TECHNICAL DIAGNOSTICS OF MAJOR COMPONENTS OF MINE WINDING MACHINES

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ABSTRACT

Quality technical diagnostic is of major importance for reliable and safe operation of mine winding machines. The paper presents summarize criteria for winding machine diagnostics. Limit wear norms are established for major components and units. Guidelines are presented for inspection of winding machines after long periods of operation.

INTRODUCTION

One of the most effective and practically the only means of vertical transport of people, materials and mineral resources, and simultaneously one of the most important units in the technological sequence of underground mining, are mine winding facilities (MWF). Their technical conditions impact not only the rhythmic and efficient work of the mining company as a whole but also the safety of all underground workers.

Technical condition means the set of machine parameters chaining in the process of its operation and at any given time defined by technical specifications. Various factors influence the change of MWF status such as mining conditions, structure and quality of units and components, level and quality of operation and maintenance, etc.

MWF technical condition depends on the quality of machine components. Establishment of individual component quality generally means inspection of the degree of change of geometrical form and dimensions, roughness and physico-mechanical properties of surfaces. Establishment of MWF technical conditions calls for precise inspection, micro-measurements, defectfinding of most important components and by means of all possible diagnostic methods – vibrometrical, acoustic, functional diagnostics method, oil analysis method, etc.

Technical status of components and machines is usually represented by the following conditions: normal, admissible and boundary. A boundary condition means that, due to various requirements, the respective component should not be operated any more. The boundary technical condition is defined by means of technical and economic criteria related to labor safety.

INSPECTION OF TECHNICAL STATUS OF ROPE WINDING DEVICE

Conditionally, rope finding device is split into major parts – steel structure and brake fields. Inspection of technical status can be carried out in the sequence shown below:

Steel structure

- Measurement of actual values of maximal static loads and of static difference between individual rope branches. Results are compared with admissible design parameters of the respective machine and, if such parameters do not exist, they can be calculated using the equations in Yochev (2002).
- Inspection of drum for cracks. If cracks are found they should be welded. Cracks of length over 200 mm are not allowed.
- Inspection of bolt, rivet and weld joints. This is done by visual inspection and hammering. Loose bolts and rivets emit specific sound. No loose or cracked joints are allowed.
- Inspection of splint joints. This is done by visual inspection and hammering. No loose or deformed splints are allowed. Axial drum displacement in respect of the main winding machine shaft is not allowed. The latter shall be measured as provided by the Technical Survey Instruction (1969).
- Inspection of flanges. No cracks are allowed and internal surface should be smooth and free of grooves and protuberances. In case of double- or multi-layer winding, the uppermost flange section should be spaced from the rope at 2.5 times its diameter as a minimum.
- Inspection of transition section from one winding layer to the other, in case of multi-layer rope winding. Inspection of the special pin as provided in Underground Mining Safety Regulations (1969) in cases of multi-layer rope winding. The surface should be smooth, free of deformations and worn-out sections exceeding 10% of design dimensions. Check for compliance with factory or design requirements.
Check of drum locking device. No cracks in welding seams are allowed or loose bolts, or cracks in supporting concrete.

Inspection of drum lacing. This should be discarded if the state of wear is such that channel bottom is located at a distance of 3-5 mm from fixing bolt heads. With multi-rope MWF the lacing should be replaced where its height under the rope is 0,8-1,0 time the rope diameter. With bi-cylindrical – conical winding devices no deformations or cracks in raceways are allowed or wear in excess of 20% the initial thickness.

Measurement of radial gaps in the free drum bearings. This is carried out by means of gap-measuring plates or by means of two measuring clocks and jacking up the free drum. One clock measures radial gap and the other one records radial displacement of the main shaft. The first clock readings are taken until the second one starts operation (the latter is due to the radial gap of the main bearings of the winding machine. Boundary values of radial gaps are shown in table 1

### Table 1. Boundary values of radial gap for friction bearings

<table>
<thead>
<tr>
<th>Main shaft diameter of winding machine, mm.</th>
<th>Boundary value, mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 - 120</td>
<td>0,8</td>
</tr>
<tr>
<td>120 - 260</td>
<td>1,0</td>
</tr>
<tr>
<td>260 - 500</td>
<td>1,2</td>
</tr>
<tr>
<td>500 - 800</td>
<td>1,5</td>
</tr>
<tr>
<td>Над 800</td>
<td>2,0</td>
</tr>
</tbody>
</table>

Boundary values of radial gaps for antifriction bearings are 0,2 – 0,3 mm for brand new winding machines and 0,8 mm for machines in operation.

