Control and Measuring Technology for Roll Grinding Machines - Compelling Technological Solutions

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The Target: High Quality Flat Products → The Key: High Quality Ground Rolls!
**hcckpm** Roll Quality Control Systems

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1. Introduction

Causes for roll defects:

▪ Normal mill operations
▪ Process errors in the mill (fire cracks, pressure cracks, bruises)
▪ Roll manufacturing process (casting inclusions)
▪ Roll service
2. Eddy Current Measurement
   – Fault detection ON the Roll’s Surface
2. Eddy Current Measurement – Fault Detection ON the Roll’s Surface

Working principle:

- Small electrical currents induced by an alternating magnetic field.
- A surface defect obstructs the eddy currents.
- The change in the eddy current field is detected and classified as crack or bruise defect.
2. Eddy Current Measurement – Fault Detection ON the Roll’s Surface

Detection of:

- Cracks
- Bruises
- Magnetism
2. Eddy Current Measurement – Bar Chart Representation

- Meaningful Visual Representation
- High-contrast Colour
- Displays Threshold Overruns

Simple and Fast Detection of Damaged Areas

Crack – Bar Chart
3. Ultrasonic Measurement – Fault Detection IN the Roll’s Subsurface
3. Ultrasonic Detection - Fault Detection IN the Roll’s Subsurface

Working principle:

- Irregularities/discontinuities in the roll body reflect the emitted Ultrasonic wave.
- Reflected sound is detected and depth + size of the discontinuity is measured.
3. Ultrasonic Detection - Fault Detection IN the Roll’s Subsurface

Detection of:

- Sub Surface Defects
- Deeper Defects
- Core Defects
3. Ultrasonic Detection - Fault Detection IN the Roll’s Subsurface

In-House 3D printing of Ultrasonic-Head:
- Optimized water flow
- Reducing bubbles
- Better water coupling

Example of In-House 3D printed Ultrasonic-Heads
3. Ultrasonic Detection - Fault Detection IN the Roll’s Subsurface

Single Sensor Head:
- One sensor shooting straight
- Detection of faults in up to 280 mm depth
3. Ultrasonic Detection - Fault Detection IN the Roll’s Subsurface

Dual Sensor Head:
- Two sensors shooting straight
- 2 Different frequencies
- Detection of faults in up to 280 mm depth
- Detection of faults close to the roll’s surface
3. Ultrasonic Detection - Fault Detection IN the Roll’s Subsurface

3 Sensor Head:
- Advanced Ultrasonic measuring method
- Different frequencies
- 3 different angles (0°, 70°, 90°)
- Detection of faults in up to 280 mm depth
- Detection of faults close to the roll’s surface
3. Ultrasonic Detection – 3D Roll Representation

- Clear Presentation
- Exact Visualisation
- Fast Overview

Easy Determination of Exact Position of Defect
4. RSIS – Roll Surface Inspection System
4. RSIS - Roll Surface Inspection System

Detection of optical defects on the Roll’s Surface such as:

- Grit Marks
- V-Shaped Patterns
- Diagonal Waves
- Chatter Marks, Ripple Pattern
- Feed Marks, Spiral Bands
4. RSIS - Roll Surface Inspection System

- Laser Module
- Photo Detector
- Fast Multi Channel Digitizer 14Bit
- Analog/Digital
- 2 GB/S Optical Data Link
- Computer Analyse Software
4. RSIS - Roll Surface Inspection System
4. RSIS – Bar Chart Representation

- Meaningful Visual Representation
- High-contrast Colour for Threshold Transgression

Easiest Determination of Roll Surface Quality
4. RSIS – Bar Chart Representation

- Clear Presentation
- Exact Visualisation
- Check Surface Image

RSIS – Chatter Map

Determination of Defects Before Rolling
5. Undulation / Chatter Detection System
5. Undulation / Chatter Detection System

