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PERFORMANCE EVALUATION OF LUBRICATING OIL IN SHAPE ROLLING MILLS OF SAIL STEEL PLANTS

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Abstract

Hot roll lubrication technology is widely used in flat and shape rolling mills. In Flat rolling mills, lubricant in the form of oil-in-water emulsion or dispersion is sprayed with the flat jet nozzles either in the roll bite or on the surface of back up rolls. In Shape rolling mills, lubricant in the form of emulsion is sprayed on the place of roll bite. Application of roll bite lubrication requires a well-engineered system so that lubricant applied on it is not carried by the roll cooling water and each drop of lubricant is burnt during rolling. Positioning of spray header at a suitable place inside the mill housing is a critical decision. In this process, ease of maintenance and safety of the system are taken care.

There are number of tangible and intangible benefits of using hot roll lubrication. Lubricant reduces friction between strip and rolls and results into major benefits like longer rolling schedules, increased tonnage per work roll use, improved surface quality of products, lower roll shop operating cost due to less wear out of work rolls, reduced electrical energy consumption, decreased rolling load and mill chatter.

In SAIL, hot roll lubrication technology was indigenously developed at Rail and Structural Mill of Bhilai Steel Plant and Section Mill, Durgapur Steel Plant.

Introduction

In Shape rolling mills, steel blooms of different thickness are rolled in hot condition to make section or round products like rails (Bhilai), angles / channels (Bhilai, Dugapur, Burnpur) wire rods and TMT bars (Bhilai, Dugapur, Burnpur), Bloom thickness is reduced between two work rolls with a required force. The shape products enter the finishing stand at about 970^{o}C. Large amount of heat energy is also generated through the reduction process. Under such condition, there is high rate of heat transfer to work rolls and thus, temperature of work roll becomes very high. Large quantity of cooling water is therefore sprayed over these rolls to control their temperatures. Work rolls of these three stands get maximum abuse and wear induced by the process. Excessive wear of the surfaces of the work rolls has been a major problem of mills. More roll wear coupled with increasing demand for higher surface quality of rolled products require frequent changes of work rolls with redressed rolls. These factors have a large impact on the operating economics of Shape Rolling Mills. To overcome this problem, hot roll lubrication technology has been developed and are successfully used in Rail Mill of Bhilai Steel Plant and Section Mill of Durgapur Steel Plant.

Hot Roll Lubrication Technology

It is very difficult to physically locate a spray header for a lubricant in Shape Rolling Mills. Work roll cooling water prevents the lubricant to reach the roll surface. Typical problems encountered are:

- Slippage of rolls because of excessive oil
- Nozzles are prone to plug from contaminants in the lubricant
- On / off sequence of the lubricant has to be controlled to ensure dry work roll
- Operator acceptance is incomplete since the process is new

To over come this problem a new technology, known as cooling water method, was developed in which lubricant was injected into the cooling water. In this process, the oil forms a fine dispersion in the cooling water at a very low concentration (500 ppm) and deposits on the work rolls. This system has proved to be a reliable and maintainable. However, due to large volume of roll cooling water, consumption of the lubricant increases many folds, which adversely affects the techno-economics of its use.

Finally, a dispersion method was developed in which neat oil spray header was replaced with a emulsion spray header using standard V-jet or flat jet type nozzles. Lubricant was injected into a separate water line to form a dispersion, which was subsequently sprayed over the surface of rolls through the header. The dispersion can be applied directly on the work rolls as shown in Fig.1. In this method, the lubricant particles in the dispersion deposit on the roll surface and form a thin oil film similar to that provided by the neat method. The result obtained with respect to lubrication condition was comparable to that obtained in neat oil method. There was however appreciable improvement in ease of maintaining the system including considerable reduction in nozzles plugging frequency. Consumption of lubricant is also the optimum.

