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Recent Mechatronics Advancements in Cement & Power Industries for Coal Unloading

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ABSTRACT- In this paper, we are presenting Mechatronic techniques which are used in industries for loading and unloading of raw materials. This paper introduces the process of the wagon loading and unloading of the raw materials presently used in the cement and other manufacturing industries. Mainly the Wagon system are used in mines, power plants, cement plants and other industries for loading the raw material and transporting them to other process of manufacturing. And the wagon unloading system is used for unloading the raw material received from the mines by the railway wagons. In industries BOXN and BOBRN wagons are frequently used. For loading and unloading the Wagons, coal conveying system is used that contains so many mechanical equipment. Presently there are mainly two types of wagon loading systems

(a) Stationary Rake and moving loader

(b) Moving rake and stationary loader

In this paper, we are presenting latest technologies of recent tipplers that are automation based. Their controlling is done through many sensing instruments which is very effective and extensive. They are fail safe, accidental safe and environment friendly too. PLC SCADA is being used for proper automation controlling which may call mechatronics as whole.

Keywords: - Wagon, tippler, automation, side arm charger, side clamps, wheel gripper, dust suppression system.

INTRODUCTION

Mankind has always tried to make their life easy and fast. And due to their innovative behaviour, the current state of automation is used to increase the productivity and to deliver uniform quality. And the research is directed towards more super human capabilities in these. Every organization wants to increase their productivity and their profit as much as can. This can be done only by maximum smart effort care and proper maintenance. And it is possible only if the equipment is in good condition with minimum breakdowns, minimum accidents, and less wastage.

This research work shows a practical analysis of transferring and monitoring of raw materials used in industries. As we know that the handling of raw material which is used at a very big scale is a very big task. Therefore, there are so many technologies that are used for the implementation of a suitable and appropriate methodology for improvement of raw material handling and coal handling systems. The focus of this research work is to check the equipment performance in coal handling plants and power generating plants and their contribution to the industry for overall operation.

For minimizing the downtime of the machine and to increase the productivity, a proper method is used for finding the status of coal handling equipment like Tippler, Side arm charger, Reversible apron feeder, Belt conveyor system, Stacker, Reclaimer.

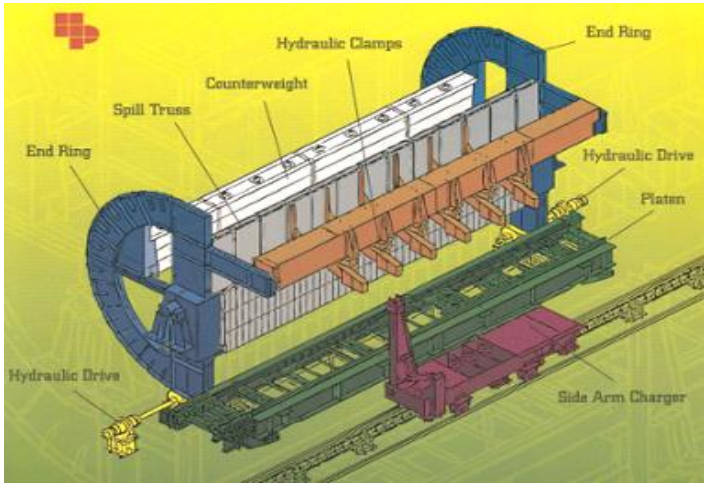

Fig 1: Labelled diagram of a wagon tippler

HISTORY OF UNLOADING OF RAW MATERIALS (PICK AND PLACE)

1. Traditionally coal and other additives were transport through road only.

   Then they could be unloaded to dump hopper situated at mines or production plants as power plants, cement and steel plants.

   - Dump hopper: Trucks may be unloaded at dump hoppers through mechanical lifts which were hydraulic based at all with only electrical controlling and completely hard wire.
   - Later road transport: Transportation through Indian rail became economical and easy. So, coal transportation became popular, but the main concern was how to unload them?
   - Traditionally Wagon unloading was done by labours only. Here labour requirements and their consumed time were high at all. Even the productivity may affect due to the slow unloading of coal.

     Process at plants was highly affected due to the slow unloading procedure. Here due to high labour utilisation we could say that risks of their health might arise due to dusty workplace.
   - Then JCB's use come in circuit. Wagons were unloaded by using JCB's and then further coal was transported by loader machines towards the further process of plants.

     But the drawback of using JCB was damage to Wagons. And that damage was paid in form of penalties from the respective parties by Rail (Indian Railway) i.e. Indian rail had penalty charges against the damage to the Wagon. This was not economical way at all. Even proper coal could not be unloaded from Wagons because of stucked material at the walls of Wagons. This method was also time consuming and less productive.

