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METHODOLOGY FOR OPERATIONAL IMPROVEMENT IN COAL HANDLING PLANT- A THEORETICAL REVIEW

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Abstract:

This paper discuss about methodology for monitoring the coal handling equipment by which failure rate can be minimized. Every organization need productivity and it is possible for several equipment working in good condition with man power itself for care and maintain. So, as to require various types of technology or sensors of automated testing rather than manual testing which has been summed up.

Keywords:

Tippler, Side Arm Charger, Operational Based Improvement.

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1. INTRODUCTION

1.1.TIPPLER FOR WAGON UNLOADING SYSTEM

1.1.1. INTRODUCTION

The material is received at the process plant by two different types of wagons as indicated above viz. BOXN wagons and BOBRN wagons. Different types of wagon unloading systems are adopted for unloading the material from these wagons. Generally, the material is discharged from the top from the BOXN wagons, while in the case of BOBRN wagons, it is discharged from the bottom. The hopper is provided below the ground for receiving the unloaded material from these wagons. Hence, the BOXN wagons need to be tilted for unloading the material into

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the hopper while the BOBRN wagons are provided with pneumatically operated gates at the bottom for unloading the material.

1.1.2. WAGON TIPPLING SYSTEM

The wagon tippling system consists of wagon tippler, the wagon positioning equipment, underground hopper, and feeder below the hopper for evacuating the material unloaded into the hopper.

1.1.3. WAGON TIPPLER

Wagon-Tippler is a mechanism used for unloading certain cars such as a wagon, hopper cars etc. it holds the rail car to a section of track and rotates track and car together to dump out the contents such as coal, iron ore etc.

The tippler structure consists of two drum-like cages resting on the eight support roller assemblies in which the coal wagons are rolled over and tipped to offload the coal. The coal falls onto a conveyor system which transports it to the grading plant.

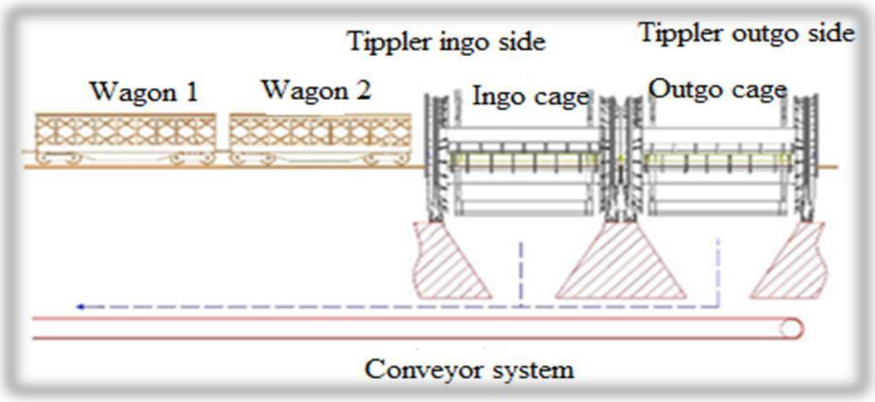

Figure 1.1: Tippler process layout.

The wagon tippler consists of a table for positioning the wagon, wagon holding mechanism, gears and pinions for rotation, drive unit, hydraulic power pack etc. The unloading cycle starts when the wagon is positioned over the wagon tippler table and the wagon along with the table rotates and discharges the material into the underground hopper. The time taken for the unloading operation is about 90 seconds. There are two types of wagon tipplers viz. rotaside which rotates about 135º and another rotary type which rotates by 180º. The rotaside wagon tipplers are provided in most of the plants in India. The drive for the rotation is the hydraulic type for smoother operation.

The main components of wagon tippler are as follows

I. Cradle
II. Tippler platform
III. End rings

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IV. Side support beam
V. Top clamp assembly
VI. Drive unit

I. Cradle

The cradle is a frame of the table, comprising two main girders, braced together. Both the rails are fitted on the two main girders. When tippler is in the down position the cradle rest on the two cup & cones and two rollers connecting two stools located on the concrete pedestals or two beams located on the top of the weighing machine(if supplied) and it is isolated from any other form of support in order to ensure correct weighting.

