

APPLICATION OF FIBRE OPTIC HOT METAL DETECTOR IN HOT STRIP MILL OF STEEL PLANT

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ABSTRACT- In hot strip mill, hot slabs are rolled into strips of required size. To sense the presence of the hot slab on the roll table different gadgets like hot metal detector (HMD), charge coupled devices (CCD), laser beam, fiber optic sensor etc are used. Positioning of sensor at right location, distance from the object to be viewed, accuracy of detection, maintenance of the system during the fault, cost etc are the few of the parameters is considered while selecting suitable sensor. In this paper limitations and application of various sensors mentioned above are discussed for the hot strip mill.

1. INTRODUCTION

Hot strip mill (HSM) is known as the mother unit of any steel plant. Where hot slabs are rolled in to required thickness and width in the mill. Basically cold slabs / blooms that are coming from continuous casting shop is the raw material for HSM, are charged into the reheating furnace of the HSM. When the slab attains the rolling temperature of 1200+ degrees C. It is discharged to the roll table from the furnace which passes through various stages of rolling processes in roughing stand, intermediate stand, and finishing stand and finally the finished product in the form of strips/ plates are taken out in the form of coils/ plates.

Generally the reheating furnace consists of pre heating, heating and soaking zone. They are gas fired furnaces. When the hot slab comes out of the furnace, needs the scales formed on the surface of the slabs to be removed before it goes to 1st roughing stand. Reduction in the thickness takes place by producing desired number of forward and reverse passes in the 4 high roughing stands. The vertical edger in the stand limits the width wise expansion of the slab. There after it enter to intermediate stand where further reduction of thickness takes place. The front end (head end) and tail end of the transfer bar is trimmed perpendicular to the length of the bar to avoid coble in the finishing stand and coiler. Before entering to the finishing stand the scales formed due to oxidation process are removed by hydraulic means. Some steel plants

have coil box in between the intermediate stand and finishing stand to avoid temperature variation across the length of the bar. The temperature at the entry of the finishing stand is around 1000+ degree C whereas at coiling point of the strip the temperature is of 600 degree C. the total length of

the mill is approximately 600- 800 meter and the weight of the slab / coil varies from 8T-12 Tons. The roughing zone, intermediate zone and finishing zone of the HSM, each zone may have more than one stand as per the design of the HSM. Single stage reduction from slab to strip is nowhere practiced

As the rolling process need s of heavy rolling torque, large rating of electrical motors, causes instability to the power system and unable to achieve their required

metallurgical properties of the finished product. The present trend is for endless rolling; on line/hot charging of slabs to the reheat furnace of medium thickness for obvious reasons(less generation of waste/scraps, increase in productivity) The age old ingot rolling practice can be seen in some of the old steel plants.

2. TRACKING OF HOT SLAB DURING MATERIAL FLOW

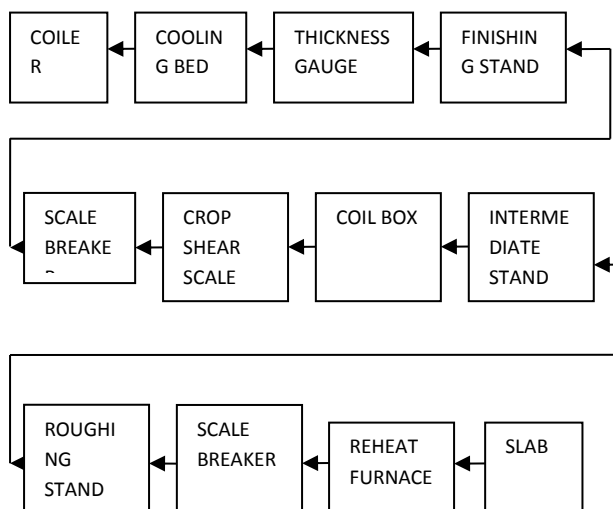
It is very important to track the hot material while in motion on roll table from the starting point to the finishing point such that each stand is ready to accept the incoming materials. The basic principle behind any hot metal detector is based on sensing the infrared radiated from the hot metal which is electro-optically processed to drive the output circuit, the presence and absence of the hot metal to the controller/PLC/PC based system for subsequent operations.

