Design of Template for Measuring Airgap along the Circumference of Stretch Reducing Mill Rolls

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Abstract: **In the application, Bharat Heavy Electrical Limited Trichy-14.Every industry faces its own type of problems per product in manufacturing. The solution of the problems may be simple but solving them gives us the credit. Most of the problem can be overcome with designing skills. The company that we entered faced a problem on rolls in 28 stand stretch reducing mill (SRM) at hot mill in seamless steel tube production plant (SSTP). The circumference of the roll in SRM unit is not uniform, so it leads to uneven air gap between the rolls. Due to this there is a "line marks" on the finished tubes. In previous method the template used for measuring the air gap is not proper and is so difficult. As these tubes are used in high pressure and high temperature application, to overcome these problems we have designed a template along with stand that is portable to measure the circumference of the rolls in SRM unit. By doing this we will able to control the air gap between the rolls. Ultimately, as a result of this approach the "line marks" of the tube will be minimized.**

Keywords: **stretch reducing mill, seamless steel tube, line mark.**

1. INTRODUCTION

In seamless steel tube plant the overall process of hot mill is shown in fig.1

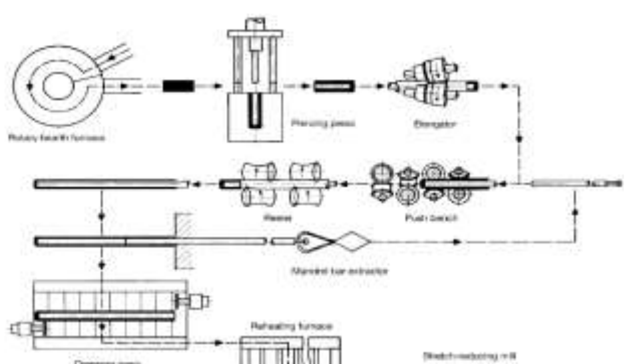

Fig.1. Layout of hot mill

Carbon and Alloy steel blooms of length ranging from 7 to 10 meters with cross section of 220 mm diameter are gas cut manually to the required length varying from 450—730 mm through cutting torch. The blooms are cut in to Billets by Oxy-Acetylene gas cutting and those billets are fed in to Rotary Hearth Furnace. Rotary Hearth Furnace is designed for bloom heating in seamless steel tube mills. Capacity of the furnace is 25 Ton/Hr. The furnace is oil-fired and uses Super Kerosene Oil The piercing press is operated through the hydraulic pressure of 100 bar for carbon steel and 120 bar for alloy steel. The maximum force it can exert on the billet for piercing is 600 Tons. Here, the bottle is pierced to form blind hole. Due to piercing operation, length of the billet is increased to 1.1 times. Elongator is equipped with three rolls and the angle between each roll is 120°. Bottle is pushed into elongator with the help of bottle pusher (i.e. mandrel with a diameter of 122mm). When three roll forged over a mandrel bar 1.8 times the bottle gets elongated. The bottle once again elongated in Push Bench without reheating. Push bench foundation bed consists of 135 slots where push bench stands are arranged in slots according to the bottle length, shell length, wall thickness. Push bench roll stands are generally comprises with three circumferentially distributed, non-driven grooved rollers. The gradually decreasing of roller pass produce reduction which main work passes, can amount to up to 25 %. In this process elongation is 10 to 15 times of its incoming length. Mandrel bar is used as internal tool. The pushing force is applied to mandrel bar by rack and pinion arrangement and max pushing speed is 6 M/Following the elongation process the tube rolled onto the mandrel bar enters detaching mill or realer to enable the mandrel to be extracted. It consists of four rollers. In Mandrel Bar Extractor, the mandrel is separated from the shell and sent back to heating grid through roller conveyor for further the pushing operation in the Push Bench. The shell or hollow from the extractor, passes over a roller table to the Saw unit, and then the closed end is cut off to obtain a pushed tube. In the course of continuous rolling process up to extraction of mandrel bar, the tube temperature falls to approx. 500°C. Consequently, it is fed to reheating furnace where it is held for between 10 to 15 minutes in order to enable it to regain forming temperature between 950℃ and 980℃. Due to the oxidation process over the surface of the billet which will be coming out of the furnace and then during travelling in conveyer, scales will be formed. To remove scales, a jet of water is poured on the tube through a set of 12-nozzles arranged circumferentially to remove scales at about 125-bar pressure. On exit from reheating furnace, the shell is subjected to high pressure water rescaling and rolled to its finished dimensions in the downstream stretch-reducing mill where no internal tool is used. This can involve further elongation up to ten times the incoming length, depending on the final dimension required. The rolled hollows formed in the SRM are then passed over a chain type Cooling Bed through a roller conveyer. The bed is 25 meters long and 16 meters width. Cooling of tubes is done in cooling bed by forced air and the temperature is brought down from 750℃ to 100℃.A set of tubes are collected by a collecting device at the end of the Cooling Bed. One set of the tubes are clamped hydraulically and the thickened are cut off from both ends of tubes. These thickened ends are caused by the length which cannot be stretched at SRM due to lack of grip at both ends of hollow. After straightening operation, the tubes are passed through the NDT unit in order to detect any defects in the tube. The two steps viz., external defects are detected by using Eddy Current Testing and internal defects by stray flux method. The defective tubes are then separated from the non-defective tubes and sent for "Cold Drawing" operation.