The cradle is pivoted in the slotted bearing, attached to toes by hinge pivot. These pivots are positioned off center to the rail track to ensure the tilting tendency in order to bring the wagon against the side bolster during the initial part of the operating cycle. The cradle has an adequate walkway on it. Sections of check rails are provided inside the rail gauge to restrict the wagon wheels in the tipped positions.

II. Tippler platform

The platform is a bridge-shaped structure. It has a length sufficient to accommodate one 8-wheeler (or two 4-wheeler) bogie type broad gauge open wagon which is to be tipped. The table is constructed of rolled steel joints with standard steel rails (60 kg/meter) mounted on it. The table is pivoted from arms extended from the sectors. The table is covered with chequered plates between the rails.

III. End rings

A pair of end rings with gear sectors mounted on the periphery will be driven by two pinions fixed on the line shaft driven through a suitable drive unit. Each of end
rings is trunnion mounted for the purpose of rotation. These end rings are built in the form of semicircle by a suitably designed plate structure.

The center of the end rings is reinforced to carry the trunnion shafts; each of these shafts, in turn, is supported on pivot bearing resting on foundations. On each ring is attached an arm known as "toe" that carries the slotted bearing and support the cradle and bearing during operation. Part of end ring is filled with concrete to provide the counterweight. This counterweight reduces the amount of work required during the tipping on the wagon.

IV. Side support beam

Full face contact between the side support beam and the side stanchions is ensured. The side support extends from a height of 1000 mm up to 2950 mm, from rail level, i.e. contact the side of the wagon over a width of not less than 1950 mm. There is metal to metal contact between the side support beam and the side stanchions of the wagon i.e., no rubber pad or any other alternative are provided on the contact face of the side support beam. The side support beam is

the movable type, the movement being done by hydraulic arrangement (No external or movable counterweights should be used with the side support beam). Facility of forward/backward movement should exist, such that it should be move & touch the wagon without applying any pressure on the wagon side wall. Movement of the side support should be controlled and the speed should be crawling just before making contact with the wagon side wall.

Behind this beam assembly are the spill plates designed to facilitate the discharge of the contents of the wagons without spillage.

V. Top clamp assembly

The wagon tippler is equipped with four hydraulically operated steel clamping arms moving through the hydraulic cylinder. All the clamps are designed to more into position as the wagon tippler begins to rotate, and they clamp on the top of the wagon at a pre-determined angle and hold the wagon firmly until it returns to its normal resting position, when the clamps release the wagon. The clamping system is designed so that it can clamp both the maximum and the minimum height of the wagon being tipped. The clamping system is capable of holding a fully loaded wagon at any position during the operation.

VII. Drive unit

The drive unit is either electromechanical or hydraulic. The electromechanical drive consists of an electric motor coupled with a speed reduction gear box and brake mounted on the input shaft of the gearbox. A hydraulic drive consists of a power pack with an electric motor and a hydraulic motor coupled with a helical gear box. The brake is built into the hydraulic motor, and an external hydraulic thrusters brake is mounted on the input shaft of the gearbox.

1.1.4. WAGON POSITIONING EQUIPMENT

There are different types of wagon positioning equipment like hydraulically operated side arm charger, beetle charger and shunting locos. The hydraulically operated side arm chargers are being used in most of the plants in India as this equipment is much faster compared to the others. The tractive force of the side arm charger is suitable for hauling one fully loaded rake.

1.1.5. UNLOADING HOPPER

The hopper provided below the wagon tippler could be either RCC type or structural steel fabricated type. In most of the plants, this will be of RCC construction. The suitable liner is provided for this hopper depending on the abrasiveness of the material handled. Generally, steel grids of 250 mm square are provided above the hopper to avoid higher size of material going through. The higher size material is removed and broken separately and then passed through the grid. The grid is sloping outwards for easy removal of such larger size material.

1.1.6. FEEDER BELOW HOPPER

The feeder below the hopper could be either vibrating type feeder or apron feeder. The apron feeder is more suitable for heavy duty application for taking the impact of the falling material. The apron feeder is driven by the hydraulic motor for smoother operation.

