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OPTIMIZATION OF IRON ORE PELLETS PRODUCTION IN SINTER PLANT

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Abstract: The aim of this paper is to optimize the production of the iron ore pellets by rectifying and providing alternate solutions to the problems that are occurred in the sinter plant of RINL- VSP(vizag). The intial problem that occurred is in hammer crushers where the breaker plates are being damaged due to high impact load. The secondary problem deals with high capacities of load continuously carried by conveyor belts, resulting in wear and tear, and spillages of materials. The concluding problem was observed in the blender reclaimer, due to the high capacity loads and long working duration support rollers & rail of bucket wheel are disintegrating from its position leading to the critical damage to the machine, by suggesting maintenance modifications for the above problems we can achieve good production outcome in steel plant.

Key Words: ***Sinter plant, Roller crusher, Conveyor, Reclaimer, roller modification, bucket wheel***

1. INTRODUCTION

1.1 Iron Ore Pellets

Pellets are little iron ore balls used in the steelmaking process. They're made employing technology that makes use of powder that's created during the ore extraction procedure. Pellets are used to make steel, which is utilised in the construction of bridges, automobiles, planes, bicycles, household goods, and much more. This ore, on the other hand, is processed in a blast furnace that operates only with free air circulation. The material must be large enough to keep room between each piece for this purpose. The ore, on the other hand, must be robust enough to avoid crushing and blocking the blast furnace. As a result, pellet production is an important part of the steelmaking process. Pellets are balls made by rolling moist concentrates of fines iron ores of various mineralogical and chemical compositions in a horizontal drum or an inclined disc, with the addition of additives and binder. Pellets are manufactured for use in iron-making operations and are categorized according to physical, chemical, and metallurgical qualities. [2] As a result, almost all of those characteristics are standardized.

1.2 Sinter Plant

Sinter plant is one of the major departments of vsp where the iron ore pellets are produced by sintering process. By this sintering process the raw materials like limestone, dolomite, coke, iron ore fines and metallurgical wastes are converted into a solid mass i.e., pellets by using the heat produced by the incipient fusion during the combustion process. This is an important process for making the steel production because the iron ore pellets concentrate 70-80% in steel.[5] Sintering process can be easily defined by the following steps and they are:-Raw material preparation, Conveyor transport,Mixing and blending, Chargimg on the sinter bed,Ignition and suction

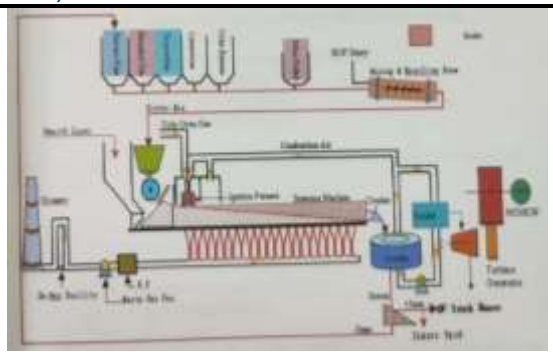

Fig 1-VSP Sinter Plant Overview

2. IRON ORE PELLETS MANUFACTURING PROCESS

2.1 Process Of Preparation Of Iron Ore Pellets

In this process, Firstly Raw Materials such as Limestone, Dolomite and coke are imported from different places and stored in Raw Material Handling Plant (RMHP). Later depending upon the requirement of the raw materials It will be sent to the Crushing Section to crush them into a required size. Limestone and Dolomite which is at 80-150mm size they are made into -3mm to 3mm size and Coke which is at 80-200mm size they are made into -3 to 3mm size. These Crushed material will under goes with screening process, In this process the unsized material will go for re-crushing and perfect sized material will sent to Raw Material Preparation Plant (RMPP) Bunkers.[6] In RMPP there will be 4 underground bunkers to store limestone, dolomite, coke and Metallurgical wastes. From all these 4 bunkers the material will fall on the weigh feeders at a fixed base mix composition. Then the base mix will conveyed to material mixing and distribution plant for primary mixing through conveyor belts. Later base mix will sent to the twin boom stacker for stacking through conveyor belts.