When the slab is rolled either in the roughing stand or in the intermediate stand the head end may form a fish tail or a part of the width of slab may be elongated more than other portion due to error caused by deviation from the center line rolling, non-uniform roll gap across the width of work roll due to improper screw down pressure at right or left side of the mill stand, non-uniform temperature across the width of slab. Such irregular shape across the width may cause cobble in the finishing stand or coiler .Hence front end and tail end needs to be trimmed at right angle to the length of the strip. The thickness of the strip at the final finishing stand varies from 1.8mm to 6mm depending upon the order received from the customers.

3. WORKING OF FOHMD / CCD CAMERAS.

The tip of the fiber optic cable is provided with a lens, which concentrates the infrared ray radiated from the hot object placed before it and transmit the IR ray to the receive element . The receiving element of electronic circuit converts optical signal to the electrical signal, amplified and trigger relevant switching devices of the electronic circuits. The fiber optic cable is kept inside the protective cover which is water cooled. The cable can be easily bent and can be placed closed to the object without affecting the performance of the system.

As the electronic processing unit is located faraway place from the hot object. The chance of failure of electronic unit due to temperature is remote. The output of the electronic process unit is fed to the PLC for necessary control of the mill stand, roll table; crop shear etc. Generally FOHMD devices are located below the hot strip in the roll table while its field of view is very small .Hence the accuracy in detection system increases. In case of any damage due to temperature, only the FO cable is effected and not the entire system. For a fish tail or irregular shape of front end, minimum three no's of such sensors can be put in a straight line across the width of strip, whose AND output defines perfect front end where to be cut. Again 2 such additional sensors placed along the length of strip at a known fixed distance, the time period at which the strips crosses the HMD determines the velocity of the moving strip on the roll table. Their data when fed to the PLC, determines the optimum trimming position in crop shear blades to cut the strip in motion by minimizing the scrap, thereby improving the productivity. Such auto operation is not possible by manual control / CCTV camera methods, where the strip positioning time before crop shear delays / reduces production.



Whereas in case of CCD (area scan, linear scan) camera, the number of active pixels due to infrared light received from the hot object located below the camera, multiplied by the pitch between the adjacent pixel determines the width and the length of the object. When the number of active pixel across the width of the strip is equal to the pre defined pixels of the width (say 70- 90 %) the cut command for front end cutting may be given by the PLC to get width as right single to the length. Hence irregular shape in the front end can be minimized .Hear again the CCD camera is water cooled and is located at the top side of the object. The image can be received in the monitor by the operators in its control cabin .Since the camera is located at a fixed height it needs perfect focusing of the object to avoid the error. The FOB of the camera covers more than the required areas. The effect of the edge radiation should be considered while calculating the dimensions of the hot object. The response time of the line scan CCD camera is faster than the area scan camera. The CCD camera is more susceptible to damage due to high temperature.

4. CONCLUSION

Different types of hot metal detectors are used across the length of the hot strip mill, whose selection are based on the performance sr sig . area scan / linear scan CCD camera sensor can be used for viewing whole surface of the object from where the width length of the object can be easily determined using suitable software. In defect classification mode the operator may nullify minimize the defects by selecting proper operational parameters whereas the FOHMD can be focused with minimum field of view angle for better accuracy which is not possible otherwise by other methods. The general purpose hot metal detector can detect the presence & absence of the hot metal on the roll table. It has been reported by replacing the general purposed HMD, CCD, CCTU camera to FOHMD system, RSP saved crores of rupees by crop optimization (minimization of waste) by head end and tail end cutting in one of their research project.

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