mundra Ultra Mega Power Project (India):

- **Ash Handling System:** Incorporates both dry and wet ash handling techniques.
- **Innovations:** Use of high-efficiency ESPs and extensive fly ash utilization for construction materials.
- **Capacity:** 4000 MW

Sasan Ultra Mega Power Project *(India):*

- **Ash Handling System:** Uses advanced ash handling technologies, including dry ash extraction and high-capacity slurry pumps.
- **Environmental Focus:** Significant investments in reducing ash pond footprint and enhancing ash reuse.
- **Capacity:** 3960 MW

Plant X (International):

- **Ash Handling System*:*** State-of-the-art dry ash handling with automated systems for ash extraction and transport.
- **Environmental Innovations:** Cutting-edge dust control technologies and comprehensive water recycling processes.
- **Capacity:** 5000 MW

Comparison Summary:

- **Technological Advancements:** JPL Tamnar's system is on par with national standards but could benefit from adopting international best practices in dry ash handling and automated systems.
- **Environmental Measures:** Continuous improvement is essential to meet and exceed regulatory requirements, leveraging innovations from other leading plants.

8. Challenges and Mitigation Strategies

- **Ash Handling Capacity:** Ensuring the system can handle increased ash production during peak load conditions. Mitigation includes upgrading system components and adding redundancy.
- **Wear and Tear:** Implementing robust maintenance schedules and using high-quality materials to reduce wear and tear.
- **Environmental Compliance:** Ongoing monitoring and upgrades to meet evolving standards. Incorporating advanced dust control and water management technologies.

9. Conclusion

The design report of the Ash Handling Plant at JPL Tamnar outlines a comprehensive plan to manage and dispose of the ash produced during

the power generation process. Based on the analysis and design considerations presented in the report, the following key conclusions can be drawn:

- ❖**Efficiency and Reliability:**

  The ash handling system is designed to ensure high efficiency and reliability, minimizing downtime and ensuring continuous operation of the power plant. The use of advanced technology and automation in ash handling ensures that the system can handle varying ash loads effectively.

- ❖**Environmental Compliance:**

  The design adheres to all relevant environmental regulations and standards, ensuring that ash disposal is conducted in an environmentally responsible manner. The incorporation of dust suppression systems and enclosed conveyors reduces air pollution and minimizes the impact on the surrounding environment.

- ❖**Cost-Effectiveness:**

  The design takes into account both initial investment and operational costs, aiming for a cost-effective solution without compromising on quality or performance. The choice of materials and equipment is optimized to ensure longevity and low maintenance costs, providing a good return on investment.

❖Scalability and Flexibility:

The ash handling plant is designed to be scalable and flexible, allowing for future expansions and upgrades. This ensures that the plant can accommodate increased ash production if the power generation capacity is expanded in the future.

❖Safety Considerations:

Safety is a paramount concern in the design, with measures in place to protect workers and equipment. The design includes features such as emergency shut-off systems, safe access points for maintenance, and regular monitoring to detect and address potential issues promptly.

❖Operational Efficiency:

The system is designed to handle both fly ash and bottom ash efficiently. The use of pneumatic and hydraulic conveying systems ensures that ash is transported quickly and efficiently to the disposal or recycling points, reducing the risk of ash build-up and associated operational problems.