Advantages:
- Totally Integrated in the grinder caliper/control
- Automatic detection of chatters / undulations
- Real Time Data, available to operator during grinding
- Readouts can be analyzed along with accelerometers to pinpoint/eliminate causes
5. Undulation / Chatter Detection System

Detection of optical defects on the Roll’s Surface such as:

- Chatter Marks, Ripple Patterns
5. Undulation / Chatter Detection System

Advantages:

- Totally Integrated in the grinder caliper/control
- Automatic detection of chatter / undulations
- Real Time Data
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The Chatter Detection System is totally integrated in the measuring system
6. VMS – Vibration Monitoring System
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- Created for very high roll surface qualities requirements
- The Vibration Monitoring System (VMS) localizes and categorizes unfavorable, critical vibrations caused by resonance frequencies between the roll and the grinding carriage.

Work principle:

- Vibration analysis of grinding machine via vibration sensors
- Allocation of relevant oscillation amplitudes to originators and listing with respect to amplitude size
- Monitoring of frequency changes over the machine’s lifetime
6. VMS – Vibration Monitoring System

Advantages:

▪ Detection of possible machine vibrations and their frequencies via vibration sensors installed on various components on the grinder.

▪ Detection of failures in advance, e.g. faulty ball bearings in gearboxes
5. RSLD – Roughness Scattered Light Detection
Traditional Measurement of Surface Roughness

Disadvantages:

- Post Process Measurement
  → No In-Grinding-Process Measurement possible
- Usually only 3 Spots are measured (Headstock side, Tailstock side, Barrel center)
  → No evaluation of the complete roll surface
- Very Slow Measurement System
- Sensitive to Outside Disturbances
- Measurement Not in Grinding and Rolling Direction!
5. RSLD – Roughness Scattered Light Detection

New Standard for Roughness Measurement:
- Optically via Scattered Light Detection
- Non-contact
- 100% Evaluation of the Roll’s Surface
- Fast – on the fly – IN-Grinding-Process Measurement
- Robust
- Measurement in Grinding and Rolling Direction!
5. RSLD – Roughness Scattered Light Detection

- RSLD delivers the Roughness Value – Aq which correlates to the traditional Ra Value
- RSLD Roughness Value describes the friction characteristic of a surface

High Friction

Low Friction

Ra = 0.64 µm
Aq = 67.3

Ra = 0.64 µm
Aq = 45.2
6. KP10 / PGC10 Control - Grinding Process History
6. KP10 / PGC10 - Grinding Process History

New Grinding History Analysis Tool Unboxes the Process

Get Information About the Whole Grinding Process

- Quick Overview
- Completed Processes
- Comparison
- Analysis

Grinding history – General Overview
6. KP10 / PGC10 - Grinding Process History

Before/After Comparison

- Display All Necessary Information on One Page
- See Roll Input and Output
- Compare Different Form Graphs
- Control Eddy Measurement
  - Crack
  - Bruise
  - Magnetism
6. KP10 / PGC10 - Grinding Process History – 100% Transparent

- Measuring “on the fly“ – with KP 10 / PGC10 control allows a 100% subsequent analysis of the grinding process
- Each grinding parameter/ change and their impact can be tracked and analyzed after grinding.
- Operators can learn from each other

Effective optimization of grinding process based on facts – no testing of parameters!
6. KP10 / PGC10 - Grinding Process History – 100% Transparent

- When is the roll surface crack-free?
- When does the roll have its required shape?
- When does the roll have its target roughness?

KP10 / PGC10 combined with the corresponding measuring systems give answers to these questions.
Summary / Conclusion

Eddy Current – Cracks, Bruises, Magnetism **ON** the Roll’s Surface

RSIS – Optical Defects **ON** the Roll’s Surface

Ultrasonic – Fault Detection **INSIDE** the Roll

RSLD – 100% advanced Roll Surface Roughness Detection
Summary / Conclusion

100% Transparent Grinding Process with 100% Roll Quality Control
Thank you very much for your time!