Lubrication: Viscosity and Macropitting

Email your question — along with your name, job title and company name (if you wish to remain anonymous, no problem) to: *jmcguinn@geartechnology.com*; or submit your question by visiting *geartechnology.com*.

QUESTION

Is the ISO VG 320 adequate, or should a higher viscosity grade be used? How can we stop macropitting in gear teeth?

Expert response provided by Robert Errichello:

Given data

- Slowest speed gear in a gear train is 0.71 m/s pitchline velocity.
- Oil application is pressure-fed circulating system.
- Oil type is mineral (SERVOMESH EE 320).
- The product data sheet (PDS) for SERVOMESH EE 320 lists ISO VG 320, VI = 90, and pour point = –3°C.

Select oil viscosity

The first step is to ensure that the oil viscosity conforms to the requirements of ANSI/AGMA 9005-F16 (Ref. 1). Table 1 shows recommended viscosity versus operating temperature for a pitchline velocity of 1.0–2.5 m/s (lowest velocity given by ANSI/AGMA 9005-F16 (Ref. 1)). Table 1 applies to a mineral oil with a viscosity index (VI) = 90.

Table 1 Recommended viscosity (excerpted from ANSI/AGMA 9005-F16 Table B.1)

Operating temperature (°C)	Viscosity grade (cSt at 40°C)
50	320
55-60	460
65	680

Information provided courtesy of AGMA.

Definitions

- Ambient temperature is the dry bulb air temperature in the immediate vicinity of the installed gears.
- Operating temperature is the bulk oil operating temperature (temperature of the oil supplied to the gear teeth).

Discussion of viscosity

Table 1 shows that ISO VG 320 is adequate if the operating temperature is ≤50°C. However, such a low operating temperature will likely require a cooler. A more typical operating temperature is 65°C, which requires ISO VG 680.

Check pour point

The next step is to ensure that the pour point of the oil is at least 5°C below the minimum expected ambient temperature at startup. The PDS for SERVOMESH EE 320 lists pour points of –3°C for ISO VG 320 to ISO VG 680. Therefore, the minimum expected ambient temperature should not be less than 2°C. If lower startup temperatures are expected, you should use oil with the required viscosity but a lower pour point such as a synthetic polyalphaolefin (PAO), or use a heater to heat the oil prior to startup.

Reduce risk of macropitting

- ANSI/AGMA 1010-F14 (Ref. 2) recommends the following methods to reduce the risk of macropitting:
- Reduce Hertzian stresses by reducing loads or optimizing gear geometry;
- Use clean steel, properly heat treated to high surface hardness, preferably by carburizing;
- Use smooth tooth surfaces produced by careful grinding, honing, or polishing;
- Use an adequate amount of cool, clean and dry (free of water) lubricant of adequate viscosity;
- For surface hardened gearing, ensure adequate surface hardness and case depth after final processing. Note that excessive surface hardness may lead to other problems, such as risk of grinding cracks.

Other considerations

Be sure to consider other criteria that are affected by oil viscosity such as pumpability, efficiency, and operating temperature. See ANSI/AGMA 9005-F16 (Ref. 1) for further information.

References

ANSI/AGMA 9005-F16, "American National Standard- Industrial Gear Lubrication," AGMA (2016).

ANSI/AGMA 1010-F14, "American National Standard- Appearance of Gear Teeth- Terminology of Wear and Failure," AGMA (2014).

Robert Errichello, PE, is a founder of GEARTECH Software, Inc. A longtime contributor to Gear Technology magazine and a Gear Technology Technical Editor, he has for more than 30 years worked or consulted for several gear companies, and has taught courses in material science, fracture mechanics, vibration and machine design at San Francisco State University and the University of California at Berkeley. He is also a member of ASM International, STLE, ASME Power Transmission and Gearing Committee, AGMA Gear Rating Committee and the AGMA/AWEA Wind Turbine Committee. Errichello has published dozens of articles on design, analysis and the application of gears, and is the author of three widely used computer programs for the design and analysis of gears.