NESANS

MAINTENANCE & OPERATIONS

The Three Critical Parameters You Should Know When Assessing the Lubrication Health of Your Cone Crusher

Master viscosity, TAN, and particle count analysis to prevent cone crusher bearing failures and extend oil life by 40%.

Author: Sivabalan Selvarajan

Published: December 5, 2025

Reading Time: 15 minutes

A bearing failure in your cone crusher costs ₹12-18 lakhs in emergency repairs, plus ₹8-15 lakhs daily in lost production during 4-7 day downtime. Yet 73% of cone crusher bearing failures are preventable through systematic oil analysis monitoring three critical parameters: viscosity, Total Acid Number (TAN), and particle count. Plants implementing quarterly oil analysis extend bearing life by 40-60% and reduce lubrication oil costs by 25-35% through condition-based oil changes rather than arbitrary time intervals.

Cone crusher lubrication systems face extreme operating conditions: eccentric speeds of 350-450 RPM generating bearing loads exceeding 180 tonnes, oil temperatures reaching 55-70°C under continuous operation, and contamination from fine crusher dust migrating past worn seals. These conditions rapidly degrade lubricant properties and generate wear debris—yet most plants change oil on fixed schedules (3,000-6,000

hours) without knowing actual oil condition, resulting in either premature oil disposal (wasting ₹45,000-65,000 per change) or catastrophic bearing failure from degraded lubricant.

This guide examines the three parameters that reliably predict cone crusher lubrication health—viscosity, TAN, and particle count—explaining how each parameter changes during service, interpretation thresholds that trigger action, and practical implementation strategies for Indian crushing operations seeking to eliminate unplanned bearing failures while optimizing oil change intervals.

Parameter 1: Viscosity—The Foundation of Bearing Protection

Why Viscosity Matters in Cone Crushers

Viscosity determines lubricant film thickness between bearing surfaces—the microscopic oil layer (typically 2-8 microns) that prevents metal-to-metal contact at bearing loads exceeding 180 tonnes. Cone crusher eccentric and countershaft bearings operate under elastohydrodynamic lubrication conditions where film thickness directly correlates with viscosity: a 25% viscosity reduction decreases film thickness by approximately 22%, dramatically increasing bearing wear rates.

Typical Viscosity Specifications:

- **New Oil:** ISO VG 150 (150 cSt at 40°C) for ambient temperatures 15-30°C, or ISO VG 220 (220 cSt at 40°C) for higher temperatures or severe duty
- **Operating Temperature:** 45-60°C typical, 70°C maximum sustainable—viscosity decreases approximately 10% per 10°C temperature increase
- **Viscosity Index:** 95-105 for mineral oils, 140+ for synthetics—measures viscosity stability across temperature range

How Viscosity Changes During Service

Cone crusher oil viscosity changes through multiple degradation mechanisms:

Oxidation (Increases Viscosity):

- High-temperature operation (55-70°C) accelerates oxidation reactions, forming acids and sludge precursors
- Oxidation rate doubles every 10°C above 60°C—oil at 70°C degrades 4× faster than at 50°C
- Produces high-molecular-weight polymers that increase viscosity 15-30% over 4,000-6,000 hours
- Creates varnish deposits on bearing surfaces, restricting oil flow and heat dissipation

Thermal Breakdown (Decreases Viscosity):

- Extreme temperatures (>80°C) crack long-chain hydrocarbon molecules into shorter fragments
- Bearing contact zones can reach 120-150°C instantaneous temperatures despite bulk oil at 60°C
- Thermal cracking reduces viscosity 10-20%, particularly in synthetic esters
- Irreversible process—damaged oil cannot recover original properties

Contamination Effects:

- Fuel or solvent contamination (rare in crushers) decreases viscosity
- Fine dust contamination (<10µm particles) can increase apparent viscosity by 5-15%
- Water contamination forms emulsions that alter viscosity measurement accuracy

⚠ **Critical Threshold:** Viscosity outside ±15% of new oil specification indicates significant degradation. A 200 cSt oil (ISO VG 220 at 40°C) showing <170 cSt or >230 cSt requires immediate investigation and likely oil change. Operating with degraded viscosity accelerates bearing wear exponentially—a 30% viscosity loss can reduce bearing life by 60-75%.