     So, afterwards the phenomenon of tippler came in existence and use.
   - Previously the tippler which was used they were basically mechanical and electrical based. Their operation was hydraulic based and the controlling was completely hard wired and electrical. Under which monitoring and supervision was highly recommended.
   - Later the mechatronics type Wagon tippler came for industrial purpose and have following characteristics:
     - Automation based.
     - Their controlling was done through many sensing instruments is very effective and extensive.
     - They are fail safe, accidental safe and environment friendly too.
     - PLC SCADA is being used for proper automation controlling.

Fig 2: Recent Wagon tippler

SALIENT FEATURES OF WAGON TIPPLER

The wagon tippler is mainly designed to unload raw materials like Coal, Coke, Lignite, Iron Ore, Limestone, dolomite and other industrial raw materials. The rotary type Wagon tippler are so designed that they invert on their own centre of gravity through some angle and they discharge their contents into hopper below rail from broad gauge open railway. Tipple handles the Wagon very carefully that it is not damaged at all.

Maximum 140 tonnes per wagon can be handled at a time. The unloading is done in only 90 seconds and 25 tippling per hour can be done. The wagon tipplers rotary are classified according to their degree of rotation mainly 135 and 180 degrees. For smoother operation of rotation hydraulic drive is used. There are mainly six hydraulic clamps are provided. The tipping for various plants will vary from 12 wagons/hr to 60 wagons/hr.

There are two circular rings in a tippler, the first one is a platform having travel rails, support rollers and second one is two girders which retains the Wagon from the top and from the side during tippling. The drive unit drives the tippler from one side. The driver side of the motor have flexible coupling, brake that operate on thruster, helical gearbox and toothed rings. The type of drive is depending on the time hours needed. The motor and the oil tank are located with the tippler. Top clamps and side beams are operated by hydraulic method. Top clamps and side beams are lined with rubber pads due to which pressure on wagon walls can be minimised. Then in-haul beetle will place loaded wagon on tippler. Then hydraulic system is now activated which balances the pressure of wagon springs. By this process the damage to the wagon can be avoided.

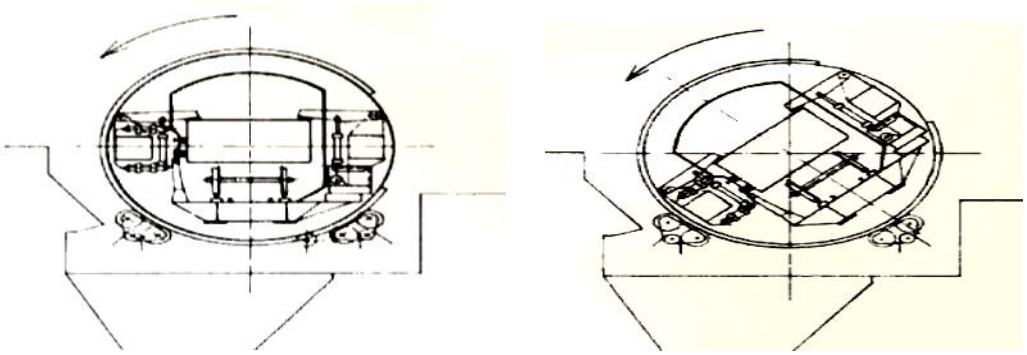

Fig 3: The principle of clamping rotary wagon tippler (tippler at normal and rotation)

MAIN COMPONENTS OF WAGON TIPPLER

- **Side arm charger:** For pushing and pulling of the wagon, forward or backward at the time of unloading the raw materials at the wagon tippler. Or simply changing the position of wagon at tippler.

Fig 4: Side arm charger

- **Unloading hopper:** RCC or structural steel fabricated type hopper is used
- **Feeder below hopper:** Vibrating type feeder or Apron feeder which is hydraulic operated.
- **Rail tracks:** For one rake length straight and horizontal track should be made.
- **Dust suppression:** Bag filter fan is used in the rotary wagon tippler to minimise the flying dust during tipping of the wagon.so that the workplace could be dust free.
- **Water spray-** In this system process water is sprayed through the nozzles situated at the top of the tippler and around the hopper to settle down the dust.
- **Weighing:** Weighing is done by the integrated electronic weighbridges that contains printer and recorder which will print gross and tare weights with other information.
- **Vibrators:** Vibrators are fitted on top clamps to complete discharge of sticky materials from wagon. These are electrical or pneumatically operated.
- **Control room:** For the operation and control of the wagon tippler, there is a control room situated at an elevated position with the tippler.