2. LITERATURESERVEY

Dezsoe et al. (1977) studied "Method of stretch reducing of tubular stock''. This research paper is to condense the so-called crop end loss off of requirement product at the ends of a tube segment a multi-stand stretch reducing mill is provided with a plurality of speed variable mill stands, at least at the upstream or entry end of the multi-stand mill. As the head end of a finite tubing segment enters the upstream end of the mill, and as the back end of the finite section enters the mill, programmed speed variations are made in the preferred mill stands, to compensate for the fact that the head end or back end sections of a finite length of pipe are acted upon at any given instant by less mill stands than intermediate sections of the tube. The selected mill stands are speed controlled such that certain ones thereof apply greater pulling force to the tube end section, while certain other mill stands apply greater retarding force. At one or more intermediate mill stand locations, mill stand speed is controlled to begin a substantial equilibrium of such pulling and retarding forces. Within this general procedure, a limiting condition at all times is that a predetermined stretch factor, for a given work piece, is not exceeded at any mill stand. Understanding of desired wall thickness, without either greater force effectiveness or maximum stretch factor, can also be a limiting condition, mainly when rolling the tail end section. The procedure of the invention may require the selected upstream mill stands to be speeded up, or slowed down, or sometimes both speeded up and slowed down at different moments, in relation to steady-state speed. [1]

Ritter et al. (1974) studied "stretch-reducing rolling mill". The invention relates to a stretch-reducing rolling mill for tubes, comprising a plurality of stands which are arranged one behind the other in the rolling direction and which are each connected with a shaft to a superimposed drive set adjacent the row of stands, and include in the stand housings distribution gear units comprising at the roll head side two parallel drive output shafts which are situated perpendicularly one above the other and of which at least one is modified to be joined with a parallel driving shaft, carrying a roll of the roll head, of an appropriate roll head modified to be inserted in interchangeable manner in the stand housings.[2]

Demny et al. (1976) studied "stretch reducing mills". A sizing mill is provided for reducing tubes having a number of roll stands set one behind the other and in which the sizing pass of at least the first stand is so out of round that the first sizing pass can cause tube reduction over the whole range of external diameters of tubes to be rolled in any given rolling program. This invention relates to stretch reducing mills and chiefly to a reducing mill for tubes having a number of roll stands which are set directly one behind the other and whose rolls form out-of-round sizing passes in the first stands in the entry direction. According to the number of rolls forming a sizing pass, an oval-like pattern or comparable non—circular pattern of the sizing pass is produced in known reducing mills of this type, due to the fact that the grooves of accurate cross section in the individual rolls deviate from the inscribed circle of the cross section of the sizing pass towards the boundaries, so that the sizing passes widen towards the gaps between the rolls. If these widening were not provided, the edges of the roll grooves would create score lines on the external surfaces of the tubes. The size of these widening is firstly dependent upon the reduction of diameter in the particular sizing pass, the greater the reduction in diameter, the larger must be the widening. Secondly, the ratio of the wall thickness of the tube to its diameter is important; the more relatively thin walled is the tube; the larger must be the sizing passes widening. In the known reducing mills, activities are made to keep the sizing pass widening as small as possible in order to keep the radial distribution of stress and deformation in the material of the tube as uniform as possible during the rolling operation, and thus to avoid an out-of-round or polygonal configuration of the cross piece of the center of the tube. Since the diameter reductions in the first sizing passes of the known reducing mills are chosen to be small, in order to avoid the collapsing of the tube, the previously mentioned known design principle leads to initial sizing passes having small widening,.[3]