After the completion of Stacking, Base mix is stored in the storage yard for 16 days. Later using the Bucket Wheel Blender Reclaimer the base mix will under goes with the reclaiming or mixing process. After the completion of reclaiming the base mix will sent to the sinter machine bunkers through conveyor belts. This base mix will undergo some quality and quantity tests and then according to the requirement of addition of material such as coke, limestone, dolomite are added to the base mix. To make into a perfect mixture after adding the required material the base mix is to sent to the mixing drum for gentle mix. After the completion of mixing , base mix is sent into the nodulizing drum to add water which maintains moisture in the base mix .[7] Later it is sent to Raw mix hopper to mix the base mix and water perfectly. Then the iron ore pellets will sent through metallic conveyor into the furnace to undergo heating process at 1200 degrees. After the heating process, the heated base mix will converted into a semi liquid cake. Using a sinter breaker machine the cake is break into small pellets. Finally these iron ore pellets under goes cooling in the cooling tower. Later the iron ore pellets goes with the sinter screeners for screening process. The unsized iron ore pellets are sent to the re-sintering process and the perfect sized iron ore pellets are sent to the Blast Furnace.

3. INTEGRATION OF HAMMER CRUSHERS

3.1 **Hammer Crusher**

Hammer crushers are commonly found in sectors including cement, coal separation, electricity generation, construction, and compound fertiliser, among others. These hammer crushers can crush materials of various sizes into uniform particles, making the next step easier. The amount of materials delivered into the hammer crusher should not be excessive, as these are used for a variety of hard and fragile minerals, including limestone, coal, salt, gypsum, and so on.[15] The hammer crusher's key benefit is that it has a solid mechanical construction, high productivity, and a wide range of applications. This crusher is also known as a hammer crusher machine because it crushes materials by colliding with them with a high-speed hammer. It also has characteristics such as a simple structure, a high reduction ratio, and high efficiency, among others.

The classification of hammer crusher are done based on following conditions:-

a) arrangement of the hammer on the rotary table like single-row hammer mill and a multi-row hammer mill.
b) different shape, like ring hammer crusher and also a box hammer crusher.

3.2 **Working Of Hammer Crusher**

The raw material will first be fed into a hammer crusher, where it will be crushed by a high-speed rotating hammer. The hammer crushes the material, which is subsequently thrown back into the crushing plate. After that, the large materials are crushed in the grate bars with a hammer, and the smaller materials are discharged from the grate bars.

3.3 **Problem Occurred In Dolomite Hammer Crusher**

1. Wear and tear of the body of hammer crusher**.**
2. Washing out the tough surface the hammer.

3.4 **Reason behind The Damage Of The Body**

1. Material used for the manufacturing of the breaker plates.
2. Depends on the rate of flow of dolomite from the hopper.
3. Material used for building the body of hammer crusher.

4. Number of hammers used for dolomite crushing.
5. High rotation of the motor.
6. High vibrations that are produced by the machine.

3.5 Modifications Suggested for Hammer

Modified hammers comprises of a) ARM b) HEAD faciend with PIN This modification is done by taking the following points into consideration

1. Economical
2. Easy in manufacturing of hammers
3. Reusable

Due to increase in the impact load that is caused by the dolomite stones it causes the sudden nod on the breaker plates. Due to this sudden load on the plates and hammers in certain situations the breaker plates and body gets damages. So, in order to overcome this problem either we need to control the rate of flow of dolomite through the hoper or we need to decrease the number of hammers. By the decrease in the number of hammer the crushing rate would be minimised i.e. the amount of material crushed before and amount after modification would be less. To increase the outcome of crushed materials the hammers no's are increased by adding more 6 hammers in the 2nd and 13th row each three. But now the problem raised in the breaker plates Here in this situation the breaker are getting damage. So this following modification which has Shown above is further modified as shown early.

