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Reduction of Drilling Machine Problems During the Operation of Blast Furnace in Steel Plant

KEYWORDS: Blast furnace, drilling machine, differential gear box, bearings

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ABSTRACT *Blast furnace is the largest known unit in iron making. Ancient blast furnaces are built from the clay. Today's blast furnaces are gigantic structure made of steel and refractories. During the operation of a blast furnace various problems are identified. In this drilling machine is the most existing problem for the down time analysis.*

Drilling machine is the most existing reason for the delay time in blast furnace. Electric drill machine is used for drilling tap holes. In that Differential gear box is one which is used for different speeds. Main problems in this gear box are failure of worm threading, shaft, and bearing. The present work is mainly focused on identification of major problems during the operation of blast furnace. Also it was observed that drilling machine problem is the main problem and remedies are suggested to reduce the 50% of the problems in the Gear box of the Drilling machine.

Introduction

Visakhapatnam steel plant is the first shore based integrated steel plant in India with 3.0 million tons of liquid steel per annum. The major process departments are coke ovens and coal chemical plant, sinter plant, blast furnace, steel melt shop & continuous casting, rolling mills.

Iron is obtained by reducing iron oxides into metallic iron in blast furnaces. The conditions in these furnaces are such that iron is saturated with carbon. In addition to carbon, the pig iron contains Silicon, Manganese, Sulphur and other impurities.

Blast furnace is the longest known unit in iron making. Ancient blast furnaces, bloomeries, were built from the clay. They small in size and produce a few kilograms of iron per day. Gradually blast furnace grew in size. Today's blast furnaces are gigantic structure made of steel and refractories. They are capable of producing up to 6000 tones of pig iron every 24 hours.

A Blast furnace is a shaft lined on the inside with refractory materials. The furnace is charged from top with burden materials, including coke, sinter, ore, lime stone, quartz, manganese oxide, and supplied from bottom with heated air and natural gas in the blast furnace is incomplete due to the intentional storage of blast, the products being CO,H_2 and N_2 . While rising, these gases heat the descending the burden material and reduce iron, manganese, and other elements from their oxides. Thus blast furnace operates on the counter current principle, the iron and slag moving downwards and the gases upwards.

After the accumulation of iron and slag at the hearth bottom, one of the holes is drilled with drilling machine. The hot metal and slag are discharged in the runner. Before hot metal is discharged rocking runner, an obstruction is placed in the runner. It separates slag and hot metal (density of slag is less when compared with hot metal, so slag floats up in the runner).The hot metal from the furnace is supplied to steel melting shop & pig casting machine shop through ladles to produce blooms, rods and steel structures. The molten slag produced by the furnace is fed to cast house slag granulation plant to produce granulated slag. The granulated slag is fed into final storage through a conveyor system.

After required amount of iron has been taped, the tap hole is plugged with a refractory mass by means of piston type electric drilling machine or electric drill pit.

IDENTIFICATION OF MAJOR PROBLEMS IN FURNACE

During the operation of a blast furnace, the problems descript mainly are Charging Problem, Drilling Machine Problem, Non Dry Furnace, Fast Flow, Ladle Derailment etc. In this Drilling machine is the most existing problem for the Down time analysis.

DRILLING MACHINE

In three different conditions, the delay time in hr/month is observed for the above problems in a blast furnace. During the month of November, down time analysis in three different conditions off blast, low blast & wind restrictions the total delay times 3.55, 6.40 & 9.25hr are observed respectively. From the problems defined above, the drilling machine problem comprises of maximum delay times 2.40, 2.90 & 3.4hr. In the three different conditions of down time analysis.

Thus drilling machine is the most existing from the other problems in a blast furnace as studied from the down time analysis. This problem is to be remedified to bring out best efficiency from blast furnace operation. Hence we have chosen problem and brought the required measures to out come the delay time & have best efficiency of blast furnace.

A blast furnace tap hole drilling apparatus is mounted so as to be movable, between the tap hole drilling and retracted positions, in an inclined plane. The mounting means for the drilling apparatus permits the vertical and/or angular adjustment of the drill bit and the drill is held in the operative position solely under the influence of hydraulic pressure. Motive fluid for the drill of the tap hole drilling apparatus is delivered to the drill, which is mounted for movement along a support beam, either by a rigid conduit system or via flexible conduits which are played out from and rewound on a reel.

OPERATION OF DRILLING MACHINE

Drill bit is fixed to the chuck at the parking position. The length of the Drill bit varies from 2.5m to4.00m depending upon the condition of Tap hole. With the help of swing mechanism Drill machine is positioned at the Taphole. Drill bit is guided at the center of the Tap hole .drill bit with drill rotation gear box at 384 r.p.m .Carriage feed is given with the

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help of differential gear box. There are three forward speeds and two backward speeds.