Scheib et al. (1977) studied "stretch reducing mill". The invention is directed to development in stretch reducing mills utilized in the manufacture of seamless and welded tubing. The stretch reducing mill is well known in its generalities, and the revelation is directed to improvements in the building of such mills in the interest of increasing the efficiency of operation and performance of the mill. The revelation is directed in part to the construction of a multi-stand stretch reducing mill with improved arrangements for removable securing the individual mill stands in position. This includes a heavy, huge structural beam from which the entire individual mill stands are suspended and which in addition serves, when the mill is ready for operation, as a means for holding the mill stands in position. In the later capacity, the beam contributes both in terms of its immense weight and in terms of distributing clamping forces to the individual mill stands from partial number of clamps. The mill also includes an better arrangement for longitudinally clamping together a series of successive mill stands, using a combination of hydraulic clamping cylinders and a mechanical fail-safe system, enabling the advantages of hydraulic clamping to be enjoyed while avoiding any serious penalty from untimely failure of hydraulic pressure. An additional trait of advantage included in the disclosure is an improved mechanism for effecting simultaneous coupling and decoupling of the individual mill stands to their individual drive motors.[4]

RadeKrianeet al (2010) studied "numerical design of a hot-stretch-reducing process for welded tubes". During stretch reducing, steel is submitted to complex stressing and straining processes. This paper gives an academic model of a heat-stretch-reducing process for the relation between the tube diameter and the wall thickness. The design is verified by a determination of the number of revolutions of rolls with every caliber for specific tubes on an industrial mill. The control of the rolled-tube dimensions established the accuracy of the drawing. With the technology of stretch reducing, earlier manufactured tubes are transformed in several passes into tubes with a selected diameter and wall thickness.1,2,3 In the processing, the tube is submitted to sturdy compression and tensile stresses during the reduction of the diameter and the diminish of the tube wall with stretching and tensile stressing. Both the types of stressing are equally dependent, complex and very high.2,3 The extent of stretching is defined by the coefficient of plastic extension and it is synchronized by the number of revolutions of the rolls during every pass. This coefficient is the ratio of the reduction of the tube diameter and wall, and the ratio of the compression and tensile stresses in the tube. The number of passes depends, on the one hand, on the essential reductions of the tube diameter and the wall, and on the other hand, on the lowering of the temperature from the first to the last reduction passes. The quality of the processed steel is of great importance, since it determines the temperature range of the processing. For this reason, tentatively, the number of passes of the stretch-reducing mill depends on the total size of the reduction and the decrease of the temperature in all the reducing passes.[5]

3. EXISITING PRACTICE OF MEASURING AIRGAP on the SRM roll

There are two types of stretch reducing rolls.

1. 380mm
2. 300mm

Each roll has a different template

METHOD OF MEASURING THE ROLLS REQUIRMENT OF TOOLS

1. Template
2. Filler gauge

In previous method the SRM rolls is measured at one point on the circumference of the rolls by butting the template at one end. The gap at the other end is measured by using the filler gauge and by adding the either side of the clearance value. The method of measuring the roll is shown in fig.2

Fig.2.Existing Practice Of Measuring Air Gap

4. STATEMENT OF PROBLEM

Measuring Department: In previous method, the air gap is measured manually by just keeping the template at one point. Since the air gap is maintained for a very small value at a range of 0.3 on either side, there is a chance of error in measuring due to shaking of human hands. Since the weight of the roll is very high it takes a lot of time by keeping the rolls in a chuck and then measuring the air gap at different points by rotating the rolls.

