Slip Ring Induction Motors

Brush Holder
Problems and Solutions

Nathan Schachter
CIMENTEC ENGINEERING LTD
SRIM Brush and Holder Issues

Focus of this presentation

- What were the issues?
- Possible reasons for occurring problems
- Interim remedies
- Permanent solutions
Rotor assembly
SRIM Brush and Holder Issues

The plant experienced numerous brush failures of the slip ring motors designed and built by GEVISA in Brazil.

- Severe arcing between the brushes and collector rings.
- Due to high vibrations of the mills.
- Vibrations amplifications on the unsupported shaft extensions of the rotors.
SRIM Brush and Holder Issues

- High brush wear requiring frequent replacement 2-3 weeks –
- Due to brush composition-carbon/copper
- Causing the collector rings to overheat and pit
- Flash over.
Raw Mill pitted collector rings
RAW MILL Flashover damage
RAW MILL MOTOR Flashover damage
RAW MILL MOTOR Flashover damage
SRIM Brush and Holder Issues

刷提升装置与电机配套，旨在提高刷子使用寿命并减少维护，但由于设计的先天缺陷以及高振动和装配不良，未按预期工作。
Brush holder with lifting device
SRIM Brush and Holder Issues

Possible causes for non performance experienced at the plant

- Internal sources of vibrations inherent to rotor design
  - Shaft material and stiffness
  - Rotor balance
  - Rotor dynamic analysis
SRIM Brush and Holder Issues

- **Brush application**
  - Composition-copper/carbon content
  - Current density of the brushes
  - Cross section and wear length
  - Brush holder – spring tensioning for positive contact
  - Tooling used to hone the collector rings
Dark stripes crowned grooves
SRIM Brush and Holder Issues

- Brush lifting device
  - Brush lifting and seating device – vibration impact
  - Maintaining positive pressure on the collector ring assembly
Brush Holder with lifting device
Brush lifting device engaged - shorting
SRIM Brush and Holder Issues

- Frequent start/stop – prevents forming of the conductive film or PATINA critical to brush wear.

- Vibration amplifications due to natural frequencies of the drive train
Raw Mill Collector – arcing damage
SRIM Brush and Holder Issues

- External sources of Vibrations
  - Mill operation – typically high vibration on VRM
  - Overriding clutch impact – disengagement for VRM only
  - Foundation design – motor and mill stand
  - Structure – building and supports
Dark bands of carbon film forming unevenly
Other Effects on Brush Wear

- Current density – check with manufacturer
- Bouncing brush – damage the collector ring surface – arcing due to vibration – spring tension
- Uneven wear – spring tension/ brush composition
Other Effects on Brush Wear

- Rotor phase unbalance
- Carbon contamination
- Cooling of the enclosure
- Causes flash over
Damaged collector rings – wrong brush/holder
Brush holder issues – heavy heat and oxidation
Failed Collector Ring Assembly due to flashover
Failed collector ring assembly
Fixed Brush damaged holder and brushes
Burnt brushes and holders
Most probable cause of internal vibrations

- Shaft profile design
- Shaft diameter - unsupported length
- Poorly supported brush holder assembly
- Discrepancies in the rotor dynamic analysis program GEVISA - GE – most probable cause
Possible solutions

- Balance rotor and components
- Soften the impact of the overriding clutch
- Replace brush & holders
- Remove lifting device
- Shorten shaft – unsupported length
Possible solutions

- Add additional bearing support -
- Larger diameter shaft – stiffer profile
- Torsion and Vibration analysis drive train
- Rotor dynamic analysis correct model
- Stiffen the support of the brush holder assembly
Implemented Interim Solutions

- **Raw Mill**
  - Minimize displacement impact of overriding clutch
  - Hone the collector ring surfaces with the correct tool.
  - Balance the rotor after the brush lifter removed
  - Replace brush & holders
New type of brush holder with linear springs

Old design

New design
Raw mill collector rings shaft extension
Collector freshly honed
Implemented Interim Solutions

- Finish mill
  - Hone the collector ring surfaces with the correct tool.
  - Balanced the rotors after the brush lifters removed
  - Replace brush & holders
Implemented Interim solutions

- Operation

- Before each start inspect the collector rings and advise of condition.

- Observe the correct brush wear length. Brushes should last 6-7 months.-Not 3 weeks

- Monitor collector ring temperature during start – Dark band formation
Collector assembly with fixed brush holders
Recommended permanent solutions

- **Raw Mill**
  - New rotor designed with shorter shaft (For HH the existing rotors shortened)
  - Reduce starting torque to alleviate the impact of the overriding clutch on the shaft extension and brushes. (This was implemented but it offers limited potential since it affects the available starting torque for the mill)
Raw Mill overriding clutch
Raw mill collector rings shaft extension (HH)
Recommended permanent solutions

- **Finish Mills**
  - New rotors designed with shorter shafts (For HH the rotors were shortened)
  - New rotor dynamic analysis using the correct model.

(Old rotors may be retrofitted at the discretion of the plant, and left as spares)
Future reliability issues

- Future performance is dependent on the maintenance of the brushes, collector rings and rheostat.
External vibrations to be addressed

- Foundation design to withstand and absorb continuously the vibrations from the mill
- Reinforce the structure – separator platform, etc
- Isolate motor’s foundation from the mill.
- Mill operation?
QUESTIONS?

Contact the presenter

905-336-2786