

Chapter 3 : Industrial maintenance

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I Troubleshooting various parts of electrical machines

1. Introduction :

Troubleshooting electrical machines is an essential activity in industry and technical installations. It involves identifying, locating, and correcting faults in different types of electrical machines, such as motors, transformers, and alternators.

2. Troubleshooting the mechanical part

Troubleshooting the mechanical side of electrical machines is just as important as the electrical side. A mechanical failure can cause significant malfunctions or even severe damage to the machine. Here's a structured guide to diagnosing and correcting mechanical problems in electrical machines (motors, alternators, cooled transformers, etc.).

2.1. Mechanical components to be inspected

- a) Bearings:
 - Defects: Wear, noise, excessive play, seizure
 - Tests:
 - Manually turn the shaft (while stationary)
 - Listen with a mechanical stethoscope
 - Vibration analysis
- b) Drive shaft:
 - Defects: Runout, breakage, wear at the bearings
 - Checks:
 - Runout (dial gauge)
 - Alignment with the driven element (laser or ruler)
- c) Rotor balancing
 - Symptoms: Cyclic vibrations, asymmetric wear
 - Action: Dynamic or static balancing
- d) Couplings and pulleys:
 - Defects: Looseness, wear, misalignment
 - Inspection:
 - Visual condition
 - Laser alignment
 - Tightness check
- e) Fan / Cooling System:
 - Faults: Broken fins, obstruction
 - Effects: Engine overheating

- Regular cleaning required

2.2. Mechanical troubleshooting procedure

Here is a detailed table that summarizes the different mechanical troubleshooting procedures

3. Troubleshooting the electrical part

3.1. Steps of Electrical Troubleshooting

Step 1: Check the power supply

- Voltage at the supply terminals (ph-ph and ph-neutral)
- Check fuses, circuit breakers, and switches
- Check the phase sequence (three-phase)

Step 2: Control Circuit Inspection

- Checking contacts (buttons, relays, contactors)
- Checking control wire continuity
- Checking timers and safety devices (limit switches, emergency stops)

Step 3: Test the Windings

- Measuring winding resistance with a multimeter
- Comparing the three phases (symmetry)
- Detecting internal short circuits or breaks

Step 4: Measuring the insulation

- Test between windings and ground (earth)
- Acceptable value $>1 \text{ M}\Omega$ (generally)
- Clean or dry if insulation is low

Step 5: Checking the protections

- Circuit breakers and thermal relays: are they properly sized?
- Status of safety contacts (NO/NC)
- Operation of thermal or electronic protection systems

Step 6: Checking the accessories

- Capacitors (single-phase or starter): check capacity and condition
- Sensors: voltage, temperature, position, current
- Regulator (AVR, inverter): integrated diagnostics, fault indicators

3.2. Critical points to inspect by machine type

Winding resistance (U-V-W)

- Phase balance control
- Insulation resistance tests (asynchronous or direct current)

Transformers

- Input/output voltage
- Iron/copper losses (no-load/load)
- Heating, oil leakage

Alternators / generators

- Excitation Check
- Output Voltage, Stability
- Voltage Regulator Check

4. Assembly work after repair

Assembly work involves installing, reconnecting and aligning all mechanical and electrical components after maintenance or repair work.

4.1. Main steps:

A. Preparation

- Checking the spare parts used
- Cleaning surfaces (contacts, supports)
- Checking the conformity of the electrical/mechanical diagram

B. Mechanical assembly

- Alignment of shafts and couplings
- Tightening of bolts to the required torque, according to standards
- Checking clearances (bearings, shafts)
- Assembly of mechanical protections and casings

C. Electrical assembly

- Connecting the power cables (phases, ground)
- Tightening the terminals (check the recommended torque)
- Checking the control wiring (relays, contactors)
- Connecting any sensors or actuators, if present

4.2. Post-troubleshooting test methods

Testing helps validate that the system is working correctly and meets safety and performance standards. The following table gives the tests to be carried out (recommended order)

Essay	Aim	Tools / Methods
Continuity test	Check connections, closed loops	Multimeter
Isolation test	Detect current leaks, weak insulation	Megohmmeter ($\geq 1 \text{ M}\Omega$ recommended)
Direction of rotation	Check that the engine is turning in the correct direction	Short power-up (pulse)
Phase test / balancing	Avoid overload and imbalance	Current clamp / voltmeter
Voltage and current measurement	Confirm compliance	Multimeter / Network Analyzer
Thermal test	Identify abnormal heating	Thermal camera or infrared thermometer
Empty test	Observe engine behavior without load	Visual surveillance + instruments
Load test	Check actual operation	Test under normal conditions

The tests to be carried out (recommended order)

4.3. Documents to be produced after testing

Table 6 summarizes the various documents to be completed after testing.

Table 6 : Documents to be produced after testing

Document	Content
Test reports	Measured values, observations
Recommissioning sheet	Date, operator, final remarks
Final state photos	Connections, junction boxes, labeling
Quality control sheet	Conforms/non-conforms, comments

5. Possible causes of failures and corresponding checks

Here is a list of possible causes of breakdowns in electrical machines, along with the corresponding checks that can be performed to detect these problems:

Components	Failure modes	Root causes	PM Actions	Frequency
Film reel holder	Bearing deterioration	No lubrication	Lubricate the bearing	Daily
	Screw looseness	Continuous rotation	Inspection of the bolts and spring	Monthly
Pulling rollers subassembly	Shaft wear out	Misalignment, Friction	lubrication of the rollers and bearings	Daily
	Bearings deterioration	No lubrication, Improper fixing	Check film rollers from jamming Inspection of the bearings and shafts, and replace as necessary	Weekly Biannually
Pulling Motor	Coils combustion	Extreme load	Inspection, and recondition as necessary	Quarterly
	Bearings wear out	Improper fixing		
Gearbox	Oil seal impairment	Expiration	1- Open the gearbox and replace the Oil seal and change the oil. 2- Inspection of the gears and bearings, and recondition or replace as necessary	Annually
	Shaft wear out	Misalignment, Friction		
	Bearings deterioration	No lubrication, Improper fixing		
	Gears cracking	Friction, No lubrication		
Optical sensor (scanner)	Sensor impairment	Dirtiness	Inspection and servicing the sensor	Quarterly
	Thumb nuts looseness	Improper fixing		
Product chute	Knurled screws looseness	Vibration, Improper locking	Adjusting and cleaning the Product chute and fixing its bolts	Monthly
Packet former	Knurled nuts looseness	Vibration, Improper locking	Inspection, cleaning and straightness	Weekly
Sealer	Thermocouple dielectric smelting	Temperature increase	Inspection of the heating elements, thermocouple, and connector	Monthly
	Thermocouple separate	Electrical contact		
	Heating elements separate	Coil combustion		
	Connector separate	electrical contact		
Packet closer	Piston plunger rod breaking	Extreme load	Lubrication of the piston	Daily
	Plastic gears break or crack	Use expiration	Inspection of teeth for the Plastic gears	Weekly
	Tube closer breaking	Worn out	Inspection of the Tube closers	Monthly