Testing Methodology and Frequency

Viscosity Measurement (ASTM D445):

- Kinematic viscosity at 40°C (primary specification) and 100°C (calculate viscosity index)

- Test cost: ₹800-1,200 per sample at certified laboratories (Bureau Veritas, Intertek, SGS)
- Turnaround: 2-3 business days for standard testing
- Sample size: 100-150 ml in clean bottle, labeled with crusher ID, hours, and date

Recommended Testing Frequency:

- **New crusher (0-2,000 hours):** Test at 500, 1,000, 1,500, and 2,000 hours to establish baseline degradation rate
- **Established baseline:** Test every 1,000-1,500 hours during normal operation
- **Extended intervals:** Test every 750-1,000 hours when approaching recommended oil change interval
- **Operational changes:** Test within 200 hours after feed material change, circuit modification, or crusher overhaul

Practical Tip: Collect samples when oil temperature reaches normal operating range (50-60°C), after crusher runs continuously for 30+ minutes. Avoid sampling immediately after startup (cold oil) or during temperature spikes—inconsistent conditions produce misleading trend data.

Parameter 2: Total Acid Number (TAN)—Oxidation Degradation Indicator

Understanding TAN and Oil Degradation

Total Acid Number measures acidic compounds formed during oil oxidation, expressed as mg KOH/g (milligrams of potassium hydroxide required to neutralize acids in one gram of oil). Fresh mineral oils typically show TAN of 0.5-1.5 mg KOH/g; as oil oxidizes under high temperature and metal catalysis, TAN increases progressively—reaching 2.5-4.0 mg KOH/g signals advanced degradation requiring oil change.

Why TAN Increases in Cone Crushers:

- **Thermal oxidation:** Oil exposed to 60-70°C temperatures reacts with dissolved oxygen, forming carboxylic acids and other acidic species
- **Metal catalysis:** Iron and copper from bearing wear accelerate oxidation reactions by 3-5× compared to non-catalyzed conditions

- **Water contamination:** Even 0.1-0.2% water content doubles oxidation rate—moisture reacts with oxidation products to form acids
- **Additive depletion:** Anti-oxidant additives neutralize acids initially, but deplete after 2,000-4,000 hours, after which TAN rises rapidly

TAN Progression and Failure Mechanisms

TAN follows predictable progression during cone crusher operation:

Phase 1 (0-2,000 hours): Minimal Change

- TAN increases slowly from 0.8-1.2 to 1.5-2.0 mg KOH/g
- Anti-oxidant additives actively neutralizing acids formed
- Oil appearance: Clear amber, no visible sludge formation
- Action: Continue normal operation, maintain quarterly monitoring

Phase 2 (2,000-4,000 hours): Moderate Degradation

- TAN accelerates to 2.0-3.0 mg KOH/g as additive reserves deplete
- Early varnish formation on bearing surfaces—visible as brown discoloration on bronze components
- Oil darkens to dark amber/brown, increased sludge formation begins
- Action: Increase monitoring to every 500-750 hours, plan oil change within 1,000 hours

Phase 3 (4,000+ hours): Critical Degradation

- TAN exceeds 3.0-4.0 mg KOH/g—acids actively corroding bearing surfaces
- Heavy varnish and sludge deposits restrict oil flow, causing localized overheating
- Oil appears black/opaque, significant viscosity increase from oxidation products
- Action: **Immediate oil change required**—continued operation risks bearing damage

⚠ **Critical Threshold:** TAN exceeding 4.0 mg KOH/g indicates oil has reached end-of-life. Operating beyond this point creates corrosive conditions that etch bearing surfaces, dramatically accelerating wear. Field studies show bearings run with TAN >4.5 mg KOH/g experience 3-4× normal wear rates, often requiring replacement 2,000-3,000 hours earlier than properly maintained systems.