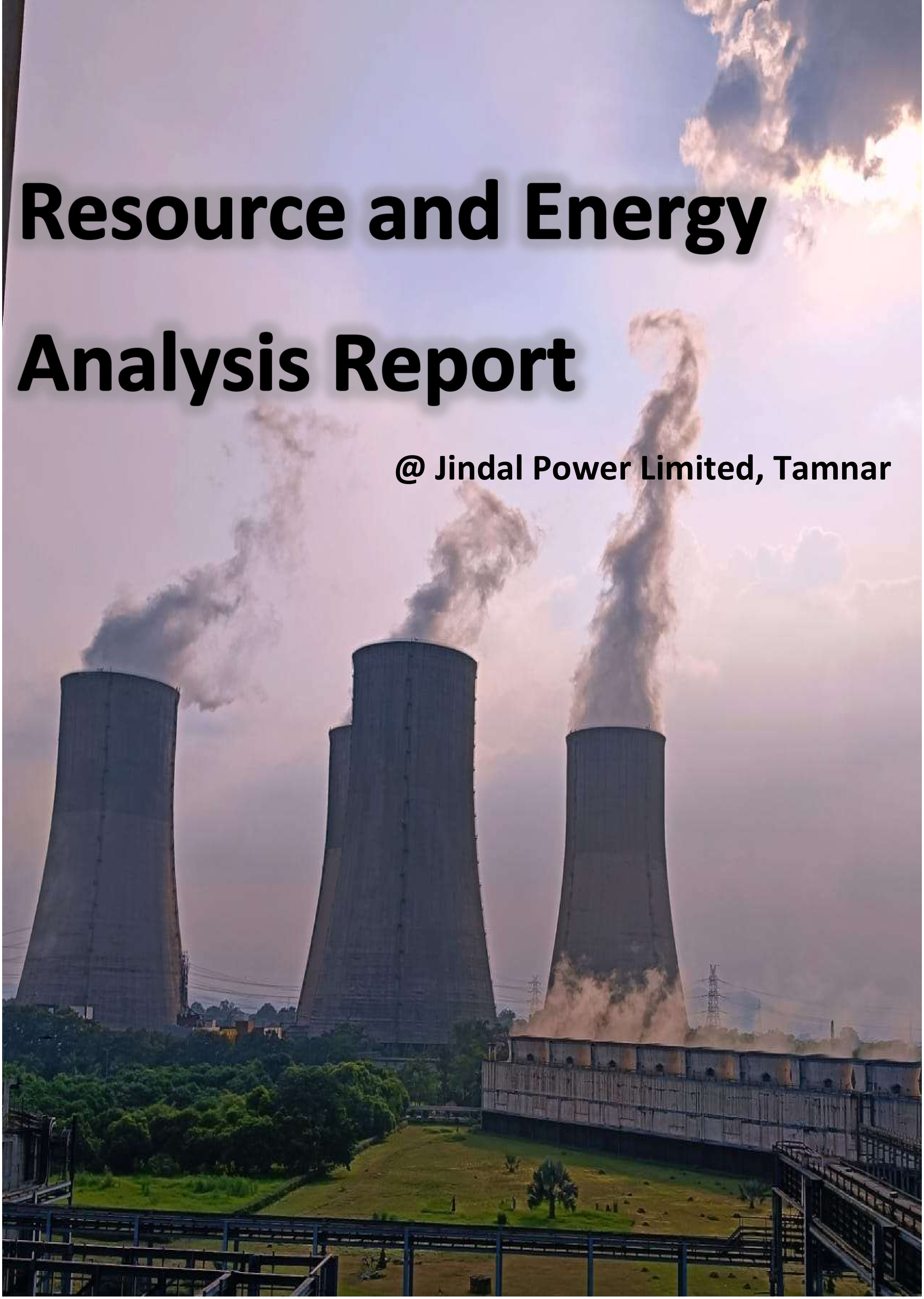
❖Innovative Solutions:

The incorporation of innovative technologies, such as high-efficiency ash classifiers and recycling systems, underscores the commitment to sustainable and forward-thinking design. These innovations not only improve operational efficiency but also contribute to resource conservation and waste reduction.