4. PREVENTION OF SPILLAGE AND BELT CUTTING OF A CONVEYOR

The skirting system purpose is in need to be understood. It comprises of two elements, one is a linear plate that is used to centralize the bulk material and the other one is a rubber skirt system. This linear plate is manufactured of a wear-resistant material and bolted or spot welded into position as needed. The abrasiveness of the ore being handled is frequently reflected in the skirting rubber assembly and its design. Airborne dust transfer and Plate type dust transfer are two methods for generating dust and spills during a transfer. The most important aspect of dust management is to completely encapsulate the transfer in an airtight enclosure using a variety of flexible dust seals. The transfer will escape under the skirt rubbers if it is entirely encased. This is one of the reasons why dust cannot be contained in fully enclosed systems due to skirt configurations. Skirting system should be a self cleaning one and it should be easy to maintain.

5. MODIFICATION OF ROLLER RAIL ARRANGEMENT OF BLENDER RECLAIMER

Blender Reclaimer is used for iron ore, lime stone & sized iron ore re-claimation in homogenized condition from stock yard in steel plant. Blending is a higher level function that aims for obtaining not only the homogeneity of properties over a given product or different ores but also to bring them to a certain targeted level. Blending implies to the work of the inlet material flow properties along with the possibility of uniformly altering the mix. Blender reclaimer after homogenization of ore piles transfers the material to the required customer or areas through conveyer. Blender reclaimer moves on the side of the stockyard area.

5.1 **Maintenance of Blender Reclaimer:-**

Service life & reliable operation of the machine depend to a large tent on the standard of maintenance of the electrical & mechanical equipment. All driven parts are to be regularly examined for faultless operation. Regular checks should be carried out in respect of lubrication points, protection devices, walkways & structure shall be regularly cleaned up rotating parts must be cleaned only when they are at standstill.

A) Lubrication:-

Following rule should be followed for lubrication:

i) Cleanliness of all greasing points

ii) Gear boxes should be inspected when there is no heavy wind & under protective tarpaulin to prevent entry of fly dust.

Electric equipment, belting, brake drums and brake lining should never come in touch with lubrications. When machine is shut down for long period all bearing must be lubricated until a grease collar built upon the edges of bearings before taking the maintenance into operation

B) Conveying System: -

- In conveying bulk materials lot of contamination of all the parts of system take place ,belt pulley and idler should be kept clean
- Baffle plate in yard conveyor chute must be set in such manner that flow of material passes onto the centre of belt reclaiming conveyor
- Worn rubber rings on the impact idlers should be replaced with new
- The rubber strips on the belt scrapper, skirt plate and chutes must be adjusted according to the degree of wear with belt scraper proper should be taken so that steel packing strip will not come in contact with belt conveyor
- When adjustable length of rubber strip is exhausted new rubber strip should be fitted

C) Idlers

Regular inspection is necessary to see whether they are rotating if they are not rotating belt may get damaged and roller wheel wear out and due to this motor will also get over loaded D) Belts. Belt should be examined once in week especially the belt joint. If found damaged it should be promptly required. Proper care should take so that belt should not rub again discharge chutes.

E) Pulleys

Pulley should be properly aligned and should be checked for its lagging to ascertain that it is not damaged, worm out lagging should be replaced.

F) Skirt Plates

Skirt plates should properly adjusted so that rubber strip are as close as possible the belt. As rubber strip wear out they must be adjusted till the useful life is extended then it should replaced.

G) Chutes

Chutes should be inspected regularly to insure that radial clearance between the back plate and bucket should be between 5mm to 10mm.

H) Gear Box

Proper care should be taken from time to time the oil level is to be checked at the oil level indicator and oil is to be filled at some interval and mode up to the require mark.

