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A STUDY ON THE HEALTH MONITORING OF HOT ROLLING MILL

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ABSTRACT

The hot rolling process is heated to a temperature suitable for rolling the slab from 1100 ° C to 1300 ° C and then rolled to a desired thickness and width. In particular, since the steel is rolled in a state of good plasticity, deformation becomes easy.

In the hot rolling process, a coil of about 20 tons is operated for 24 hours at a cycle time of about 2 minutes.

In recent years, due to the increase of high strength steel, the load of the equipment has been increased, causing unexpected breakdown of equipment such as spindle, coupling, speed reducer, etc., resulting in loss of production.In order to cope with this problem, we developed a system for assessing the integrity of facilities.

So far, we have been performing the physical model based facility diagnosis through the CMS (Condition Monitoring System) based on the vibration sensor. However, in this study, the comprehensive big data based facility diagnosis of the operating factors such as Roll Force, Tension, Speed, and a new sensing technology for acoustic and thermal imaging.

Similar researches have been conducted in other steel companies, and in particular, it is reported in the literature that the on-line torque measurement system is being used to diagnose facility health

However, the online torque measurement system is difficult to install and operate in all rolling mill STDs due to administrative problems and cost problems.

In this study, we conducted a study to monitor the health of the equipment using motor current, sound and thermal image of the driving body.

Keywords: Hot Rolling Mill, Health Diagnosis

1. INTRODUCTION

Rolling is a process in which a metal material having a relatively good plastic deformation is passed through rolls rotating at room temperature or high temperature to produce various shapes of materials. In the hot rolling process, the slab is heated to a temperature suitable for rolling the slab to 1100 ° C to 1300 ° C And then rolled to a desired thickness and width.

In the hot rolling process, slabs are passed through a reheating furnace to form a vertical scale breaker (VSB), a roughing mill, a finishing mill, a run-out table (ROT), a down coiler, Process. Figure 1 shows the hot rolling process.

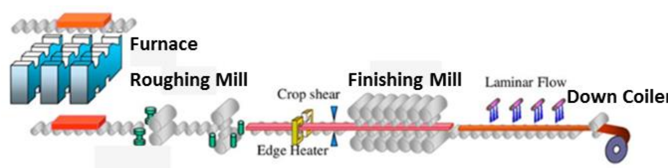

Figure 1 : the hot rolling process.

The target facility of this study is the drive facility of finishing mill.

The purpose of the hot rolling mill is to manufacture the slabs that have been worked in rough rolling at the final size required by the customer. It is the core process of the hot rolling process, such as securing the material by ensuring the proper temperature for each application, typically a tandem type rolling mill in which 6 to 7 rolls are continuously installed.

The rolling mill is connected to the motor-reducer-pinion STD-spindle-roll. The hot rolling process is a 24-hour continuous cycle with a cycle time of about 20 tons.

Figure 2 shows the configuration of the mill drive of one STD.

In recent years, due to the increase of high strength steel, the load of the equipment has been increased, causing unexpected breakdown of equipment such as spindle, coupling, speed reducer, etc., resulting in loss of production.

We will develop a system for assessing the integrity of facilities to cope with large facility failures at steel mills.

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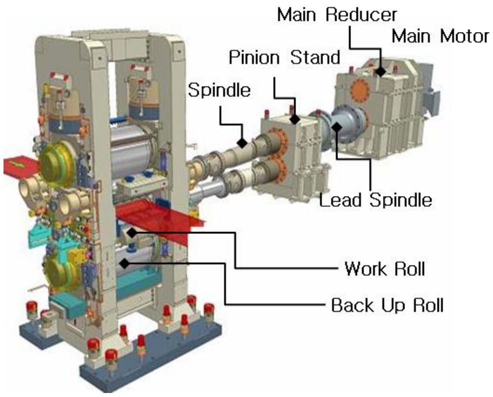


Figure 2 : The configuration of the mill drive of one STD

The purpose of this study is to predict the abnormal state of the rolling mill drive system and analyze the load condition. Recently, researches on the diagnosis and life prediction of rolling mills have been progressed, and the concept of implementing integrated diagnosis and management technology that can be implemented in one factory (or facility) is integrated.

As the 4th industry has become an issue, interest in the implementation of Smart Factory is rising and researches related to PHM (Prognostics and Health Management) are being activated. In particular, facility diagnosis technology through artificial intelligence technology is actively proceeding.

To manage the health of the facility, it is intuitive to provide facility information + maintenance history + current facility status IoT sensing + status prediction, and a standard model for fused total solution is needed.

In the prior study, there was a survey of the rolling facility monitoring system of Primetals, on-line torque measurement technique of hot rolling mill, Asset Health Monitoring, and a non-contact type fall vibration measurement system using electromagnetic induction phenomenon. [1]~[4]

So far, we have been performing the physical model based facility diagnosis through the CMS (Condition Monitoring System) based on the vibration sensor. However, in this study, the comprehensive big data based facility diagnosis of the operating factors such as Roll Force, Tension, Speed, and a new sensing technology for acoustic and thermal imaging.

In this study, we study the facility health monitoring method of a new hot rolling mill by analyzing the motor current of the drive motors and adding machine learning algorithms including operating factors and new sensing techniques.