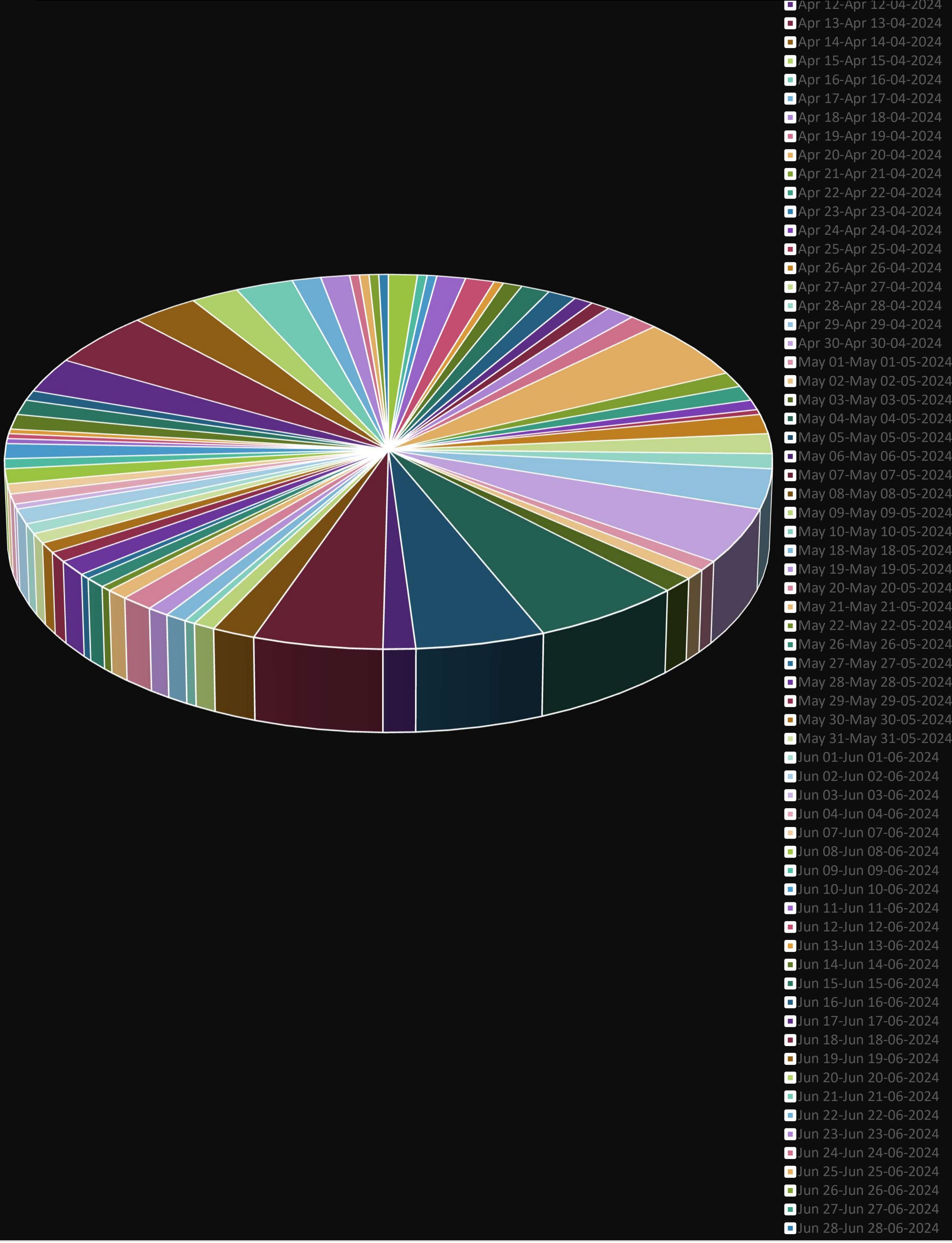
In conclusion, the ash handling plant at JPL Tamnar is a testament to cutting-edge engineering and sustainable practices. By addressing efficiency, reliability, environmental compliance, and safety in every aspect of its design, the plant not only meets but exceeds industry standards.

