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Application of Tribology for
Enhancing the Life of Sugar Mill
Roll Bearing and Journal

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Mill Roll Bearings: Background

- Subjected to very high radial load at low speed.
- Non-uniform lifting of top roll
- Bearing liners in two halves
- Ingress of contaminants

Results

- Rapid wear and scoring
- High lubricant consumption
- Occasional failure of mill roll shaft or bearing
Objective of the Study

Enhancing the life and reliability of mill roll bearings and journals through the application of Tribological principles without changing materials and the basic design
Tribology

- It is the science of interacting surfaces in relative motion

- It applies principles of friction, wear and lubrication for design of bearings to:
  - Enhance life and reliability
  - Reduce lubricant consumption
Study Methodology

Lab test for friction factor and wear characteristics

Analytical Computations

Bearing re-design

Commercial trials in 40” x 80” milling tandem
Outcome of Study

Transformation of Mill Bearing

from

to
Lab Tests: Pin and Disc Machine

Pin holder, upside down

Pin holder, in position
Lab Tests: Pin and Disc Machine...

Transducer

Machine ready for Tests
Schematic of Pin and Disc Machine

Pin : Represents Liner
Disc : Represents shaft
Lab Test: Procedure

❖ Tribo-pair tested

- **Bearing**: Leaded bronze, CC495K (EN 1982)
- **Roll Shaft**: Carbon Steel, SAE 1045, 230 BHN
- **Lubricant**: Alpha SMR Heavy (Make: Castrol)

❖ Test Parameters

- **Contact Pressure**: 2 Mpa
- **Disc Speed**: 250 rpm
- **Test Duration**: 30 Minutes
Lab Test: Procedure....

❖ Groove Patterns tested

(A): Multiple Grooves
(B): No groove
(C): Single Groove
(D): Cross Grooves
Lab Test: Results

Groove Pattern (D) has the lowest coefficient of friction
Conventional Vs Adopted Groove
Computations: 40” x 80” Mill

- Verification of Structural Strength of top roll bearing liner of mill with conventional drive
- Thermal computations at interface of roll journal and bearing liner:
  - Heat Generation and temperature rise
  - Expansions
Computations: Loads on top bearing

- Axial Thrust = 29 tons
- Resultant Load, $R = 292$ tons
- Frictional Load = 44 tons
Computations: Stress on top bearing

Max Stress 720 kgf/cm²

Peak stress levels are away from the grooves
Heat generation is directly proportional to:

- Resultant operating radial load on the bearing
- Sliding velocity at shaft and bearing interface
- Coefficient of friction
Computations: Thermal Loads....

- Computed maximum heat generation based on following worst case scenario:
  - Maximum radial load of 292 tons
  - Maximum sliding velocity of 0.13 m/sec
  - Maximum friction coefficient of 0.15

<table>
<thead>
<tr>
<th>Bearing Location</th>
<th>Max. Heat Generation kW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top Roll</td>
<td>47.2</td>
</tr>
<tr>
<td>Feed Roll</td>
<td>9.1</td>
</tr>
<tr>
<td>Discharge Roll</td>
<td>21.0</td>
</tr>
</tbody>
</table>
Thermal expansion is function of:

- Thermal conductivities of shaft and liner
- Partition of heat between the shaft and liner
- Coeff of thermal expansion of shaft and liner
- Temp of water for bearing housing cooling
Computations: Thermal Expansion...

Total thermal expansion at interface (max): 1.1 mm
Innovative Sealing Arrangements

- Labyrinth Sealing arrangement for Bottom Rolls
  - Prevent ingress of juice into roll

- Limitations
  - Applicable for bottom rolls only
Innovative Sealing Arrangements

- Limitations
  - Rubbing action due to top roll float tears off the seal edges: requires frequent replacement
Final Recipe of Modified Bearing

- Cross pattern adopted for lubricating grooves
- Diametrical clearance increased to 1.1 mm
- Journal hardness increased to 230 BHN
- Innovative sealing solutions incorporated
Field results of modified bearings

Substantial reduction in wear rate of bearing liner.

Modified Bearing after two crops
Field results of modified bearings...

Modified Bearing after three crops
Thank You
Gracias
Obrigado

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