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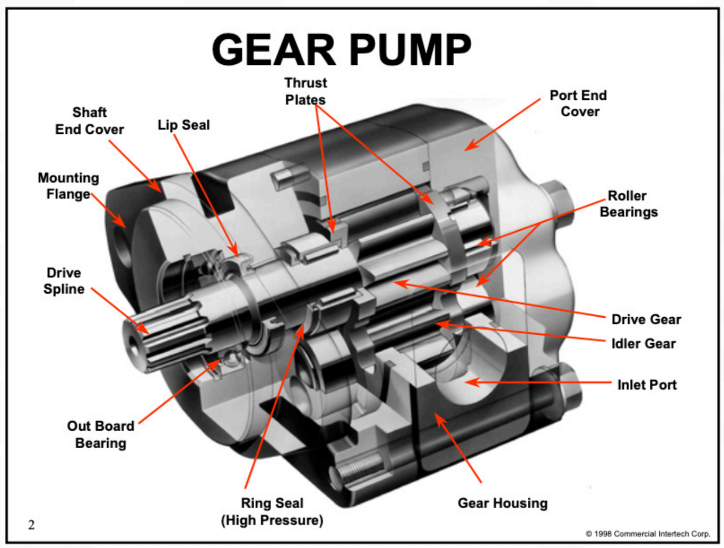
Why Pumps Fail
Report by David White
9/12/2025

For decades, manufacturers such as APE, ICE, and more recently Antaeus, have relied on gear pumps as the primary drive circuit for powering vibratory hammers. Within the industry, it is widely recognized that these pumps—most notably the P465 15x15 Parker units (previously produced by Commercial Intertech and now commonly supplied by Permco)—have a consistent early-life failure rate. **Approximately 10–15% of pumps experience catastrophic failure within the first week of operation,** equating to about one in ten units. However, if a pump survives this initial break-in period, it will almost invariably provide reliable service for decades. For over thirty years, the central question has remained: why do one or two pumps in every batch fail within the first week, while the remainder deliver long, trouble-free performance? What underlying factors drive this pattern?

Historically, when pumps have failed during the initial break-in period, the explanation has almost always been attributed to a single cause: **oil starvation leading to cavitation**. In practice, this is often described as an operator inadvertently closing the inlet valve and depriving the pump of oil. This explanation has generally gone unchallenged for two main reasons: (A) power units are not equipped with sensors capable of disproving whether a valve was closed at startup, and (B) no compelling alternative has been offered. Nevertheless, there is strong evidence that many of these early failures occurred under conditions where oil starvation was highly unlikely, suggesting that cavitation is not the universal explanation it has been assumed to be.



The second most commonly cited cause has been attributed to the manufacturers themselves: **operating gear pumps at pressures far beyond their intended design limits.** Pump vendors argue that these pumps were never engineered to withstand continuous loads approaching 4,800 PSI. Pump suppliers have long maintained that the responsibility lies with the equipment manufacturers, noting that similar pumps used in other industries—where maximum operating pressures are significantly lower, typically well below 4,500–4,800 PSI—rarely experience such failures. From this perspective, the issue is characterized as a pump-sizing error specific to pile driving applications.

Of course, pumps can fail prematurely for a wide range of reasons. However, the focus of this report is narrower: to address one specific and persistent question. Over more than 30 years of using gear pumps in vibratory hammer applications, **why do some units operate reliably for decades while others fail within the first week? What distinguishes the short-lived pumps from those that provide long-term service?**

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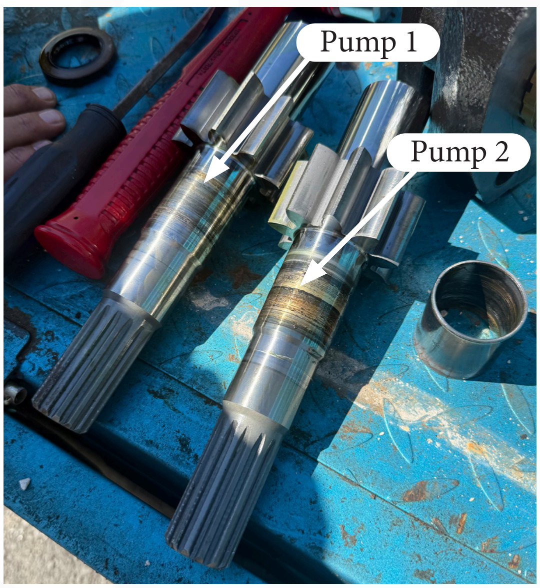
Let us begin with a basic question: among the pumps that fail within the first week, what specifically goes wrong? The answer, in nearly every documented case, is consistent. The front bushing overheats, generating enough heat to burn the seals on the thrust plates. The heat buildup eventually will destroy the shaft seal and allows oil to escape into the pump drive. Based on the failures I have personally observed, virtually all early-life pump failures follow this same pattern. **It almost ALWAYS is the front bushing that failed first.**

This naturally raises the next question: why is the failure localized to the front (drive-shaft side) of the pump? Why not the rear, or the center? What unique conditions cause the front end to fail first? Does it experience higher pressure, reduced lubrication, or greater exposure to contaminants? For decades, these questions have persisted without a clear answer.

Today, however, we may finally be approaching one. In this report, I present two pump examples—both of which failed within the first week—and detail the results of their tear-down and examination.