For oil change, old oil should be internally removed and gear box should be carefully raised with raising oil which should also be removed completely before filling

I) Coupling

The operation and maintenance of hydraulic coupling should be carried out in accordance with the proper procedure In case of gear coupling worn out geared halves should be replaced

J) Bearing

Firstly bearing should be thoroughly free from old grease the bearing housing raised and provide with clean antifriction bearing grease

During lubrication attention has to be paid no dirt gets into the bearing. Antifriction enclosed in gear boxes do not required lubrication.

5.2 **MODIFICATION AND RECTIFICATIOON OF FAILURES in ROLLER**

A) Rectification

One of the causes of the failure of the guide roller bearing is impression of fine dust for that regular maintenance procedure and uses of covers wherever necessary is done

B) Modification:-

To avoid lack of lubrication lubricant like servo gem EP2 & SS320 or SS460 oils are used.

5.3 **MODIFICATION OF THRUST ROLLER**

There are 4 axles' supports on these positions the bucket wheel is supported through a single wheel which is hinged type. Each axle supports 2 rollers.

This single support was first hinged so that load is balanced on 2 rollers. This is not enough to withstand the thrust so this front axle hinged support was changed to a single support axle. Blender reclaimer was originally design by a company by the name of MUKAND.

Their original design comprised of all six thrust bearing but it has now totally 10. This modification was done keeping certain factor in mind. Such as newly put for guide roller take up the thrust while reclaimation so that the wheel does not get misaligned. There are certain co-ordinate(x, y) which decides the type of rotation of wheel whether it is concentric or eccentric it must be maintained at (1343, 518) for the wheel to more concentrically. Due to wear & tear wheel rotates wrongly due to change in dimension in such cases the set of 4 thrust rollers on top which take up maximum load are changed of all together as to have uniform wear

5.4 **RECTIFICATION OF BUCKET WHEEL DRIVE SYSTEM :**

The bucket wheel base and the rail base should be grinded in order to create roughness between them for the purpose of holding. Next to them some heat must be applied in such a way that two bases should fix each other and then coupling is done using nuts and bolts, Along with that welding should be done between the sides of bucket wheel and the support rail for the purpose to be fixed tightly. Thus by doing them the wheel arrangement can be rectified and the blender reclaimer can work more time repeatedly for blending of base mix compare to previous time.

6. CONCLUSION

6.1 Overall Conclusion

Sinter plant capacity is 9.879 Million Tonnes of Gross sinter per annum but Due to the Technical issues in the plant, production is decreased to 7.11Million Tonnes of Gross sinter per annum.We have modified those issues with our reliable solutions in the sinter plant and increased the production of sinter up to approx 8.568Million Tonnes.

6.2 Integration of Hammer Crushers:

In order to protect the body of the Hammer Crusher certain (<96) number of the hammers are to be aligned so that the impact load on the breaker plates are get minimized. As the number of the hammers get increased it result in increase of impact load which cause wear and tear to the body of hammer crusher. And in case of the hammer it is better to use arm and head faciend by pin because it is economical and easy for maintenance. And this type of hammers can here-used.

6.3 Prevention of Spillage and Belt Cutting of a Conveyor:

When installing a skirting system, all of the above factors must be taken into account. Alternative alternatives and options must also be considered. This includes the transfer chute design, although it should be handled individually. In some cases, the use of slider beds can be used to alleviate impact idler access as well as maintaining acceptable clearances. Overall, it's important not to lose sight of what matters, because material entrapment can damage a conveyor belt. Spillage and dust management should not come at the cost of the belt.

6.4 Modification of Roller Rail Arrangement of Blender Reclaimer:

We have dealt with the blender reclaimer identifying the problem involved in its operation and suggested some modification needed to made , to have trouble free operation and avoid some undesirable phenomenon like friction ,sway non- circularity (with the help of guider). The other problem like balancing of rotating masses is the major problem has being resolved through the provision of additional thrust rollers to the existing thrust roller arrangement by increasing them from 6 to 10.

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