1.1.7. RAIL TRACKS

The layout of the rail tracks is such that the track will be straight and horizontal for one rake length on the inhaul side and also on the outhaul side. This is preferable for achieving faster unloading rate and the effort required by the side arm charger would also be minimum. In case it is not possible to have the straight length to accommodate one full rake on either side, then shunting operation is required using the plant loco and hence, it takes the turnaround time more.

1.1.8. DUST CONTROL SYSTEM

Plain water spray type dust suppression system is provided for suppressing the dust generated during the unloading operation. Spray nozzles are provided at the top of the wagon tippler and also around the hopper for spraying the water and settling the dust. An enclosed shed is provided for the wagon tippler so that the dust is contained within and not spread to the other parts of the plant.

1.1.9. CONTROL ROOM

A control room is provided adjacent to the wagon tippler at an elevated position for operation and control of the wagon tippling system. The complete view of the unloading system is available from this control room. Generally, the time taken for unloading the rake is about 4 hours with one wagon tippler in operation.

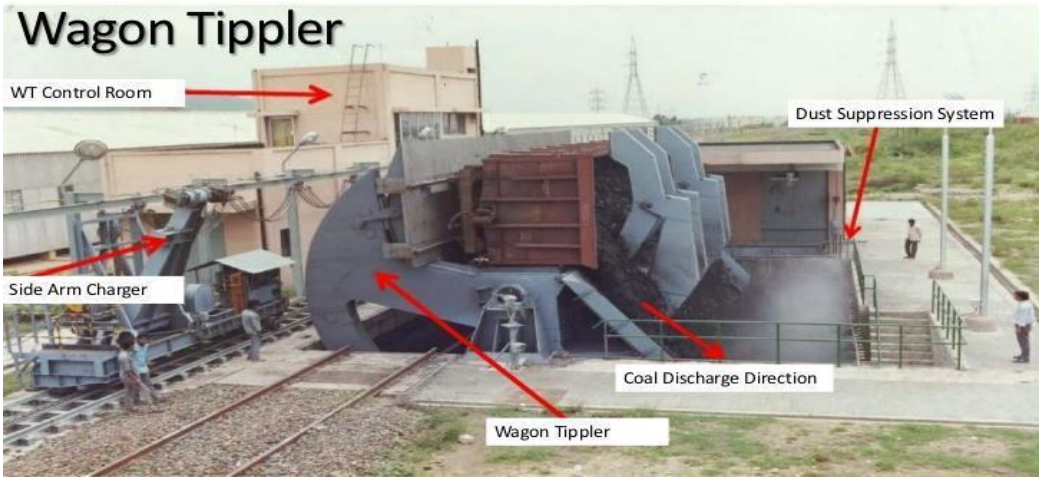

Figure 1.2: A typical operation in Wagon-Tippler section.

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Methodology for determining the status of Tippler: Parameters, aspects, and technology.

Table 1.1: Methodology for determining the status of Tippler.

Parameter	**Component**	**Sensor/Technology**
Vibration	Motor Gear Box	Vibration analyzer Instrument
Power	Motor	Watt meter Torque Sensor
Speed	Motor Tippler Rotating Drive/ Brake system component	Optical/ Magnetic encoder Magnetic RPM picks up Sensor
Temperature	Motor Material Hydraulic Oil	Thermocouple Infrared temperature Sensor
Pressure	Hydraulic Oil	Pressure gauge
Shock	Gear Box Coupling (Revolving element like ball & roller bearing)	Shock pulse meter
Minor Crack	All accessories in Tippler	Ultrasonic flaw detector
Foundation Columns	All accessories in Tippler	Mechanical or electrical strain gauge
Hotspot	Bearing Other parts of machinery	Infra-red thermometer Remote sensing
Thickness of paint, Coating	Hood Channel	Ultrasonic/ Eddy Current thickness meter
Corrosion	Tippler equipment like hood, beam, structure etc...	Corrosion meter
Leakage	Oil at high pressure	Ultrasonic Leak Detector

1.2.SIDE ARM CHARGER

The Side Arm Charger (SAC) is used for wagon positioning at the wagon tippler for unloading of materials. It is used for pushing / pulling a rake of 59 wagons one by one on tippler.