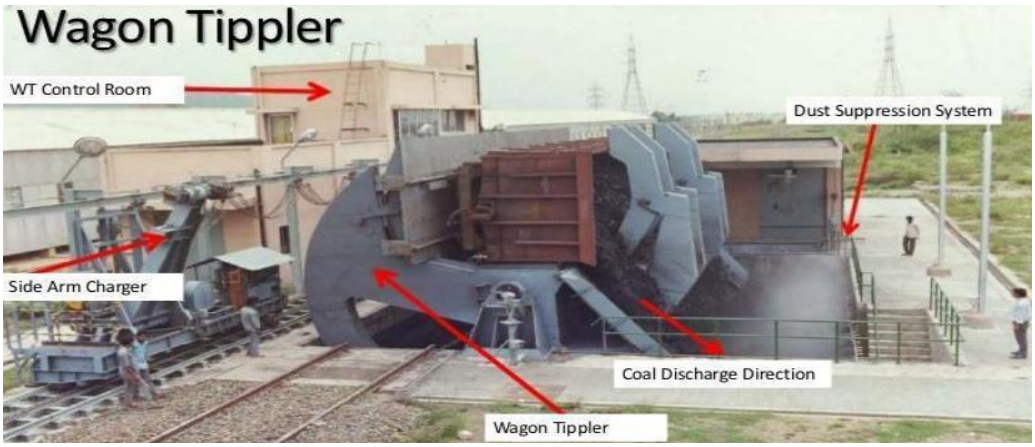

Fig 5: Complete view of wagon tippler section

DEMURRAGE CHARGES

Indian railways provide 48/59 wagon train for industrial material conveying. By a locomotive through pushing and pulling way, coal and other raw materials rakes or train with BOXN type wagons reach at rail yard side for unloading. Indian railway gives particular time duration or some hours to make the wagons unload, which is approximate 7 hours to 10 hours (or may

vary over different raw material and wagon quantity). Over this duration of time given by railway, Indian railways put demurrage charges at the rate of 150 Rs/hr/wagon for first hour delay and later on this demurrage gets double, triple and so on.

WORKING PRINCIPLE

First of all on the rail track at yard side the first wagon is placed at 4 meters distance from the weighing bed or weighing platform. Then side arm charger couples the wagon with a normal 'Knuckle couple' and pulls it at the platform of tippler. Then line man decouples the wagon from SAC. The weighing bed captures its weight and within 30-50 seconds through automation, it records at SCADA and weigh controller as well; for further calculation of material received quantity.

After this, operator gives command from control panel for further operation, this mode is called manual mode. Likewise auto mode and local mode also works. In automatic mode, just after capturing weight wheel grippers comes up and grips tightly all the wheels. During this SAC arm goes up so that it could not colloid with wagon while moving backward.

Now side clamp and top clamp operation starts through PLC's automation command to hydraulic cylinders. As both top and side clamp applied signal feedback comes to PLC; PLC releases the tip command and instantly both motors In-haul and Out-haul which are drive operated and under master slave configuration.

Right the way both the motors rotates the weighing platform with tightly hold wagon up to 135/180 degrees and at the same time water spray starts and wagon became unloaded; for rotation control ultrasonic devices or other inputs are taken for PLC control which can control its further movement.

Finally after discharging of material wagon comes back at 0 degree position with the platform. Now release operation offside clamp, top clamp, wheel gripper takes place and another wagon is pushed by SAC to be situated at the weighing bed. Further the cyclic operation occurs till the whole rake of coal not unloaded.

Table 1.Tipping time cycle

Sr.	Function	Time taken (seconds)
1.	Time taken in placement and ejection of wagon	59
2.	Weighing time of loaded wagon	3
3.	Tip	39
4.	Pause	5
5.	Return	35
6.	Weighing time of unloaded wagon	3
	TOTAL	**144**

CONCLUSION AND FUTURE SCOPE

Beyond Mechanical and only electrical combination of technology, the mechatronics combination is extensively successful and economical as well. These mechatronics based tipplers are feasible, more user friendly, more efficient, reliable, more precise in control, safer and enhanced in features and functionality. With higher machine utilisation and lower labour utilisation the mechanical and electronic combination of new wagon tipplers (pick and place) are best in class and extensive.

As the future aspect we can further research over the wireless communication between the tipplers and PLC but with no communication at all. Over decoupling of wagons from SAC may also be made to automate instead of appointing line man over there for optimized labour cost.

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