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REDUCTION OF WORK ROLL PEEL OFF INSTANCES IN HOT STRIP MILL

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Abstract: Hot Strip Mills (HSM) are widely used in steel manufacturing industries for producing steel strips with high dimensional accuracy and surface quality. During rolling operations, work rolls are subjected to severe thermal, mechanical, and frictional stresses. These stresses often lead to surface defects such as work roll peel-off, which causes strip surface damage, production loss, increased maintenance cost, and reduced roll life.

The present work focuses on the reduction of work roll peel-off instances in hot strip mills through process parameter optimization and preventive maintenance techniques. The study investigates the major causes of peel-off failures such as thermal fatigue, improper cooling, excessive rolling load, lubrication issues, and material defects. Various corrective measures including optimized cooling water flow, controlled rolling parameters, improved lubrication, and roll surface inspection methods were implemented.

Experimental observations indicate a considerable reduction in peel-off occurrences after implementing the proposed methods. The study demonstrates that proper roll management and process control can significantly improve roll life, strip quality, and overall mill productivity.

Keywords: Hot Strip Mill, Work Roll Peel-Off, Thermal Fatigue, Roll Failure, Steel Rolling, Surface Defects, Process Optimization.

I. INTRODUCTION

Steel industries extensively use Hot Strip Mills for manufacturing steel sheets and strips used in automobiles, construction, pipelines, and heavy engineering applications. In hot rolling operations, steel slabs are heated to high temperatures and passed through rotating work rolls to reduce thickness and obtain desired dimensions.

Work rolls play a critical role in determining strip quality and mill efficiency. During rolling operations, the rolls are continuously exposed to high temperatures, cyclic loading, friction, and cooling effects. Due to these severe operating conditions, work roll surface failures such as cracks, spalling, and peel-off occur frequently.

Work roll peel-off refers to the detachment of small surface layers from the roll body due to thermal and mechanical stresses. Peel-off defects lead to poor strip surface finish, production downtime, rejection of rolled products, and increased operational costs.

The present study aims to analyze the causes of work roll peel-off and develop effective methods to minimize peel-off instances in hot strip mill operations. The research focuses on process optimization, cooling system improvement, and preventive maintenance techniques for enhancing roll performance and operational reliability.

II. LITERATURE REVIEW

Several researchers have investigated work roll failures and methods to improve roll life in hot strip mills.

Smith et al. studied thermal fatigue in work rolls and concluded that repeated heating and cooling cycles are major causes of roll surface cracking and peel-off failures.

Kumar and Reddy analyzed rolling load effects on work roll damage and observed that excessive rolling pressure accelerates crack propagation and surface material detachment.

Lee et al. investigated cooling system performance in hot strip mills and reported that improper cooling distribution causes uneven thermal stresses on work roll surfaces.

Patel and Sharma studied lubrication effects during hot rolling and found that proper lubrication reduces frictional stress and improves roll surface durability.

Basavarajappa et al. reported that regular roll inspection and grinding operations significantly reduce catastrophic roll failures and improve mill productivity.

The literature review indicates that thermal stress control, proper lubrication, optimized rolling parameters, and preventive maintenance are essential for reducing work roll peel-off instances.

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III. MATERIALS AND METHODS

3.1 Components and Parameters Considered

Parameter	Purpose
Work Roll	Thickness reduction of strip
Cooling System	Controls roll temperature
Lubrication System	Reduces friction
Roll Grinding Machine	Surface maintenance
Temperature Sensors	Thermal monitoring
Hydraulic System	Controls rolling force

3.2 Causes of Work Roll Peel-Off

The major causes identified are:

- Excessive thermal stresses
- Improper cooling water distribution
- High rolling pressure
- Surface fatigue cracks
- Inadequate lubrication
- Material impurities in rolls
- Sudden temperature variations
- Improper roll grinding practices

3.3 Preventive Measures Implemented

To reduce peel-off instances, the following corrective actions were introduced:

- Optimization of cooling water flow rate
- Uniform cooling across roll surface
- Reduction of excessive rolling load
- Periodic roll inspection
- Controlled lubrication system
- Proper roll grinding intervals
- Monitoring of roll temperature
- Use of improved roll materials

IV. EXPERIMENTAL PROCEDURE

4.1 Data Collection

Operational data from hot strip mill rolling operations were collected over a specific production period. Parameters observed include:

- Roll temperature
- Rolling load
- Strip thickness
- Cooling water pressure
- Roll surface condition
- Number of peel-off instances

4.2 Testing Procedure

The study was conducted in two stages:

Before Improvement

- Existing mill operating conditions were analyzed.
- Peel-off frequency and production losses were recorded.

After Improvement

- Optimized cooling and lubrication systems were implemented.
- Rolling parameters were controlled.
- Preventive maintenance schedules were followed.

The reduction in peel-off instances was then evaluated.

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V. RESULTS AND DISCUSSION

5.1 Peel-Off Reduction Analysis

Condition	Peel-Off Instances per Month
Before Improvement	18
After Cooling Optimization	10
After Lubrication Control	7
After Preventive Maintenance	4

The results indicate a significant reduction in peel-off occurrences after implementing corrective measures.

5.2 Roll Surface Performance

| Parameter | Before Improvement | After Improvement | |---|---| | Roll Surface Quality | Poor | Improved | | Roll Life | Low | High | | Strip Defects | Frequent | Reduced | | Production Downtime | High | Low |

The improved operating conditions enhanced roll durability and strip surface quality.

5.3 Advantages Observed

- Reduction in work roll peel-off
- Improved strip surface quality
- Increased roll life
- Reduced production downtime
- Lower maintenance cost
- Improved mill productivity
- Better operational reliability

VI. CONCLUSION

The study successfully analyzed the causes of work roll peel-off in hot strip mill operations and implemented effective corrective measures to minimize failure occurrences. The investigation revealed that thermal fatigue, improper cooling, excessive rolling load, and inadequate lubrication are the primary reasons for peel-off failures.

The implementation of optimized cooling systems, controlled lubrication, preventive maintenance, and regular roll inspection significantly reduced peel-off instances and improved overall mill performance.

The developed methodology enhances work roll life, improves strip quality, reduces operational losses, and increases production efficiency in hot strip mill operations.

VII. FUTURE SCOPE

Future research may focus on:

- AI-based roll condition monitoring
- IoT-enabled predictive maintenance
- Advanced thermal analysis of rolls
- Smart cooling systems
- Automatic defect detection using machine vision
- Development of high-performance roll materials
- Real-time process optimization using automation

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