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Cavitation in Hydraulic Gear Pumps

Effects, Causes, Visual Indicators, and Diagnosis

1. What Cavitation Is (Gear Pump Context)

Cavitation occurs when local pressure at the pump inlet drops below the fluid's vapor pressure, causing vapor bubbles to form. As these bubbles move into higher-pressure zones inside the pump, they collapse violently, generating micro-shock waves that damage metal surfaces.

In gear pumps, cavitation most commonly occurs:

- At the inlet port
- Along the gear tooth roots
- On the housing inlet side
- On thrust plates / wear plates

2. Primary Causes of Cavitation in Gear Pumps

Inlet / Supply Issues (Most Common)

- Restricted suction line (undersized hose, collapsed liner, clogged strainer)
- High inlet velocity (line too small or too long)
- Cold oil (high viscosity at startup)
- Pump mounted too high above reservoir (excessive lift)
- Air leaks on suction side (loose fittings, cracked hoses)

System / Operating Conditions

- Operating pump above rated speed
- Excessive backpressure at inlet
- Incorrect fluid (wrong viscosity grade)
- Rapid cycling or demand spikes
- Low reservoir level causing vortexing



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3. What Cavitation Damage Looks Like

Visual Indicators on Components

Gears

- Frosted or matte appearance on gear teeth
- Micro-pitting (pepper-like surface texture)
- Rounded or eroded tooth edges
- Damage concentrated near the root of the gear teeth

Housing

- Pitting near inlet port
- Erosion patterns that look like sandblasting
- Uneven wear localized to the inlet side

Wear / Thrust Plates

- Fine pitting or washboard texture
- Localized erosion rather than uniform wear

Cavitation damage is not smooth or polished — it looks violent and irregular.

4. Sound & Operational Symptoms

Cavitation produces distinct audible and performance clues:

- High-pitched whining
- Growling or rattling noise
- Noise increases with speed
- Fluctuating flow or pressure
- Excessive vibration
- Pump heats oil rapidly

If the noise goes away when speed is reduced, cavitation is strongly suspected.



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5. How Cavitation Differs from Other Failures

Failure Mode	Visual Damage	Key Difference
Cavitation	Pitting, erosion, frosted metal	Localized to inlet side
Abrasive Contamination	Scratches Scoring	Directional wear marks
Lack of lubrication	Smearing, blue discoloration	Heat damage present
Overpressure	Shaft or gear breakage	No pitting patterns
Normal wear	Polished surfaces	Even and gradual

6. How to Determine Cavitation (Step-by-Step)

Step 1: Inspect the Pump Internals

- Look for pitting near inlet
- Check gear tooth roots and housing inlet
- Confirm damage pattern is localized, not uniform

Step 2: Review Suction Conditions

- Measure inlet hose ID vs pump flow
- Check for collapsed hoses or clogged strainers
- Inspect fittings for air leaks (especially above oil level)

Step 3: Verify Operating Parameters

- Confirm pump RPM is within rating
- Check oil viscosity at operating temperature
- Verify oil temperature during startup

Step 4: Field Test Indicators

- Reduce pump speed → if noise decreases, cavitation likely
- Warm oil before startup → cavitation may disappear
- Bypass suction strainer temporarily (for test only)



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7. Common Field Mistakes That Cause Cavitation

- Using pressure-rated hose on suction
- Undersizing suction plumbing
- Adding a fine filter on pump inlet
- Ignoring cold-start procedures
- Mounting pump too high above tank

8. Preventing Cavitation in Gear Pumps

Best Practices

- Suction line velocity \leq 2–4 ft/sec
- Short, straight suction runs
- Large-radius bends only
- Flooded inlet whenever possible
- Warm oil before high-speed operation
- Use manufacturer-recommended viscosity

9. Typical Failure Analysis Conclusion Language

“Inspection of the pump components revealed localized pitting and erosion concentrated at the inlet side of the housing and gear tooth roots. These damage patterns are consistent with cavitation caused by insufficient inlet conditions. Based on the observed wear characteristics, the failure is not attributed to material defect or manufacturing error.”