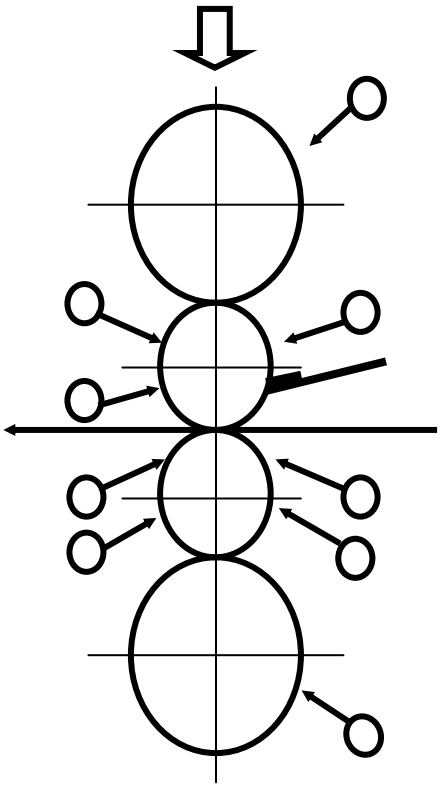

Fig.1 Arrangement of cooling and lubrication headers at a finishing mill

Method for selection of lubricating oil

The approach adopted in introducing hot roll lubricating oil in the mill had three major steps, as described below:

(a) Laboratory formulation and evaluation
(b) Industrial evaluation
(c) Commercialisation

(a) Laboratory formulation and evaluation

Formulations of candidate oils were carried out in the laboratories by oil suppliers. Selection of suitable chemistry of the candidate oils was guided by requirements of the subject mill. Most promising oil sample was selected from a lot of samples based on their physico-chemical properties and performances at some of the tribological rigs.

(b) Industrial evaluation

Best oil selected in the laboratory is being tried in mill. Lubrication system is designed on the basis of dispersion method (Fig.2) and the oil-in-water dispersion was applied on rolls. The basic lubrication system is located in the mill area. Rolling lubricant was stored in a steel tank of capacity 600 litre and it served as reservoir. A separate emulsion tank of 5000 litre with stirrer was erected for preparation of water emulsion. Emulsion was circulated continuously by means of a hydraulic pump. Filtration was provided at suction side. The relief valve provided system protection against over pressurisation. The pump output was directed to the emulsion headers. In operation the system continuously recirculated lubricant through the manifold. As required the individual solenoid valves were energized to apply emulsion on rolls.

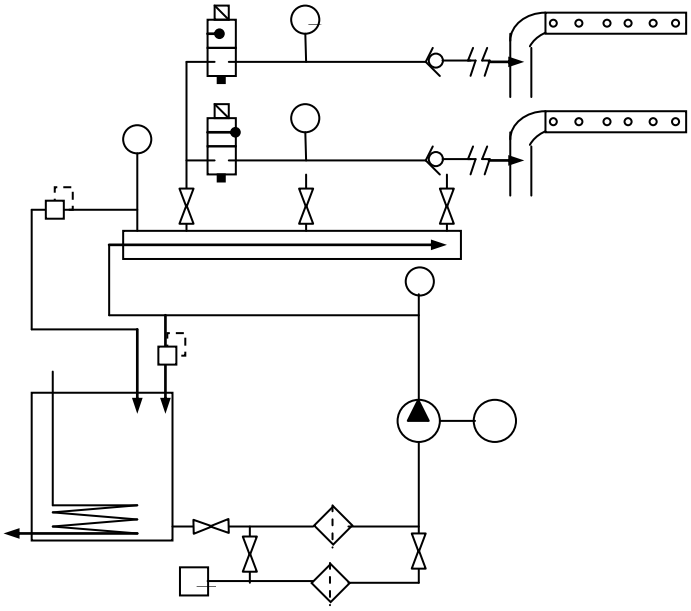

Fig.2 Schematic of hot rolling lubrication system

(C) Comercialisation

Hot roll lubrication system is in regular use in Rail and Structural mill of Bhilai Steel Plant and Structrual Mill of Durgapur Steel Plant. Separate systems are provided for top and bottom headers. Oil is supplied through metering pumps and is enabled only during rolling. Metering pump speed is regulated to maintain a specified flow rate for the process.

