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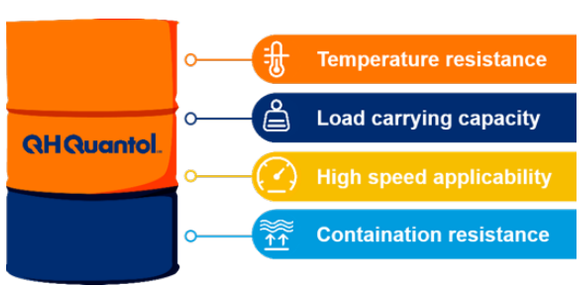
QH Quantol™ and the Power of Four: A Practical Methodology for Grease Selection

Selecting the right grease isn't simple But we've made it clearer with the Power of Four

Grease doesn't fail because it's "bad." It fails because it was never suited to the conditions it faced. When you look closely at equipment failures related to lubrication, almost each one can be traced back to a mismatch in just four key operating factors.

This insight is what sits behind the **Power of Four** methodology.

By consistently asking simple questions about four constraints – temperature, load, speed, and contamination – you can quickly narrow down the grease options and avoid most lubrication problems before they even begin.



Temperature: how hot does it run?

Temperature is a frequent cause of grease failure. If it's not properly considered, the grease may never get the chance to perform as intended.

What you're really asking: can the grease withstand the highest temperatures the equipment will see, not just on average, but at peak conditions?

A useful way to think about grease is like a race car tire. Within its design range, it keeps its shape and grips the road. But push it too hard then it gets hot and degrades quickly: it stiffens, loses flexibility, and performance drops sharply. At the next bend, the car hits the barrier.

With grease, at the right operating temperature, its structure stays stable and it releases oil in a controlled way into the contact. When it runs too hot, it ages much faster – oil release becomes unreliable (often decreasing over time), the grease dries and hardens, the contact is starved of lubrication, and failure follows.

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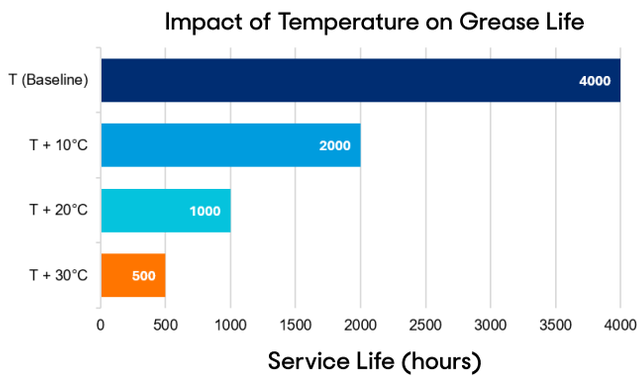
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One of the main causes of this degradation is *oxidation*, essentially the "rusting" of oil:

- It starts with oxygen from the air reacting with the base oil trapped in the grease.
- Heat accelerates this process dramatically. Then by-products form (acids, varnish-like residues) which leads to thickening of the grease, oil release drops, and deposits form.
- The result is a dry, hardened grease, so the bearing receives less oil, friction increases, temperature continues to climb, and the whole cycle accelerates.

Oxidation follows the Arrhenius effect: it rises exponentially with temperature, so a common rule of thumb is that every +10°C increase can roughly cut grease life in half.

That's why a bearing running "a bit hot" should never be ignored: it can have a disproportionate impact on reliability.



The impact of temperature on grease performance must be carefully evaluated, as the temperature experienced by the grease is often lower than the process temperature itself.

This is particularly true when the bearing is shielded or equipped with water cooling. To select the most suitable grease for a given temperature, the most reliable approach is to measure the actual operating temperature directly, using an infrared sensor or thermal imaging camera.

Decoding grease color

Don't overreact to color changes: dark grease isn't automatically failed grease. Additives can darken as they work, and contamination is common in many industrial settings (e.g. fine metallic particles). Treat color as a signal, not a diagnosis. Always confirm with other symptoms:

- Hardening or dryness
- Burnt smell
- Deposits or crusting
- Noise or temperature rise

With critical equipment, you can go even further by taking a used grease sample and analyzing oxidation (FTIR spectroscopy) or changes in consistency.

