NESANS

TECHNICAL GUIDES

Plant Start-Up Sequence: Proper Procedures to Protect Equipment and Production

Follow correct plant start-up and shutdown sequences. Protect crushing and screening equipment while maximizing production efficiency.

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Jaw crusher flywheel inspection is a critical safety activity that prevents catastrophic failures capable of causing serious injury or death. Flywheel cracks, often invisible to casual observation, can propagate under cyclic loading until sudden, explosive failure occurs. A systematic inspection program using proper techniques can detect developing cracks before they reach critical size, allowing safe planned replacement rather than emergency response to a dangerous failure.

Understanding Flywheel Function and Failure Modes

Flywheel Function in Jaw Crushers

The flywheel serves critical functions in jaw crusher operation:

- **Energy storage:** Stores kinetic energy during non-crushing portion of cycle
- **Energy release:** Delivers stored energy during crushing stroke

- **Load leveling:** Smooths power draw from motor
- **Speed regulation:** Maintains consistent eccentric shaft speed

Operating stresses: Flywheels experience significant cyclic stresses from:

- Centrifugal force from rotation (tension in rim and spokes)
- Torque fluctuations from crushing cycle
- Belt tension from drive (asymmetric loading)
- Thermal cycling from operation

Common Failure Modes

FAILURE MODE	LOCATION	CAUSE	DETECTABILITY
Rim cracking	Outer edge	Centrifugal stress, impact	Visual, UT
Spoke cracking	Spoke roots	Cyclic bending, casting defects	MT, PT, UT
Hub cracking	Around keyway, bore	Press fit stress, torque cycles	PT, UT
Keyway damage	Key seat	Impact loading, loose fit	Visual, PT

Consequences of Flywheel Failure

Flywheel failure is among the most dangerous events in crushing operations:

- **Projectile hazard:** Fragments travel at high velocity (up to 200+ m/s)
- **No warning:** Failure occurs instantaneously without audible warning
- **Wide danger zone:** Fragments can travel 100+ meters
- **Secondary damage:** Structural damage to plant, equipment

Visual Inspection Procedures

Preparation

Before visual inspection:

1. Lock out all energy sources (electrical, mechanical, hydraulic)

2. Verify crusher cannot rotate (blocking recommended)
3. Clean flywheel surface of dust, grease, debris
4. Ensure adequate lighting (1000+ lux recommended)
5. Have magnifying glass (10×) available for detailed examination

Inspection Checklist

AREA	WHAT TO LOOK FOR	ACCEPT/REJECT CRITERIA
Rim outer surface	Cracks, chips, gouges	Any crack: Investigate. Chip >10mm: Evaluate
Rim inner surface	Cracks, corrosion	Any crack: Reject. Significant corrosion: Evaluate
Spoke surfaces	Cracks, especially at roots	Any crack: Reject
Hub bore	Cracks, fretting, wear	Any crack: Reject. Fretting: Evaluate
Keyway	Cracks, deformation, wear	Any crack: Reject. Deformation >0.5mm: Evaluate
Balance weights	Loose, missing, damaged	Any issue: Repair before operation

High-Stress Areas

Pay particular attention to high-stress concentration areas:

- **Spoke roots:** Where spokes meet hub and rim
- **Keyway corners:** Sharp corners concentrate stress
- **Any machined features:** Holes, grooves, steps
- **Repair welds:** Heat-affected zones
- **Casting anomalies:** Porosity, inclusions, cold shuts

Non-Destructive Testing Methods

Magnetic Particle Testing (MT)

Most effective for detecting surface and near-surface cracks in ferromagnetic materials:

Application:

- Best for spoke roots, keyway areas
- Can detect cracks as small as 0.1mm
- Requires cleaning but minimal surface preparation
- Provides immediate visual indication

Procedure:

1. Clean inspection area (remove oil, grease, paint)
2. Apply magnetizing current (yoke or prod method)
3. Apply magnetic particles (wet or dry method)
4. Examine under appropriate lighting (visible or UV)
5. Demagnetize after inspection

Dye Penetrant Testing (PT)

Effective for detecting surface-breaking cracks in any material:

Application:

- Useful for hub bore, machined surfaces
- Works on non-magnetic materials
- Can detect very fine cracks
- Requires thorough cleaning

Procedure:

1. Clean surface thoroughly (solvent cleaner)
2. Apply penetrant, allow dwell time (10-30 minutes)
3. Remove excess penetrant carefully
4. Apply developer, allow developing time
5. Examine under appropriate lighting

Ultrasonic Testing (UT)

Can detect internal defects not visible at surface:

Application:

- Rim thickness measurement and defect detection
- Detection of subsurface cracks
- Assessment of casting soundness
- Requires trained technician

Key measurements:

- Rim thickness at multiple points (detect wear or corrosion)
- Scan spoke sections for internal defects
- Hub bore area for cracks

Inspection Frequency and Scheduling

Recommended Inspection Intervals

INSPECTION TYPE	FREQUENCY	PERFORMED BY
Visual walk-around	Daily	Operator
Detailed visual	Monthly	Maintenance technician
MT/PT critical areas	Quarterly	NDT technician
Comprehensive NDT	Annually	Certified NDT inspector
After incidents	As needed	NDT technician

Factors Requiring Increased Frequency

- Flywheel age approaching design life
- Previous repairs or crack indications
- Severe operating conditions (impact loading, overloads)
- Visible damage or wear
- After tramp iron events

Crack Assessment and Decision Making

When Cracks Are Found

1. **Immediately:** Stop the crusher, do not operate
2. **Document:** Photograph, measure, record location
3. **Assess:** Determine crack type, size, orientation
4. **Consult:** Contact OEM or qualified engineer
5. **Decide:** Repair (if permissible) or replace

General Guidelines (Consult Engineer for Specific Cases)

FINDING	TYPICAL ACTION
Any crack in spoke	Replace flywheel
Crack at keyway	Replace flywheel
Crack in hub	Replace flywheel
Small rim chip (<10mm, no crack)	Blend, monitor
Large rim chip (>10mm)	Engineering evaluation required
Surface porosity (casting defect)	Engineering evaluation required

Repair Considerations

Flywheel repair is generally NOT recommended due to:

- High consequence of failure
- Difficulty achieving original material properties
- Residual stress from welding
- Risk of hidden defects

If repair is considered (only with OEM approval):

- Must be performed by qualified welder with approved procedure
- Requires post-weld heat treatment

- Comprehensive NDT required after repair
- Reduced inspection intervals afterward
- Document everything for liability purposes

Flywheel Replacement Criteria

Mandatory Replacement Triggers

- Any crack (except as specifically evaluated and approved)
- Keyway damage beyond limits
- Bore wear exceeding tolerance
- Rim thickness below minimum
- Significant imbalance that cannot be corrected
- Age exceeding manufacturer's recommended service life

Service Life Considerations

Flywheel service life depends on:

- **Material:** Typically ductile iron or cast steel
- **Design:** Safety factors in original design
- **Operating conditions:** Loading severity, speed
- **Maintenance:** Balance, alignment, lubrication

Typical service life guidance: 15-25 years or 100,000-150,000 operating hours for well-maintained flywheels without defect indications. However, always follow OEM guidance for specific equipment.

Guard Inspection

Flywheel Guard Requirements

Guards provide the last line of defense against flywheel fragment hazards:

Guard construction requirements:

- Steel plate construction (typically 6-12mm minimum)
- Designed to contain fragments at maximum operating speed
- Secure mounting that withstands impact
- Complete enclosure of rotating mass

Guard Inspection Checklist

ITEM	CHECK	ACTION IF FAILED
Guard integrity	No cracks, holes, severe corrosion	Repair or replace guard
Mounting security	All fasteners present and tight	Replace missing, tighten loose
Clearance	No contact with rotating parts	Adjust guard position
Coverage	Complete enclosure of flywheel	Add sections if incomplete
Access doors	Interlocked, secure when closed	Repair interlock, adjust door

Documentation and Records

Inspection Records

Maintain comprehensive records including:

- Date and time of inspection
- Inspector name and qualifications
- Inspection methods used
- Areas inspected
- Findings (including "no defects found")
- Measurements (rim thickness, bore diameter)
- Photographs
- Actions taken or recommended

Equipment History File

Maintain a complete history file for each flywheel including:

- Original specifications and certificates
- Installation date and operating hours at installation
- All inspection reports
- Any repairs performed (if applicable)
- Operating conditions and any incidents
- Balance records

Conclusion

Flywheel inspection is a non-negotiable safety requirement for jaw crusher operations. The consequences of flywheel failure—potential fatalities and catastrophic damage—make thorough inspection essential. Implement daily visual checks, monthly detailed inspections, quarterly NDT on critical areas, and annual comprehensive NDT by certified inspectors. Any crack finding requires immediate shutdown and engineering evaluation. Never operate a crusher with a cracked flywheel. Maintain guards in proper condition as the last line of defense. Document all inspections thoroughly. The cost of inspection and planned replacement is insignificant compared to the potential consequences of failure.

Topics: #Plant Operations #Safety #Start-Up Procedure

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