The oil / water dispersion is formed in a static tube mixing unit located just before the spray header. For the system to give fast response, the dispersion should be created in close proximity to the header. By doing so, the time for the oil to break out is minimized, and thus the length of piping is reduced. The spraying angle should be as big as possible. The header's spray width is adjusted to the width of the strip being rolled through pneumatically operated shut – off valves. Limiting the spray width and applying oil only during rolling operation minimize the oil consumption.

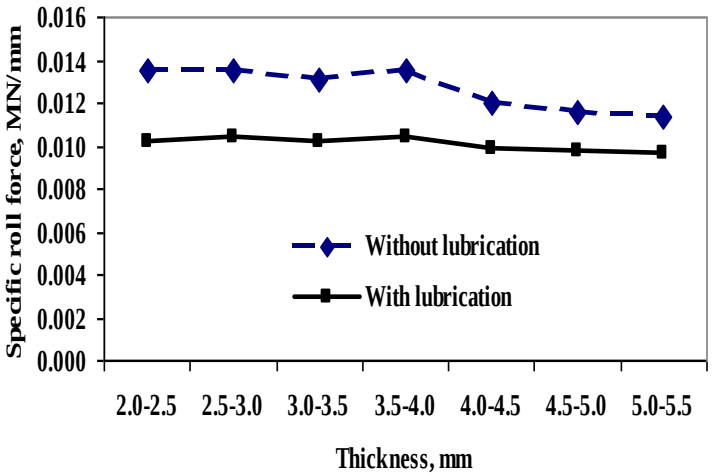

Fig.3 Specific roll force with and without lubrication

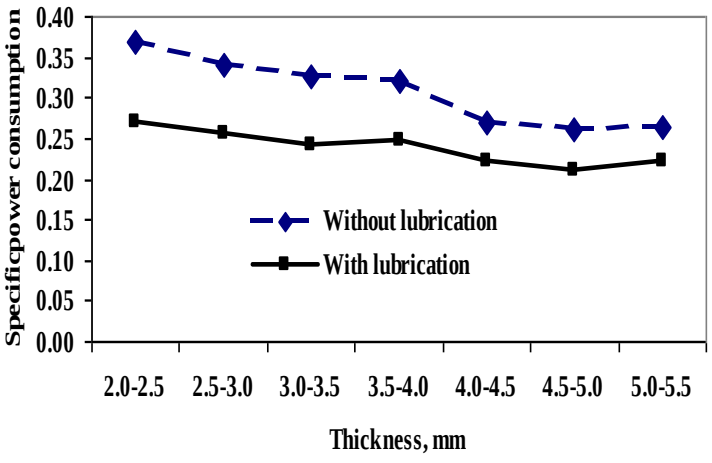

Fig.4 Specific power consumption for different strip thickness

Benefits of Hot Roll Lubrication

There are numerous benefits of using hot rolling lubrication in Shape Rolling Mills as given below.

- Decreased rolling load due to reduced friction
- Less electrical energy consumption due to reduced roll torque
- Extended roll campaign length due to less roll wear
- Better strip surface quality and less rolled-in-scale
- Better strip thickness and profile tolerance due to reduced mill chatter / vibration

Use of roll lubrication system reduces the roll bite friction consequently reduces mill load resulting minimisation in roll wear. Less wear will enhance the roll campaign length. In practice it has been observed that with the use of lubrication system, length rolled through iron rolls increased by 20%

The reduction in power consumption or rolling load of the order of 15-25% has been achieved in both mills (Fig.3 and 4). It has assured the users that under optimum conditions, the friction coefficient at the roll bite can be reduced by up to 25% using hot rolling oil.

Conclusion

The roll lubrication system reduces the friction coefficient between rolled materials and rolls. The application of roll lubrication during rolling reduces the rolling load and there by reduces the power requirement of the mill drive. It also improves the work roll life substantially. Considerable savings in terms of reduced power consumption and increased roll campaign life justifies the investment cost. The positive impact on mill vibration, equipment life and quality helps to improve efficiency of the mill further.

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