Upon inspection, the journals of both shafts exhibit severe scoring. The bushings—within which the journals are designed to rotate—had worked loose, and both shafts show nearly identical patterns of damage.

It is evident that the journal and bushing experienced significant overheating. Under normal operating conditions, the journal is supplied with oil, providing the lubrication necessary to prevent exactly this type of damage. In these failed pumps, however, the journals appear to have been deprived of adequate lubrication at this location, leading directly to failure. This observation lends some credence to the long-standing theory that "early pump failures are related to oil starvation". However, a closer inspection of the pump reveals something peculiar: only the drive-end bushing failed. None of the other bushings within the pump show comparable damage.

This leads to an important question: **if the pump were truly starved of oil, why is it that only the front drive bushing fails? In a scenario where no oil enters the pump, we would expect ALL of the bushings to suffer comparable damage. Yet, in practice, the failure is consistently confined to the front bushing.** What makes the front bushing uniquely vulnerable?

Before I reveal my conclusion consider this: IF the pump were completely starved of oil—for example, if a valve had been closed—then the pump would have no ability to generate pressure. In such a scenario, the unit would simply be spinning dry, with all journals and bushings subjected to equal friction in a zero-pressure environment. Logically, this would result in uniform damage across all bushings and journals. Yet, in actual failures, the damage is not evenly distributed; it is isolated almost exclusively to the front drive bushing.

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Conclusion

The consistent pattern across these early-life pump failures points to a common mechanism: **air intrusion at the drive shaft.** The shaft side is the only location where air can enter the system, and once the shaft seal is compromised, air is drawn into the pump. This air displaces the oil film beneath the drive-end bushing, cutting off lubrication to the journal.

The sequence of failure can be summarized as follows:

1. Shaft seal failure → air is drawn into the pump.
2. Air displacement → oil is forced away from the drive bushing, eliminating lubrication.
3. Bushing failure → the journal overheats and scores severely.
4. Contamination migration → debris from the scored journal enters other areas of the pump.
5. Thermal escalation → heat damage progresses until the front thrust plate seals are burned.
6. Final failure mode → the pump loses pumping capacity and typically discharges oil into the pump drive.

Examinations of failed pumps consistently reveal this pattern: a broken shaft seal, a destroyed drive-side bushing, and heavy scoring localized at the front. The wear signature is <u>not</u> consistent with long-term contamination but rather with acute, short-duration failure originating at the front and progressing backward. Notably, the rear components exhibit significantly less damage than the front, further supporting this conclusion.

It is more accurate to state that 10–15% of shaft seals fail, and that these seal failures in turn lead to pump failure, rather than suggesting that the pumps themselves inherently fail at that rate. The pump's reliability is therefore closely tied to the integrity of the shaft seal; when the seal holds, the pump will typically run for decades without issue. When it fails, the resulting air intrusion initiates the chain of events that destroys the pump.

So what would case the shaft seal to prematurely break?

Front and Back of broken shaft seal

Notice the burnt uneven areas of the side of this shaft seal. This is important clue as to how this pump is failing, I believe air is escaping through this failed outer seal and destroying the pump.

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Probable Root Cause of Premature Seal Failure

The **evidence points to shaft seal failure as the initiating event in nearly all early-life pump breakdowns.**

I believe the top 2 possibilities are as follows:

1.) **<u>Incorrect Sealant selection during the assembly procedure.</u>** Instead of using Permatex Aviation Form-A-Gasket No. 3—a non-hardening sealant that maintains flexibility over time—many assemblies have been completed with Loctite. Because Loctite hardens and becomes brittle, it is less forgiving in dynamic applications. Approximately 10–15% of the time, either excessive or insufficient Loctite is applied, leading to deformation of the seal or the creation of micro-gaps through which air can be drawn. Loctite is <u>NOT</u> allowed by pump manufactures, like Permco, for use on the shaft seal,

Correct Sealant for Shaft Seal

2.) **<u>Insufficient curing time:</u>** Proper sealing requires that the sealant cure for 24–48 hours. When this step is skipped or rushed, the shaft seal is left vulnerable to leakage, compromising its ability to maintain an airtight barrier. It seems to be very common that pumps that have been made in an urgent timeline fail much more often than pumps that have sat on the shelf. I believe it has to do with the curing time of the shaft sealant that was used.

The Possibility of Pressure Spike Contribution

It remains possible that high pressure spikes early in a pump's life contribute to premature failures. In such cases, it is plausible that the spikes may dislodge or deform the shaft seal. **However, the evidence suggests that pressure alone is not the dominant factor.** If shaft seals were inherently unable to withstand pressure spikes, we would expect to see failures distributed throughout the entire service life of the pump. Instead, the data shows a clear pattern: pumps that survive the first week almost always continue to operate reliably for decades.

This long-term reliability indicates that pressure spikes are routinely endured by pumps over their lifetime. Therefore, when failures do occur in the first week, the pressure event is likely acting in combination with another contributing factor. The most consistent explanation is improper shaft seal assembly—specifically, the choice of sealant, its application, and the adequacy of curing time.

<u>Next tests will involve measuring air intake into the pump on recently failed pumps to see if this conclusion can stand the test of time with additional data.</u>

Special thanks to Tim Grotting, Steve Scharff, Fluid Design, and Antaeus for contributing to this discovery!