TAN Testing Implementation

Test Method (ASTM D664):

- Measures total acidity through potentiometric titration with KOH solution
- Test cost: ₹1,500-2,200 per sample at certified laboratories
- Turnaround: 3-4 business days typically
- Combine with viscosity testing for cost efficiency—most labs offer package pricing at ₹2,000-3,000 for viscosity + TAN

Interpretation Guidelines:

- **TAN <2.0 mg KOH/g:** Oil condition satisfactory, continue normal operation
- **TAN 2.0-3.0 mg KOH/g:** Moderate degradation, increase monitoring frequency, plan oil change within 1,000-1,500 hours
- **TAN 3.0-4.0 mg KOH/g:** Advanced degradation, change oil within 500 hours
- **TAN >4.0 mg KOH/g:** Critical—change oil immediately (within 50-100 operating hours)

Cost-Benefit Analysis: A crushing plant operating a cone crusher with 350 liters oil capacity (ISO VG 220 at ₹185/liter = ₹64,750 per change) previously changed oil every 3,000 hours based on OEM recommendation. After implementing TAN monitoring at ₹2,200/test quarterly (1,000-hour intervals), data showed TAN reaching 2.8 mg KOH/g at 4,200 hours—still acceptable for continued operation. Extending to 4,500-hour change interval saved one oil change annually (₹64,750), while quarterly testing cost ₹8,800/year—net savings ₹55,950/year plus reduced disposal costs. Additionally, bearings lasted 18% longer due to better oil condition management.

Parameter 3: Particle Count—Early Warning of Wear and Contamination

ISO 4406 Cleanliness Codes Explained

Particle count measures solid contamination in oil using ISO 4406 cleanliness codes—a three-number format (e.g., 18/16/13) indicating particle concentrations at three size ranges:

- **First number:** Particles ≥4µm per 100 ml

- **Second number:** Particles ≥6µm per 100 ml
- **Third number:** Particles ≥14µm per 100 ml

Each code number represents a range of particle counts according to ISO scale:

- **Code 15:** 1,300-2,500 particles per 100 ml
- **Code 16:** 2,500-5,000 particles
- **Code 17:** 5,000-10,000 particles
- **Code 18:** 10,000-20,000 particles
- **Code 19:** 20,000-40,000 particles

Target Cleanliness for Cone Crushers:

- **New oil fill:** 17/15/12 or better (filtration during filling essential)
- **Normal operation:** 18/16/13 or better—adequate for rolling element bearings under typical conditions
- **Warning level:** 19/17/14—indicates filtration issues or early bearing wear, investigate cause
- **Critical level:** 20/18/15 or worse—high contamination causing accelerated bearing wear, immediate corrective action required

What Particle Count Reveals About Crusher Condition

Particle count changes indicate specific failure modes and contamination sources:

Gradual Increase (Normal Wear):

- ISO code increases by 1-2 levels over 2,000-3,000 hours (e.g., 17/15/12 → 18/16/13)
- Indicates normal bearing wear generating fine metallic particles 2-15µm size
- Typically stabilizes when filtration removal rate equals wear generation rate
- Action: Continue monitoring, no immediate concern if below 19/17/14

Sudden Spike (Abnormal Wear):

- ISO code jumps 3+ levels within single interval (e.g., 18/16/13 → 21/19/16 in 500 hours)
- Indicates bearing surface damage: spalling, pitting, or severe abrasive wear

- Often accompanied by increased vibration, noise, or oil temperature
- Action: **Stop crusher immediately**, inspect bearings, analyze particle composition through ferrography

High Small Particles (Code ≥4µm Elevated):

- First code number high (20-21) while third number moderate (14-15)
- Indicates fine dust ingression from worn seals—crusher dust migrating into oil system
- Particles predominantly silica/mineral rather than metallic
- Action: Inspect and replace worn seals, upgrade filtration (5µm absolute rather than 10µm)

High Large Particles (Code ≥14µm Elevated):

- Third code number high (16-17) relative to first number (18-19)
- Indicates bearing surface fatigue generating larger wear debris
- Precursor to catastrophic failure—large particles indicate advanced bearing damage
- Action: Schedule bearing inspection within 200 operating hours, prepare for replacement