Resource and Energy Analysis Report

@ Jindal Power Limited, Tamnar



H_2 cylinders consumed



Insights and Conclusions about H_2 Cylinders Consumed in JPL Tamnar Thermal Power Plant

This pie chart represents the daily consumption of hydrogen (H_2) cylinders in a thermal power plant at JPL Tamnar, Raigarh, India, over a period from April to June 2024.

Insights:

1. Uniformity in Consumption:

- Each segment of the pie chart represents a single day's H_2 cylinder consumption. The segments appear relatively equal in size, indicating that the daily consumption of hydrogen cylinders is fairly consistent over the observed period.

2. Daily Distribution:

- Given the large number of segments, it suggests that the data covers a substantial number of days (approximately 90 days, from April 1 to June 28, 2024). Each day’s consumption has its own segment, highlighting the specific daily usage.

3. No Dominant Consumption Pattern:

- There are no significantly larger or smaller segments, implying there are no extreme variations or outliers in daily H_2 cylinder consumption.

4. Daily Consumption Stability:

- The consistent segment sizes indicate stable daily operations and a predictable pattern in hydrogen cylinder usage, which is important for inventory management and operational planning.

Conclusions:

1. Operational Consistency:

- The plant demonstrates operational consistency in its use of H_2 cylinders, which is crucial for maintaining efficient and reliable power generation processes. Consistent consumption also suggests stable operational conditions without significant disruptions or variations in production levels.

2. Effective Inventory Management:

- The even distribution of cylinder usage implies that the plant likely has an effective inventory management system in place, ensuring that H_2 cylinders are available as needed without shortages or excess.

3. Planning and Forecasting:

- With stable daily consumption patterns, the plant can accurately forecast future H_2 cylinder needs, aiding in cost management and logistical planning. This predictability is beneficial for long-term operational planning and budgeting.

4. No Major Maintenance or Operational Issues:

- The lack of significant variations in daily consumption suggests there were no major maintenance activities or operational issues that disrupted the normal use of H_2 cylinders during this period.

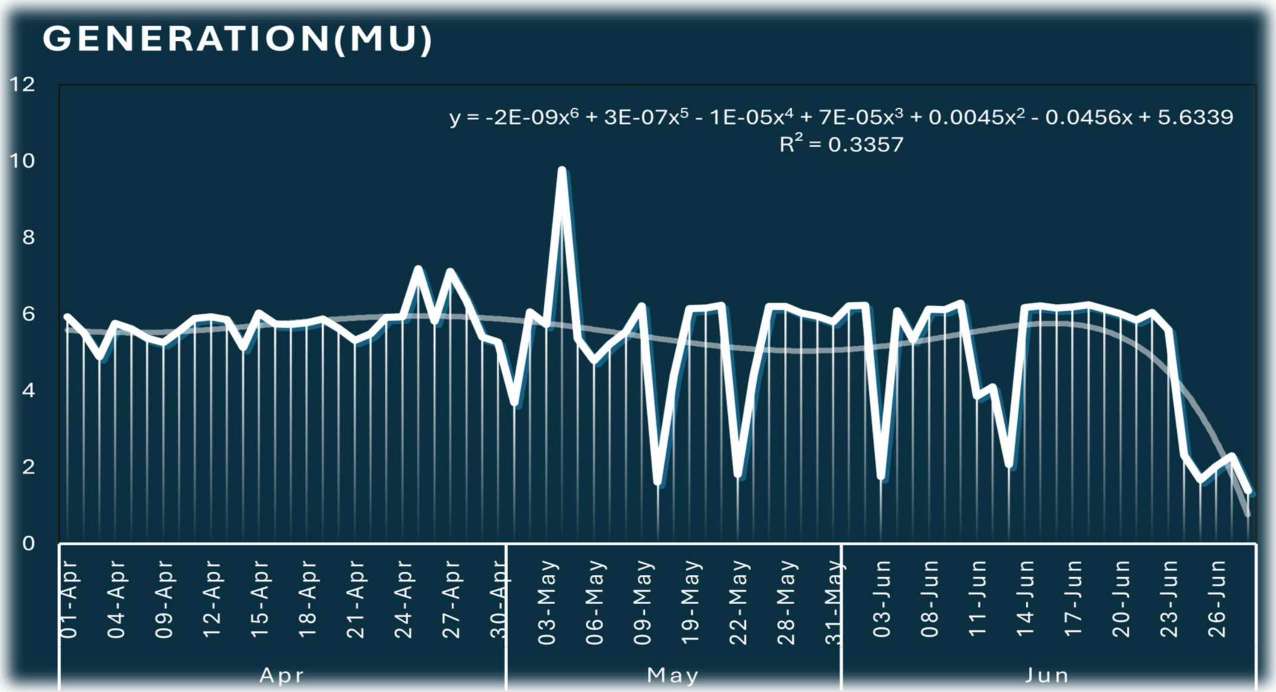
5. Potential for Optimization:

