ABRASIVE SLURRY TESTING OF DIFFERENT TYPE OF STEELS USED IN AGRICULTURAL MACHINERY

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Wear process

- Abrasion
- Surface fatigue
- Erosion
- Corrosion

Fig. 3 – Tillage tools during operation

Wear influencing factors

Operational factors:
- Speed 3-12 km/h, depth: 5-8 cm deep

Environmental factors:
- Soil, loam and sand

Material factors:
- Low alloyed martensitic steel 27MnB5 (DIN 15529)

Fig. 4 – Tribosystem examination

Tribosystem Elements
- Example in ploughing
- Contacting materials: 27MnB5 – soil particles (non-spherical e.g. granules)
- Geometry of contacting parts: Symmetrical grooved shape in "Sheet-compressed soil"
- Surface topography: The surface finish in changing abrasive particle size of soil
- Contact configuration: High contact
- Relative motion: Sliding to soil
- Load: Dynamic, impact load
- Lubrication: Soil and weather dependent
- Environment: Changing humidity, temperature, contamination, vibration

Fig. 5 – Slurry pot test set-up

Wear mechanism in soil engaging tools: low stress open three body abrasion – Experimental simulation of ploughing action of the tine using lab-scale soil test

Methodology

- Input:
  - Specimen mounted vertically on holders on different radius
  - Specimen orientated 45° to the slurry flow
  - Abrasive media: Kinured (Al₂O₃): 1:1 water
  - (Ratio set to achieve proper media flow and abrating effect)
  - Ploughing depth: 60-100 mm, surface velocity: 1-2 m/s
  - Pot wall is cooled by water circulation in the outer jacket

- Output:
  - Wear mechanism in test specimen (low stress open three body abrasion)
  - Shaft is eccentrically placed in a cylindrical container (prevent media from rotation, adequate agitation for mixing)
  - Ranking of candidate materials with reference from original tine material
  - Specimen weight, dimensions, hardness and surface topography

Fig. 6 – Test specimen on different R

Results and conclusions

- Abrasion and surface fatigue from the impact of solid particles was observed based on the orientation
- Specimens facing the center of rotation and orientated 45° to the flow of particles showed higher wear rate and experienced pitting as an additional mechanism
- The pitting was present on the lower pressure region of the media
- Surface of the contact area smoothened: Ra 0.5-1 Ra 0.09 μm
- Contact surface hardened (+ 5-14 HV compared to unworn region)
- Specimen orientation had bigger effect on wear rate than surface velocity (radius)

Fig. 7 – Test specimen geometry change

Material ranking for a more wear resistant material

Martensitic steel (478 HBV, UTS 1523 MPa) has better performance:
- High hardness of the martensitic microstructure lead to a better performance
- Material promoted to replace original material

Fig. 8 – Hardness test results and surface topography

Fig. 9 – Mass loss in function of operating distance [km]

Fig. 10 – Relative mass loss [%(kg)] of tested materials

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