2. ROLLING MILL DRIVE SYSTEM DIAGNOSIS

The driving equipment of the rolling mill is connected by a motor-reducer-Pinion STD-spindle-roll.

The components of each facility must be diagnosed with different characteristics.

The abnormality of the motor greatly affects the condition diagnosis in the support bearing constituting the rotating body of the motor and the degree of distortion of the AC signal of the motor current signal.

Lead spindle or spindle is affected by torque or bending of the spindle itself. The influence of the torque or bending of the spindle is an increase in the load of the rotating equipment.

In most cases, there is a lot of anomalies in the coupling, which is both connections, rather than the ideal of the spindle itself. The facility inspectors periodically determine whether a heating condition or a coupling is occurring in the coupling to determine whether a precise check is necessary. If a diagnosis of an abnormal condition is made in advance, a response plan can be established as soon as possible.

The method of monitoring abnormality of rotating machinery of the past has been mainly used as a simple diagnostic method through a statistical technique using a vibration sensor. A system to apply the precise diagnosis method using the frequency analysis method to the cause of the abnormality is constructed online, but in the tendency management side, the simple result is important for the worker performing the maintenance work. However, as the system configuration is complicated and the number of independent variables increases, it is necessary to predict the abnormality early. In order to realize this, it is necessary to construct a diagnostic system by multivariate analysis and to calculate the Mahalanobis distance algorithm to distinguish between the normal state and the abnormal state of the system.[5]~[10]

In this study, the MD indicator was introduced as a method to make the judgment of the abnormality of the facility faster. It is a method to grasp the tendency more quickly than the diagnosis result by existing physical analysis method.

2.1 Application of Signal Analysis Techniques

Figure 3hows a method for detecting an anomaly of a facility using the conventional vibration RMS size.

It monitors the tendency of the vibration RMS value, and detects the abnormality of the equipment through the preset warning and warning signal.

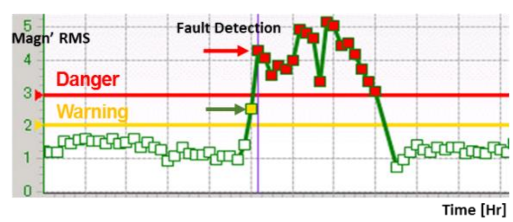


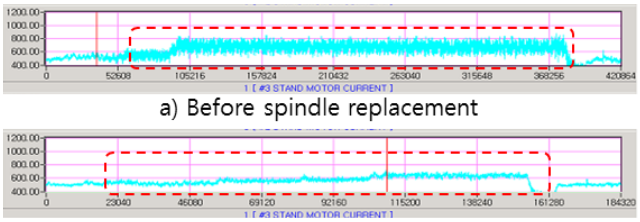
Figure 3 : A Method for detecting using conventional vibration

Figure 4 shows the tendency of the motor current signal changes before and after the spindle change of the rolling mill drive system.

Figure 5 shows an example of MD index development with multivariate signal.

a) represents the MD index of the standard model for quantifying the index, b) the MD index at the time of normal operation, and c) the MD index trend graph when there is an abnormal symptom.

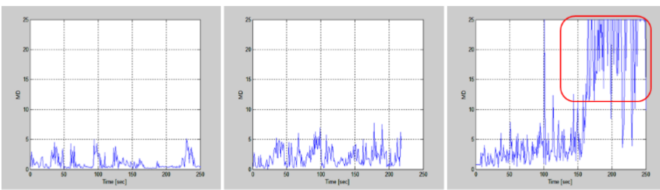
This study verifies the applicability of the MD index to the diagnosis of equipment failure.



a) Before spindle replacement

b) After spindle replacement

Figure 4 : Example of motor current signal analysis



a) MD Standard b) Stable State b) Unstable State

Figure 5 : an example of MD index

2.2 Non-contact Diagnosis Method of Driving Part

A motor, a speed reducer, a pinion stand, etc., supported by the bearing portion of the rolling mill can monitor the abnormality diagnosis through the tendency management using a contact type sensor,

In the case of a spindle or a coupling connected to it, there is no signal for monitoring.

An indirect way through the surrounding signals can be used to identify these anomalies, but the response is delayed.

This study introduces a method of temperature management through a thermal camera and a non - contact acoustic measurement method as a method of diagnosing the coupling errors on both sides of the spindle.

The example shows how to control the coupling temperature trend.

It is possible to maintain the stabilization of the operation by carrying out the maintenance through the preliminary plan through the inspection.

Figure 6 shows an example of equipment abnormal monitoring using a thermal imaging camera of a coupling connected to a spindle.

Figure 6 : abnormal monitoring using a thermal imaging (ex)

3. CONCLUSION

This study is about the construction of a new concept CMS for evaluating the soundness of a hot rolling mill.

- It was found that the abnormality of the driving system itself can be judged through the motor current value as a factor for predicting the abnormality diagnosis of the rolling mill drive system.

- The MD index was used as a defect index to identify the abnormal signs of the rolling mill in advance.

- A method of diagnosing the condition of the coupling, which is the spindle connection, was made to check the signs through thermal and acoustic signal analysis.

It is expected that the improvement in productivity will be great due to the anticipation of the advance of the rolling mill..

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