- While the stable consumption pattern is positive, it also indicates an opportunity for potential optimization. Analyzing the usage further could identify areas where hydrogen use can be made more efficient, reducing costs and improving overall plant efficiency.

Summary:

The pie chart depicting H_2 cylinder consumption at JPL Tamnar's thermal power plant reveals a consistent and stable usage pattern over three months. This consistency points to effective inventory management, operational stability, and the potential for further optimization in hydrogen usage. The insights gathered from this data can aid in enhancing operational efficiency and planning for future requirements. In conclusion, the analysis of H_2 cylinder consumption at JPL Tamnar's thermal power plant reveals a high degree of operational stability and efficiency. The consistent and predictable usage patterns underscore effective resource management and provide numerous opportunities for optimization and improvement. These insights are invaluable for maintaining the plant’s reliability, reducing costs, and ensuring sustainable and safe operations. The plant's ability to manage hydrogen consumption effectively is a testament to its robust operational practices and commitment to excellence in power generation.

Hydrogen pipelines used in thermal power plants



This graph represents the energy generation (in Million Units, MU) over a period from April to June. The graph includes a polynomial trendline (6th degree) fitted to the data with its equation and R^2 value indicated.

Insights:

1. Overall Trend:

- The energy generation shows a fluctuating pattern with some peaks and troughs.
- The polynomial trendline indicates a general decline over the three months.

2. Peaks and Troughs:

- *There is a noticeable peak around early May with the generation spiking to above 10 MU.*
- *Significant drops are visible around mid-May and mid-June.*

3.Polynomial Trendline:

- *The trendline equation is:* **$y = -2E^{-9}X^6 + 3E^{-7}X^5 - 1E^{-5}X^4 + 7E^{-5}X^3 + 0.0045X^2 - 0.0456x + 5.6339$**
- *The R^2 value of 0.3357 suggests that this polynomial model explains around 33.57% of the variance in the data. This indicates a moderate fit, but not a very strong one*.

Conclusions:

1. **Variability:**
   - The energy generation is quite variable, with multiple peaks and troughs over the three months. This could be due to various operational, maintenance, or external factors affecting the generation capacity.

