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Improvement in Production Yield of Hot-rolled Coil by Controlling Process Cobbles

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Abstract: The yield is dependent upon many factors, such as cobbles, total scrap generation, crop loss and scale loss. It appears that the huge quantity of scale is mainly responsible for the yield loss. However, by the correlation study, it reveals that the number of cobbles is the major contributor to the yield loss. The innovation lies in changing the focus of attacking the real problem by analysing the operating data which was not surfaced earlier. The focus shifted from the furnace to the mill and the cobbles studied through the years deeply. All the analysis proved to be helpful for the future prevention of the similar kind of failure. The internal target of bringing down the number of cobbles per month in single digit was taken. This also helped in improving the maintenance practice and reducing the amount of delays significantly. The yield was improved by 0.93%.

Key words: hot-rolled coil; yield; cobble; scale loss; finishing mill; correlation

It is a general observation that the worldwide demand of crude steel has remained stagnant for quite a long time. Simultaneous drop in steel price has forced the steel industry to face tremendous challenge. Therefore, as a survival measure, there is a need of drastic cost cutting, while improving the product quality and customers has been focused at the same time.

One of the important tools for this drive of cost cutting is the improvement of production yield, without compromising on product quality. In the present paper, some of the key factors that lead to yield loss in a hot strip mill were discussed and how the most critical issues were identified and addressed in the hot strip mill of Tata Steel Ltd., India, was introduced, so as to achieve a significant amount of savings from yield loss point of view, yet maintaining the product quality.

The hot strip mill converted steel slabs into steel coils by subjecting the slabs first to high temperature soaking in a reheating furnace for a certain time, followed by hot rolling treatment using a series of rolls. Slabs were received from the continuous caster and arranged in the sequence of the charging schedule at the slab yard before charging into the furnace.

It is a complex system of operation at hot strip mill and the performance is much dependent on the external factors, such as timely supply of slabs from slab caster, consistent fuel supply, uninterrupted power supply, etc. Any delay caused by any of these factors directly affects the material yield. For example, if the slabs are kept inside the reheating furnace for a longer time more than the normal residence time, it will lead to the formation of heavy scale on slab surface, which is a potential cause of yield loss.

The present study aimed at the analysis of operating data[1] and practices of hot strip mill in Tata Steel Ltd., India, with an objective of optimising the production yield. The operating practices were thoroughly examined, starting from the slab charging into the reheating furnace to the coil production in the downcoiler after rolling in the finishing mill. It may be noted that there was a limited scope of improvement in this exercise, since the material yield was already optimized to a great extent.

Strip quality control is one of the major tasks in flat rolling. Various works[2-8] have been done to control the strip profile and shape in terms of crown and flatness by utilising computer simulation model. When the thickness is beyond the customer's tolerance, the coil is rejected and the yield is directly affected.

1 Process Flow

Fig. 1 shows the schematic representation of a hot strip mill, which is very similar to that of Tata

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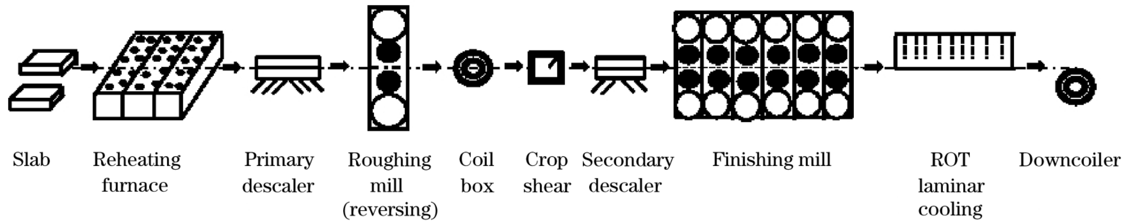

Fig. 1 Hot strip mill layout

Steel Ltd.

The raw material for the hot strip mill is the cast steel slabs, which are produced by the continuous slab caster. The slabs are inspected and dressed, if required, and transferred to the slab storage yard by heavy-duty transfer trolleys. Slabs are stored in the slab yard of the hot strip mill with the help of overhead cranes equipped with slab handling tongs. After casting, the steel slabs undergo cooling, and therefore, it is necessary to soak the slabs in a reheating furnace, at an appropriate temperature for a certain length of time, to make it suitable for subsequent hot rolling. The mill layout and equipment have also been designed to permit hot charging.

Slabs of various steel grades and widths are properly organised and sequenced before charging into the reheating furnace, depending on the final gauge and width requirements. The slabs are charged one-by-one onto the slab receiving table using a semi-portal crane and charged into the furnace with the aid of a slab charging device. The reheating furnace plays a key role in (1) heating up the slab to the desired temperature uniformly and (2) supplying hot slabs to the mill consistently and effectively. The walking beam slab reheating furnace has been designed to heat the slab up to a temperature of about 1 250 ℃.

The average slab residence time of the slab in the furnace is 3 h. It can vary depending upon the mill throughput. The increase in the slab residence time inside the furnace also increases the scale formation over the slab and the losses. In order to minimize the losses, by controlling the scale formation, the furnace temperature is reduced during the mill detention period.

The heated and soaked slab, after getting discharged from the reheating furnace, passes through a 200 bar hydraulic descaler system, thereby opening up the fresh surface for the subsequent deformation process. The slab enters the reversing four-high roughing mill, with an attached heavy duty edger on the entry side. The 210 mm thick slab is rolled to 20—40 mm thick transfer bar. The edger reduces the slab width by a maximum of 90 mm (effectively) to eliminate side spread and to reduce the number of slab widths. Necking control is provided in the edger to improve yield. High pressure descaling headers located in the roughing stand descale transfer bars during roughing passes.

The transfer bar up to a maximum of 40 mm in thickness is coiled in a coil box and subsequently uncoiled to feed the bar into the finishing mill train to permit near isothermal rolling in the finishing mill. The use of the coil box avoids zooming of the finishing mill stands, which, in turn, avoids the imposition of heavy kick loads on the power supply system. The deformation of the front and back end of the strip is cropped by a drum type crop-shear and the strip passes through a secondary descaler prior to entering the finishing train.

The finishing mill consists of six numbers of 4-high stands equipped with a hydraulic descaler. The finished strip emerging from the last finishing stand is cooled by a laminar spray cooling system as it traverses the run-out table. After that, it is coiled in the hydraulic downcoiler having step control. The formed coils are stripped from the downcoiler, placed on the coil conveyer, suitably strapped on the circumference and eye, weighed, marked by robotic paint marking machine and sent to the coil yard for dispatch.

The strip coils are uncoiled, strengthened, side trimmed and cut to length, weighed and marked in a shearing line and dispatched as sheets and plates duly packed.

2 Variables Affecting Production Yield

The overall production yield of a hot strip mill depends on a number of factors. Some of the important factors are listed below.

(1) Slab mass This is the input mass to the hot strip mill. Slab weighing is done on the slab-receiving table before charging into the furnace. This data is captured in system as slab consumption.

(2) Gross production Each coil after final pro-