⚠ **Real-World Example:** A secondary cone crusher (220 kW) showed particle count progression from baseline 17/15/12 to 18/16/13 over first 3,000 hours (normal wear pattern). At 3,500 hours, routine sample showed sudden jump to 20/19/16. Vibration analysis revealed eccentric bearing developing spalling on outer race. Bearing replacement at scheduled shutdown (150 hours later) cost ₹2.8 lakhs vs. ₹14.5 lakhs emergency repair if bearing failed catastrophically. Early detection through particle count monitoring saved ₹11.7 lakhs plus avoided 5-6 day unplanned downtime (₹45-55 lakhs lost production).

Particle Count Testing and Filtration Management

Test Method (ISO 4406/ASTM D7647):

- Automatic particle counter using laser light obscuration or light extinction
- Test cost: ₹1,800-2,500 per sample at certified laboratories
- Turnaround: 2-3 business days typically

- Critical: Use proper sampling technique—flush sample port for 30 seconds before collecting to ensure representative sample

Filtration System Requirements:

Cone crusher oil filtration directly controls particle count and bearing life:

- **Filter Rating:** 10µm absolute (β10 ≥200) minimum, 5µm preferred for extended bearing life—β-ratio indicates filtration efficiency (β10=200 means filter removes 99.5% of 10µm particles)
- **Flow Capacity:** Filter entire oil volume 2-3× per hour (700-liter system requires 1,400-2,100 LPH filter flow)
- **Bypass Valve:** Opens at 1.5-2.0 bar differential—prevents filter collapse during cold startup when oil viscosity is high
- **Change Interval:** Replace filters when differential pressure reaches 2.0-2.5 bar, typically every 800-1,500 hours depending on contamination level

Cost Impact Analysis: Upgrading filtration from standard 25µm to high-efficiency 5µm absolute increases filter cost from ₹2,800 to ₹6,500 per element, with more frequent changes (every 800 hours vs. 1,500 hours). Annual filter cost increases ₹12,000-18,000. However, improved cleanliness extends bearing life by 35-50% (from 18,000-20,000 hours to 24,000-30,000 hours), saving ₹4.5-6.5 lakhs per bearing set replacement cycle. For crushers with ₹8-12 lakh bearing sets, ROI on premium filtration is achieved in 2-3 years.

Implementing Oil Analysis Program: Practical Guidelines

Sample Collection Procedure

Proper sampling technique ensures accurate results:

1. **Operating Conditions:** Collect samples during normal operation at steady-state temperature (50-60°C), after minimum 30 minutes continuous running
2. **Sample Point:** Use mid-stream location (oil return line preferred)—avoid dead zones or immediate post-filter locations

3. **Flush Port:** Drain 200-300 ml through sample port before collecting sample to purge stagnant oil
4. **Clean Container:** Use new bottles provided by laboratory—never reuse containers (residual oil contaminates sample)
5. **Sample Size:** Collect 150-200 ml minimum for complete analysis (viscosity, TAN, particle count)
6. **Labeling:** Document crusher ID, operating hours, date/time, oil temperature, and any operational abnormalities
7. **Shipping:** Submit samples within 24-48 hours—extended storage can alter particle distribution

Testing Package and Frequency

Standard Quarterly Package (Every 1,000-1,500 hours):

- Kinematic viscosity at 40°C and 100°C
- Total Acid Number (TAN)
- Particle count (ISO 4406 code)
- Water content (Karl Fischer method)
- Total package cost: ₹3,500-5,000 per sample
- Turnaround: 4-5 business days

Extended Analysis (Bi-annually or as needed):

- All standard tests plus:
- Elemental analysis (ICP spectroscopy)—identifies wear metals (Fe, Cu, Cr) and contamination (Si, Al)
- Ferrography—microscopic examination of wear particle morphology to diagnose failure modes
- FTIR spectroscopy—measures oxidation, nitration, sulfation by-products
- Cost: ₹8,000-12,000 per sample
- Use for diagnostic investigation when primary parameters indicate abnormal conditions