Production Department: If the air gap measurement results in error then there will be a line marks on the rolls which leads to heavy loss for a large scale company and the rolls cannot be used later. Line marked product is again sent to surface finishing which it include a rework and it lags time for shipping.

Assembly Department: During assembling, the rolls will not properly fit into the frame of SRM stand and it will damage the gear setup.

MATERIAL OF FIXTURE

TABLE.1: PROPERTIES OF TEMPLATE

Material designation	BMPS3
Metallurgical condition	Oil hardening non shrinking die steel or C16 chrome plated to 0.8mm depth
Hardness	60HRC

TABLE.2: DESIGN REQUIRMENTS FOR FIXTURE:

S.NO.	COMPONENT	SPCIFICATION	QUANTITY
1	Casted rod	30mm diameter	3
2	Bolt and nut	25mm diameter	2 pair
3	Rectangular base metal	100*100 mm	1
4	Bearing	30 mm inner race	1
5	Digital dial gauge		1

The hardness of template (55-60hrc) is greater than the hardness of roll (50-54hrc)

5. DESIGN OF PORTABLE FIXTURE

Fig.3and 4 shows the design of fixture for template. This design is used to measure the air gap with maximum accuracy. Hence it makes easy for assembling the rolls in the stands. By doing this the problem is rectified in the SRM unit itself rather going and rectifying in the assembly. This fixture is designed using AutoCAD 2013 software and it is drafted for accurate air gap. Thus it uses digital dial gauge for measuring air gap. The fixture designed is portable.

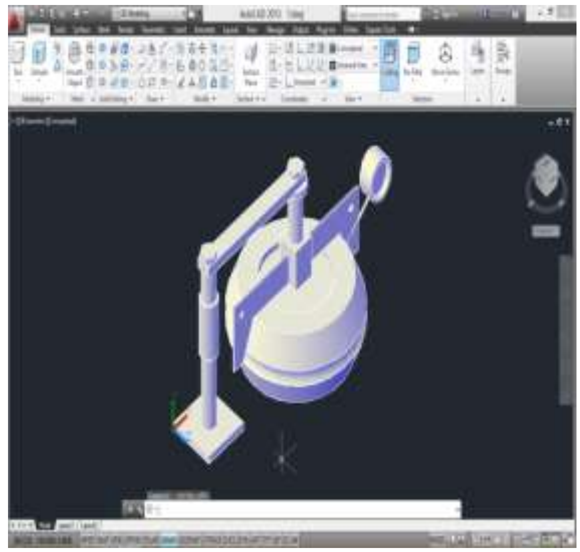

Fig.3.Design of Fixture

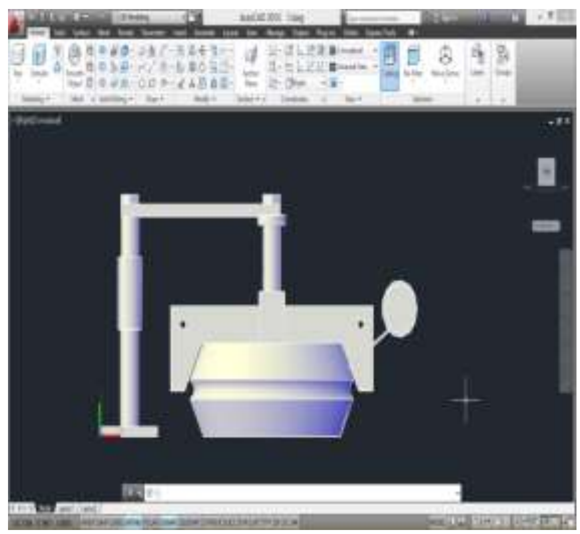

Fig.4.Right Side View

6. CONCLUSION

An incorporated approach of modeling of portable fixture has been designed in this work. This approach is essential for manufacturing plant. This paper covers the design of portable fixture for template. The air gap of the SRM rolls is maintained at very accurate. So the line mark in the product is avoided in stretch reducing mill itself before entering into the cold drawing section and hence rework of smoothening the surface is also reduced. This work transforms the theoretical knowledge of fixture design to practical application. This portable fixture for template is taken into consideration for implementing in seamless steel tube plant at BHEL.

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