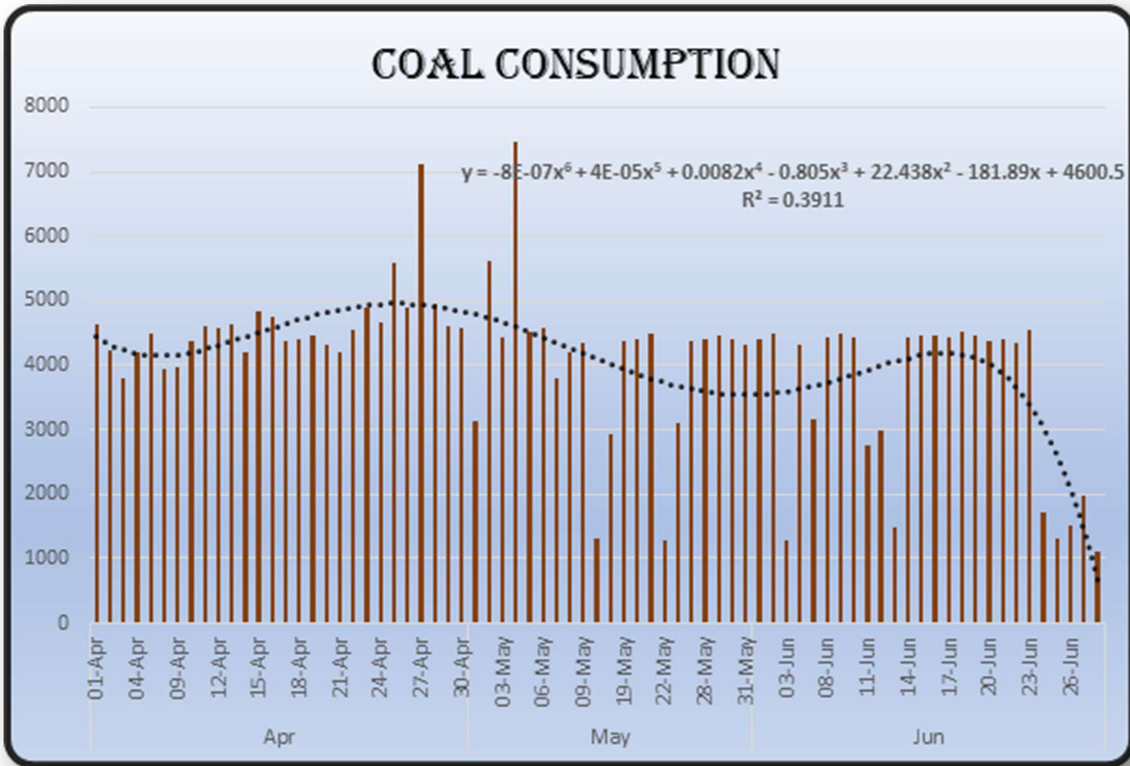
2. **Declining Trend:**
   - The polynomial trendline indicates a slight declining trend in energy generation over time. This could be indicative of underlying issues that need addressing or seasonal variations**.**

3. **Moderate Fit:**
   - The R^2 value shows that the polynomial trendline moderately fits the data, suggesting there are

other factors not captured by this model that are influencing energy generation.

4. **Operational Efficiency:**
    - Efficiency, Regular maintenance schedules, unforeseen outages, or demand Identifying the reasons for the significant peaks and drops in generation could help improve operational fluctuations might be some areas to investigate.

Overall, while the polynomial trendline provides a general overview, a deeper analysis with additional data and factors might be required to better understand and address the variability and trend in energy generation.



Insights:

1. **Overall Trend:**
    - The trend line shows a fluctuating pattern with multiple peaks and troughs, indicating periods of both high and low coal consumption.

2. **Peak Consumption Periods:**
    - Notable peaks in coal consumption are observed around late April and early May, suggesting higher operational activity or increased demand during these periods.