Interpretation and Action Thresholds

Condition-Based Oil Change Decision Matrix:

VISCOSITY CHANGE	TAN (MG KOH/G)	ISO CODE	ACTION REQUIRED
±10%	<2.0	≤18/16/13	Continue operation, maintain quarterly monitoring
±10-15%	2.0-3.0	18/16/13 to 19/17/14	Increase monitoring to 750-hour intervals, plan oil change within 1,000-1,500 hours
±15-20%	3.0-4.0	19/17/14 to 20/18/15	Change oil within 500 hours, inspect filtration system
>±20%	>4.0	≥20/18/15	Immediate oil change required (within 50-100 hours), inspect bearings

Important Note: Take action based on worst parameter—if any single parameter exceeds threshold, implement corresponding action even if other parameters are acceptable. For example, TAN at 4.2 mg KOH/g requires immediate oil change regardless of acceptable viscosity and particle count.

Program Economics and ROI

Annual Cost for Quarterly Monitoring:

- Four quarterly samples at ₹4,000 each = ₹16,000/year
- Laboratory courier/logistics = ₹2,000/year
- Staff time for sampling and record-keeping (4 hours/year at ₹500/hour) = ₹2,000/year
- **Total program cost: ₹20,000/year per crusher**

Quantified Benefits:

1. **Extended oil life (25-40%):** Changing oil based on condition at 4,500 hours vs. arbitrary 3,500 hours saves one change every 3-4 years = ₹64,750 every 3.5 years = ₹18,500/year
2. **Extended bearing life (35-50%):** Bearings lasting 25,000 hours vs. 18,000 hours reduces replacement frequency from 2.25 years to 3.1 years = ₹10.5 lakh bearing set cost amortized over 3.1 years vs. 2.25 years saves ₹1.3 lakhs/year
3. **Eliminated emergency repairs:** Preventing one catastrophic bearing failure every 4-5 years = ₹15 lakh emergency repair avoided = ₹3 lakhs/year amortized

4. **Avoided production loss:** Preventing 5-day emergency shutdown every 4-5 years = ₹50 lakh lost production = ₹10 lakhs/year amortized

Total Annual Benefits: ₹14.6 lakhs
Program Cost: ₹20,000
ROI: 730% (benefits are 7.3× program cost)

This calculation is conservative—many plants realize additional benefits including reduced maintenance labor (planned bearing changes during scheduled shutdowns rather than emergency mobilization), improved crusher availability (fewer unplanned stops), and extended component life beyond bearings (eccentric bushings, main shaft, gear components all benefit from superior lubrication management).

Conclusion: Systematic Monitoring Eliminates Guesswork

Cone crusher bearing failures and premature oil disposal both stem from the same root cause: managing lubrication by arbitrary time intervals rather than actual oil condition. The three critical parameters—viscosity (film thickness and bearing protection), TAN (oxidation degradation), and particle count (wear and contamination)—provide quantitative assessment of oil health, enabling data-driven decisions that simultaneously extend component life and reduce lubrication costs.

Plants implementing quarterly oil analysis monitoring report 40-60% bearing life extension, 25-35% reduction in oil consumption (through optimized change intervals), and near-elimination of unplanned bearing failures. For crushing operations where a single bearing failure costs ₹12-18 lakhs in repairs plus ₹40-75 lakhs in lost production, a ₹20,000/year monitoring program represents the highest-ROI maintenance investment available.

The key is consistency: establish baseline degradation rates during first 2,000 hours of operation, maintain quarterly monitoring thereafter, and respond decisively when parameters exceed action thresholds. Oil analysis doesn't prevent bearing wear—it provides early warning before wear becomes failure, creating the visibility needed to schedule maintenance on your terms rather than the crusher's.

Topics: #Cone Crusher #Crusher Reliability #Maintenance #Oil Cooling

NESANS

www.nesansindia.in
SF No 20/1, Eachanary Madukkarai Road, Coimbatore, TN 641024
+91 9578 799 755