Foaming characteristics of gear oils

1. Surface foam and oil/air mixture

In gears and oil circulation systems, undesirable foam may form, or air may be finely dispersed in the oil.

Therefore, it is important to know whether the problem is due to surface foam or air mechanically incorporated into the oil. These two are often confused and quite difficult to distinguish.

Before using an antifoam additive, the nature and the causes of foaming have to be determined. In some cases, a foam test will help analyzing the phenomenon.

An antifoam additive can reduce or avoid surface foam, whereas it cannot prevent, but will even enhance the inclusion of air in the oil. The foaming characteristics and air shedding capacity of gear oils are largely determined by the viscosity of the oil. Normally, the foam of low-viscosity gear oils disintegrates faster than the foam formed in highly viscous products.

Ambient temperatures may also have a strong effect on foaming. In wintertime, viscosities can be much higher than in summertime.

A gear oil of ISO VG 680 has a viscosity of 680 mm²/s at 40°C. When using the oil in winter –time at an operating temperature of 20°C, its viscosity increases to approx. 3500 mm²/s.

2. Causes and effects

Possible reasons for foam formation are manifold and are often influenced by the operating conditions. Excessive foaming is rarely due to the oil used.

Possible reasons for foaming:

- **With circulation lubrication:**

  - defoamer removed by filter

  - oil cycles too high

  - feed pressure of pump too high

  - cross sections of oil lines too small

  - intake of air

- **With immersion lubrication**

  - Wrong filling quantity

  - Inadequate geometry of the oil reservoir / gear box

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- **General causes**
  - Gear oil mixed with oil of an other brand
  - Gear oil contaminated by bearing grease
  - Gear oil contaminated by dust
  - Gear oil contaminated by water

During operation of the gear, air is always incorporated into the gear oil. Therefore, foaming cannot be fully avoided after switching off the installation and in large oil reservoirs also during operation.

Very pronounced foaming may result in:

- increase of the internal gear pressure

- oil loss due to foam ermerging from the gear ventilation

- Reduced load carrying capacity of the oil in the rolling bearing and the tooth contact area

- Reduced heat dissipation

3. Test methods

3.1 Standard test methods

Foaming characteristics of gear oils are determined according to ISO 6247, superseding DIN 51566, or according to ASTM D 892.

DIN Norm 51 566 contains a note to the effect that the test method is applicable to oils with viscosities > 500 mm²/s to a limited extent only. Nevertheless, it is also used for evaluating the foaming characteristics of gear oils of ISO VG class 460 – 1500.

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In the test, air is fed through a diffuser ball into the oil to be tested. Immediately after switching off the air current, the volume of the surface foam is determined in millilitres. After a rest period of 5 minutes, the volume of the surface foam is measured again and expressed in millilitres.

The test is carried out at a temperature of 25°C and 95°C. It does not allow determining the increase in volume of the air entrapped in the oil.

The latest draft of the gear oil standard DIN 51 517, part 3, specifies the following limiting values:

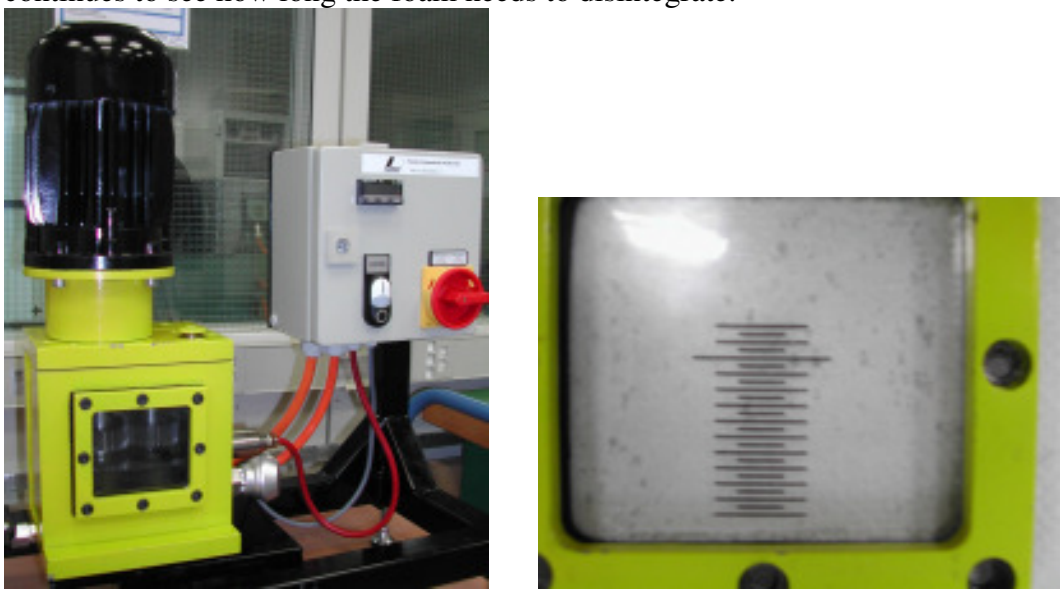
- ISO VG 68 to 460 — 100 ml after switch-off — 10 ml after 10 minutes
- ISO VG 686 to 1500 — 150 ml after switch off — 10 ml after 10 minutes

3.2 Flender foam test

As the a.m. test methods allow only a limited transfer to practice, the company A. Friedr. Flender in Bocholt, Germany, designed a specific foam test (see figure below).

In the Flender foam test the oil is filled into a gear with horizontal gear wheels. After starting the gear, the gear wheels act like a twirling-stick and convey air into the oil. After a defined running time the overall increase in volume is measured, i.e. both the oil/air mixture and the surface foam are determined and evaluated.

The Flender specification tolerates an increase in volume of up to 15% after switch-off. Recording continues to see how long the foam needs to disintegrate.



Flender foam test

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4. Summary

Foam formation in gear oils may have manifold causes. To solve the problem, the causes and the foaming tendency have to be analyzed.

If pronounced foaming occurs immediately after starting the system, it may be due to specific design features and be corrected correspondingly.

If elevated foaming occurs during operation after a longer running time, it may be due to a modified foaming behavior of the oil. This, however, does not necessarily mean that the oil has to be changed at once because with an increase in foam volume of up to 15% (determined by the Flender foam test) a loss in performance due to a lower load carrying capacity is not to be expected.

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