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Load: how much pressure is the grease carrying?

Load squeezes the oil film like stepping on a sponge.

What you're really asking: is the oil film strong enough to avoid metal-to-metal contact?

The viscosity of the oil should be high enough to be able to separate the surfaces in contact. But under very high or shock loads, this lubricating film can collapse instantly. Extreme pressure and solid additives can be added as a last line of defense.

In low-speed applications, the opportunity to form a full lubricating film is limited. As a result, the grease must have sufficiently high viscosity to protect the surfaces - think crane turret bearing or roller table bearings in a steel mill.

If the applied load exceeds the grease's load-carrying capability, the equipment will begin to deteriorate in several ways which all lead eventually to seizure and catastrophic failure:

- Smearing: Localized plastic deformation of surface asperities under high load and sliding, often seen in rolling bearings where the lubricant film collapses momentarily.
- Scuffing (adhesive wear/scoring):
  Severe adhesive damage caused by breakdown of the lubricant film, leading to microwelding and tearing of material along the sliding direction.
- Spalling (surface fatigue):
  Subsurface cracks initiate and propagate due to excessive Hertzian stresses, eventually causing material to flake off from the surface (common in bearings and gears).
- Pitting (micro- and macropitting):
  Repeated overstressing leads to surface-initiated fatigue, resulting in small craters (micropitting) or larger pits (macropitting).
- Galling/severe adhesive wear:
  Extreme form of adhesion under very high loads, where large areas of material transfer occur, potentially leading to seizure.

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Understanding load isn't always as simple as it sounds.

Imagine you press a knife against your skin with the same force, but in two different ways:

1. Blunt side (back of the knife): The force is spread over a large area. It feels like a push, but doesn't cut.
2. Sharp edge (blade): The same force is concentrated on a very small area. The pressure is much higher, and it cuts easily.

The choice of grease should therefore depend not only on the magnitude of the loads and shocks in the system, but also on how these loads are distributed, taking into account the type of bearings that support them.



Speed: What speed does it run at? More importantly, what's the n·dm?

At low speeds, load is often the limiting factor. But as speed increases, the problem shifts. Instead of mainly supporting load, the grease must now cope with internal molecular movement, shear, and heat generation. Think cake batter in a food mixer.

What you're really asking: is the grease at risk of being churned, overheated, or channeled away?

In high-speed bearings, grease is constantly being worked, sheared, churned, and redistributed inside the bearing. This creates internal friction and heat. If the grease isn't designed for it, several familiar symptoms appear:

- Overheating caused by excess churning and viscous drag, particularly right after regreasing
- Channeling or starvation, where grease is pushed to the sides of the bearing race and does not re-flow
- Loss of grease consistency leading to softening and inadequate film formation ("dry" contact)
- Seal purging or leakage from seals due to pressure and centrifugal effects
- Darkening and oxidation, resulting from thermal stress.

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What qualifies as "high speed"?

To properly assess speed, engineers often use the n·dm factor (speed multiplied by bearing size).

n·dm = Rotation Per Minutes (RPM) × mean bearing diameter (mm)

This gives a more realistic measure of how fast the rolling elements are actually moving and, therefore, how much stress the grease experiences.

This is why a small bearing running very fast can be just as demanding as a much larger bearing running at a medium speed. From the grease's perspective, what matters is the level of shear and heat, not just the RPM.

In practical terms, as speed increases, the grease typically needs to flow more easily and resist mechanical breakdown. Using a grease designed for low-speed, high-load conditions in a high-speed application is a common cause of overheating and early failure.

Speed level	n·dm Range	Technical Interpretation
Low Speed	< 200,000	Load-driven regime; minimal shear. Suitable for high-viscosity oils.
Medium Speed	200,000 – 500,000	Balanced load/speed conditions; standard bearing speeds.
High Speed	500,000 – 1, 000,000	Increased shear, heat generation; requires lower-viscosity oils (<100 cSt) and shear-stable thickeners.
Very High Speed	> 1, 000,000	Extreme shear; only specialty greases with low-viscosity base oils, esters/polymers, and highly stable thickeners can perform.

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Contamination: What are the environmental constraints?