Brake fields

- Inspection of working surfaces and thickness of brake fields. The work surface should be smooth and free of cracks or grooves. The maximum admissible groove depth is 0,1 mm. Minimal thickness wear of brake fields is 15% the nominal dimension. Micro-cracks are admissible if not reaching the brake field end.
- Measurement of radial displacement of brake fields. This is carried out by means of measuring clock. The drum is rotated with speed of 0,2-0,3 m/s without using the brake in order to prevent reading of rum bearing gaps. Admissible values of radial displacement for drums of diameters greater than 3500 mm is 1,2 mm. For all other machines - 0,8 mm.
- Inspection of heating temperature. Is should be noted that the braking system is not used for stopping (except for emergency stops) but rather for locking the winding machine. Therefore, no burnt-out paint shall be present near the fields or blue-grey field sections signifying overheating. Presence of such signs is due to faulty dynamic braking system and presence of protuberances on field surface or maladjusted brake. The admissible temperature of brake field heating is 70 - 80 °C.

**INSPECTION OF BRAKING SYSTEM STATUS**

The braking system comprises three components – braking device, drive and control system.

**Braking device**

Fig. 1 shows the most common braking device.

- Inspection of brake cover plates. The inspection is visual and by measurements. No operation is allowed with broken cover plates.
- During replacement of cover plates, the contact area of the new ones should be at least 50% of their total surface area.
- Measurement of cover plate wear. The most worn-out plates shall be removed and their thickness measured. The admissible cover plate wear is the one where the distance from the working surface to the most protruding part of supporting structure is 5 mm for pressed plates, and 10 mm for timber ones.
- Inspection of supports and foundation under the brake beams. No cracks in foundation are allowed.

**Brake fields**

- Inspection of degree of wear of finger joints. Finger joints should be dismantled first and micro-measurement should be carried out. Radial gaps shall be measured, the values thereof are shown in Table 2.

### Table 2. Boundary value of radial gaps in finger joints of braking device

<table>
<thead>
<tr>
<th>Gap, mm</th>
<th>Nominal diameter of joint opening, mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.25</td>
<td>18-30</td>
</tr>
<tr>
<td>0.30</td>
<td>30-50</td>
</tr>
<tr>
<td>0.35</td>
<td>50-80</td>
</tr>
<tr>
<td>0.42</td>
<td>80-120</td>
</tr>
<tr>
<td>0.50</td>
<td>120-160</td>
</tr>
<tr>
<td>0.60</td>
<td>160-200</td>
</tr>
</tbody>
</table>

Boundary
Brake drive
Most common brake drives for winding machines are shown on fig.2 and fig.3.

- Inspection of frame and foundation for cracks. No cracks are allowed in the metal section or concrete.
- Inspection of working surfaces of cylinders and pistons of working and emergency brakes. No scratches, grooves, channels or visible wear are allowed.
- Inspection of finger joint wear. This is carried out by means of micro-measurements. Radial joint gaps are measured, the values whereof are shown in Table 2.
- Measurement of distance between brake loads in end position and surrounding structure. In lower end position, the minimal distance between loads and pit bottom should be 300 mm. Minimal lateral distance is 10 mm for steel walls and 25 mm for concrete walls.
- Establishment of degree of wear of load supporting bar. Maximal admissible wear of bar diameter is 0.4 – 0.5 mm.
- Inspection of spring block in case of spring-load drives. No operation is allowed with broken or deformed springs or pins with defective thread.

Brake control system
It is sufficient to inspect basic system components – pressure regulators and valves.

Recording of pressure regulator parameters. A graph should be developed of the relationship of working cylinder pressure and control coil current. Current varies from 30mA (± 10mA) to 160mA (± 20mA) and back. For RDBV regulators, 25 stable phases should be recorded. For RDU regulator, 50 stable phases should be recorded.

CONCLUSION
MWF technical diagnostic involves quality measurement and inspection of all major components, details and units.
Boundary technical condition is established on the basis of technical, economic and safety criteria. For mine winding facilities, the economic criterion is not the most important one.

For technical diagnostics of some of the most important MWF components, such as rope winding device and braking system, it is recommended to use the above boundary wear norms.

For inspection of serviceability and safety after along operation periods of mine winding facilities, in addition to above-described actions, it is necessary, to inspect the technical condition of the following major components:

- Reducing gear;
- Suspension ropes of hoisting skips;
- Hoisting skips;
- Winding ropes;
- Shaft reinforcement;
- All ancillary mechanisms;
- MWF electric units.

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