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1.2.1. WORKING PRINCIPLE

A train of 59 loaded wagons is brought in by a locomotive pushing/ pulling and stopped with the leading wagon within the range of the Side Arm Charger using trackside marker boards (under bidder's scope). Bidder is known as contractor, supplier or vendor who responds to an invitation to bid the tender. The work in the range or scope of bidder's is known as bidder scope. The loco is decoupled and dispatched and the charger is driven to the leading wagon. Its arm can be lowered and it can be coupled to the first wagon of the train. The train is hauled forward by the charger until the front of the first wagon is about 4 meters away from the tippler. The charger is stopped and the first wagon is uncoupled from the train. Then, the charger is forwarded onto the leading wagon, which forward onto the tippler. This automatically decouples the charger & its arm is raised before it travels back to the train. The tippler is rotated for tippling the wagon. On reaching near the standing train, the charger arm is lowered and coupled to the train ready for repeating the cycle. In the next cycle, the train is drawn up by one wagon length, the front wagon is decoupled & the next cycle is repeated. When the next wagon is located on the tippler table the previously tippled wagon is ejected simultaneously. On the outhaul side, the empty wagon forms a new train ready for collection by a locomotive.

1.2.2. DESCRIPTION OF SIDE ARM CHARGER

The Side Arm Charger consists of hydraulic power pack, power supply system, supports, electrics, buffer stop, rack & pinion, control cabin, automatic coupler/decoupler etc. The main component of side arm charger is as follows

I. Structural components
II. Charger frame
III. Drive unit
IV. Lubrication system

I. Structural components

The Side Arm Charger runs on its own track parallel to the main track. It has a stroke of suitable length from a point on the inhaul side of tippler to a point on the out haul side. It is fitted with an arm pivoted at right angles and operated through a hydraulic system for raising and lowering. The arm has an automatic coupler to couple/decouple the wagons.

II. Charger frame

The charger frame consists of a single fabricated frame on which every other item is directly mounted to form a robust compact unit. The charger runs on four steel wheels mounted on spherical roller bearings. To resist the moment reaction of the pushing force, two pairs of steel side guide rollers is fitted. They are fitted on spherical roller bearings and have a simple lockable adjustment for true running and to take up wear. The side guide rollers runs on the sides of the rail heads of the charger running track. The arm is of welded construction.

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III. Drive

A side arm charger is hydraulically driven through rack and pinion arrangement. The charger is electrically interlocked with tippler for proper sequential operation with respect to operational & safety requirements. Easy access, adequate maintenance spaces, working platforms, inspection covers are provided for all the equipment located in the Side Arm Charger for safe and quick maintenance. All edges and openings are provided with guards. Chequered plates on floor are provided to prevent slipping.

IV. Lubrication system

A Centralized system of lubrication is provided for the equipment. However, all parts of the equipment needing manual lubrication are easily accessible. All oil pipes and grease nipples are well covered to prevent damage from materials from falling on them.

Figure 1.3: A snap shot of Side Arm Charger positioning the wagon in Tippler area

Methodology for determining the status of Side Arm Charger: Parameters, aspects and technology

Parameter	**Component**	**Sensor/Technology**
Vibration	Hydraulic Motor	Vibration analyser Instrument
Power	Hydraulic Motor	Watt meter Torque Sensor
Speed	Hydraulic Motor/ SAC Drive	Optical/ Magnetic encoder Magnetic RPM pick up sensor
Temperature	Hydraulic Motor Material Hydraulic Oil	Thermocouple Infrared temperature sensor
Pressure	Hydraulic Oil	Pressure switch (sensor)
Shock	Gear Box Coupling (Revolving element like ball & roller bearing)	Shock pulse meter

Minor Crack	All accessories in SAC	Ultrasonic flow detector
Foundation	Side arm charger	Mechanical or electrical strain gauge
Hot spot	Bearing Other parts of machinery	Infra-red thermometer Remote sensing
Corrosion	SAC equipment like arm, coupler, structure etc...	Corrosion meter
Leakage	Hyd. Oil at high pressure	Ultrasonic Leak Detector
Position	Side Arm Charger	Proximity switch
Over travel	Side Arm Charger	End limit switch

2. CONCLUSION

This paper emphasizes the different types of technology and sensors are used for measuring the coal handling equipment in coal handling plant which increases their production rate and also helpful for management people for smooth operation.

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