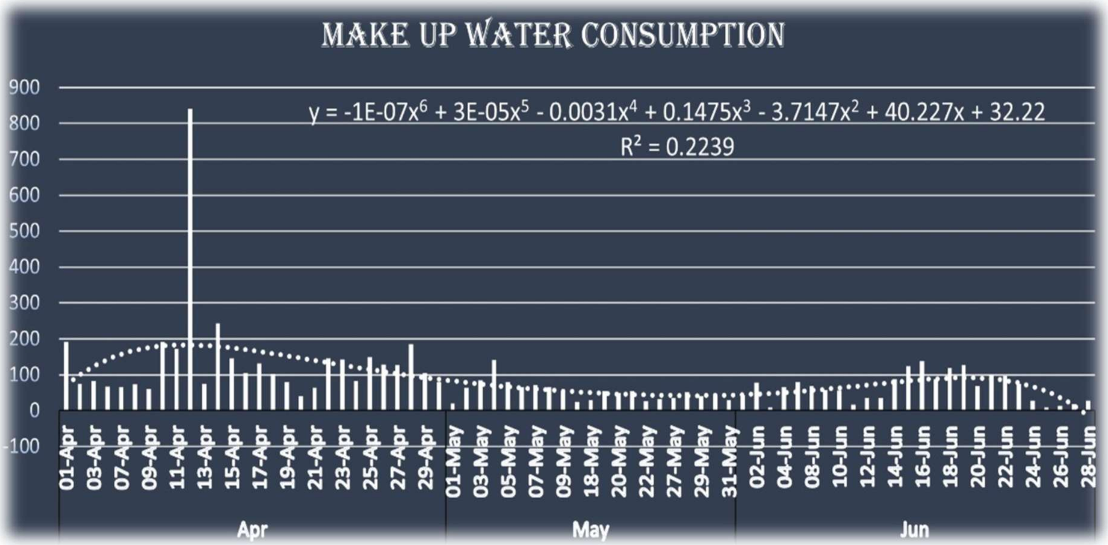
3. **Low Consumption Periods:**
    - Troughs are observed towards the end of April and mid-May, indicating periods of reduced coal usage. These could be due to maintenance activities, lower demand, or other operational factors.

4. **Variability in Data:**
    - The coal consumption values range between approximately 2000 to 7000 units per day, reflecting substantial day-to-day variability. This variability suggests that coal consumption is influenced by a variety of factors, which may include operational changes, maintenance schedules, and external demand fluctuations.

5. **Polynomial Trend Line:**
    - The polynomial equation :$\mathbf{y= -8E^{-7}x^6+ 4E^{-5}x^5+0.0082x^4-0.805x^3+22.438x^2-181.89x+4600.5}$ provides a mathematical model for the observed trend. The R-squared value of 0.3911 indicates a moderate fit, suggesting that while the equation captures the general trend, it does not account for all the variability in the data.

Conclusion:

The coal consumption data over the period from April 1st to June 25th indicates a fluctuating pattern with significant variability. The polynomial trend line, represented by a sixth-degree equation, provides a moderate fit to the data, explaining approximately 39.11% of the variability in coal consumption. This suggests that while the trend line captures the general pattern, there are additional factors influencing coal consumption that are not accounted for by the model.



The graph titled "Make Up Water Consumption" shows daily water consumption over a period from April 1 to June 28. Here are some insights and conclusions based on the graph:

Insights:

1. General Trend:

- The polynomial trendline equation indicates a sixth-degree polynomial fit: **$y = -1E\text{-}07x^6 + 3E\text{-}05x^5 - 0.0031x^4 + 0.1475x^3 - 3.7147x^2 + 40.227x + 32.22$**

- The R^2 value is 0.2239, suggesting that the polynomial trendline explains about 22.39% of the variance in the data.

2. Data Points:

- There is significant variability in daily consumption.

- An extremely high peak occurs on April 10, with consumption around 800 units.

- After mid-April, consumption generally decreases, with occasional small peaks.

3. Monthly Observations:

- April: High variability with the highest consumption peaks.

- May: Lower overall consumption compared to April, with less pronounced peaks.

- June: Continued decrease in consumption, with relatively stable and low values towards the end of the month.

Conclusion:

- High Variability: The high consumption peak on April 10 could indicate a specific event or anomaly that caused a spike in water usage.

- Decreasing Trend: There is a noticeable downward trend in water consumption from April to June.

- Polynomial Fit: The trendline equation suggests a complex relationship with multiple inflection points, but the low R^2 value implies that the polynomial model does not fully capture the underlying pattern of the data.

- Recommendations:

- Investigate the cause of the peak on April 10 to understand the anomaly.

- Implement measures to maintain the downward trend and possibly stabilize water consumption at lower levels.