Fig: 1 Drilling machine at Blast furnace

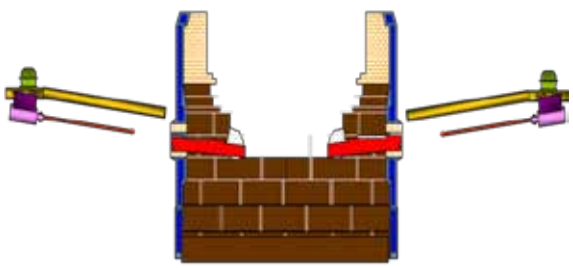

Fig: 2 Twin tap hole operation

At the initial position, drill bit is horizontal; on drilling its inclination is 9degree

PROBLEMS IN DRILLING MACHINE

It has been identified from the down time analysis that drilling machine problem is the most existing reason for the delay time in blast furnace. The actual procedure for this time delay is Failure of differential gear box, Drilling machine is unable to open the tap hole, Failure of swing connecting rod, Drill chuck burning, Chain snatching, Drill rotation gear box, Drilling machine has the problems in its mechanisms which has different failures like shearing failure, crushing failure and there is a main problem with differential gear box which is shaft bending and failure of worm threading.

DIFFERENTIAL GEAR BOX

Differential gear box is one of the main components of the Drilling machine which is used to drive the drilling machine. An arrangement of gears in an epicyclic train permitting the rotation of two shafts at different speeds, used on the rear axle of automotive vehicles to allow different rates of wheel rotation on curves.

Fig: 3 Internal Structure of differential Gear box

Usually Gear box consists of two halves as shown in the figure above.

The left half consists of two shafts which has worm threadings,these are the inputs of the gear box .Right half of the gear box consists of gear mechanism,it has two bevel gears connected to the shaft by means of ball bearings. In between the two bevel gears a planet wheel is placed which rotates in the direction perpendicular to the direction of rotation of the bevel gears.These arrangement is kept in between the two worm wheels which has worm gears on it and it is attached to the shaft by means of bearing to rotate freely and the shaft acts as an output of the gear box.

This entire mechanism is kept in a box with specified dimensions which are constant.

When the two input(motor) shafts rotates the worm wheels rotate with the help of worm gear tooth on the input shafts. The output of the box will obtain by the rotation of the output shaft. A chain is connected to the gear box which will move the drilling machine in both forward and backward directions.

A variety of gearboxes find applications in a number of industries depending on the end use. Some of the industries using gearboxes include: Agricultural, Industrial, Construction, Mining, Petrochemicals, Food processing.

PROBLEMS & SOLUTIONS

The main problems that occur in differential gear box are the failure of the worm threading on the motor shafts, worm wheels, bevel gears etc.

- Bending of the shaft due to high impact of loads.
- Failure of the bearings due to heavy loads

From the calculation of taper bearing and as per the bearing catalogue for bearing 32210 the dynamic load is 7000kgs approx next higher size of the bearing is 33210 with same O.D and I.D and width of 32mm.its dynamic load is 11000 kgs and can be accommodated in the same housing modification may be done for minimizing the breakdowns.

PROBLEM WITH BALL BEARING:

The radial ball bearing is fitted on rear end side of gear box which is always exposed to a radiation temp of 140 deg centigrade during running tap hole. The bearing seizures and the jams the gear box. Recommendation is sort for changing the bearing from 6207 to 6207C3, which is having more clearances for absorbing the thermal changes. Finally the following solutions are made to reduce the problem in the drilling machine at furnace.

SOLUTIONS:

- To replace the bearing 32210 with 33210
- Make input shafts with EN18 material to increase the bearing seating
- Make suitable bearing housing
- Assemble the bearings in housing on input shafts
- Assemble the gear box properly
- Fabricate heat protection plate of 700x500 mm

Figure 3 & 4 shows the difference between the old product which has failures in shafts and bearings and modified shafts and bearings.

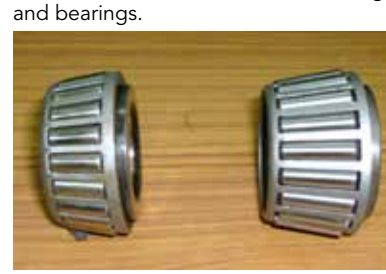

Fig: 3 Old (Left) and Modified (right) Bearings

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Fig: 4 Old (top) and Modified (bottom) Shafts

CONCLUSION

In the present work a study is carried out to indicate the various problems in the operation of a Blast furnace. From the data obtained about the problems in furnace at steel plant, it was observed that the drilling machine problem is the main problem.

To reduce the drilling machine problems two methods are suggested. They are providing changes in the bearings and bearing seatings. By increasing the length of the bearing seating and changing width of the bearing, it can reduce the 50% of the problems in the Gearbox. Finally solutions are made to reduce the problem in the Drilling machine at furnace.

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