Even a grease perfectly matched to the temperature, load and speed of your application will fail if it can't stay in place, so product selection needs to reflect the environment, not just the mechanical conditions.

Think of a sandcastle by the sea. It holds its shape at first, but as waves wash over it, the structure softens and is gradually carried away.

What you're really asking: is something contaminating or washing the grease out?

In real-world operations, external contaminants are sometimes unavoidable even with proper sealing. These can wash grease away, weaken its structure and additives, or interfere with its ability to hold and release oil.

Water is the number one culprit, and washout is the biggest problem of all because the grease then can't do its primary job of keeping the lubricant (the base oil) in the contact. An expensive, advanced grease (synthetic base oil; packed with premium additives) that isn't resistant to washout or water contamination will perform no better – and sometimes worse – than a basic lithium EP2 grease.

Corrosion is another key factor that often goes overlooked. In humid conditions or where aggressive fluids are present, damage can begin even when equipment is idle. Over time, this deterioration can become a major contributor to failure.

Consequences of contamination:

- Chemical softening or hardening
- Anti-wear and Extreme Pressure additives weakening
- Grease washout leading to lubrication starvation
- Rust and corrosion

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Industry/Application	Typical Source of Contamination	What's Happening in Practice
Steel and Aluminum mills (hot & cold rolling)	Process fluids (water based-emulsions), scale-laden water	Continuous exposure to water-based emulsions used for cooling and lubrication; washing out grease from work roll bearings
Automotive manufacturing & metalworking	Coolants, cutting fluids, wash fluids	Bearings near machining zones are exposed to mist, splashes, and fluid migration
Mining & quarrying	Rain, groundwater, slurry water	Open equipment and harsh environments lead to ingress from weather and wet material handling
Food & beverage	Washdowns, steam cleaning, product residues	Hygiene-driven cleaning cycles regularly expose bearings to water and detergents
Tube and Pipe manufacturing (pilger mill, cold forming)	Forming fluids (water based-emulsions), scale-laden water	Continuous exposure to water-based emulsions used for cooling and lubrication

Putting the Power of Four into Practice

All greases are exposed to these four fundamental constraints: temperature, load, speed, and contamination. The balance between them defines what "good performance" looks like.

By taking a few minutes to ask structured questions around each of these areas, you can quickly move from a generic choice to a targeted solution.

It is important to recognize that these four parameters do not capture the full complexity of real-world applications. Mechanical design factors can also drive failure, and grease-related properties such as pumpability, how easily the lubricant can be delivered to the contact, especially through long piping systems, can be equally critical.

From there you can go deeper, looking at things like relubrication practices, failure modes, or consumption levels, but the foundation always remains the same. Grease selection is about understanding the reality of the application. The Power of Four gives you a simple way to do that consistently, confidently, and with better results.

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Operational constraint	Questions to support grease selection
 Temperature	What is the normal operating temperature (and peak temperature) of the bearing/housing? Does temperature trend upwards over time between regreasing cycles? Any hot spots (one bearing hotter than the others)? Any signs of heat stress: hard/dry grease, burnt smell, crusting, varnish-like deposits?
 Load	What load does the bearing see: steady, shock, vibration, or frequent starts/stops? Any events like shocks, vibrations, jams, or product hits? Are there signs of overload/misalignment: unusual noise, rising power draw, frequent failures? Is it axial load or radial load or both?
 Speed	What is the speed (rpm) in normal operation? What's the bearing dm or n·dm (speed factor) if known/can be estimated? Is the equipment running continuous or in short fast cycles (acceleration/deceleration)? Any symptoms of speed mismatch: grease churning, temperature rise at higher speeds, leakage/purging patterns?
 Contamination	Is there water spray, washdown, steam, or regular cleaning nearby? Any process fluid exposure (coolant, emulsion, acid/alkaline solution, chemicals)? How does contamination enter: seals, open housings, pressure washing, condensation? What do you see: milky grease, softened/diluted grease, washed-clean areas, rust staining, frequent relubrication need?
Bonus	How the equipment is lubricated (manually or automatic greasing system) What's the current relubrication interval and quantities? What's the most common failure mode here: overheating, wear, washout, corrosion?

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