

Flender Foaming Test GG-V 425 Rev.1

Description of the testing instrument; carrying out the test; assessment criteria

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1 Introduction

Excessive foaming and too slow an air release of dispersed air in gear oils have a negative influence on the load carrying capacity of gears and bearings. In addition, excessive foaming can result in oil leaking at shaft seals and breather screws. This is why gear oils should be checked for foaming characteristics and air release properties.

In the "Flender Foaming Test", a gear pair rotates in the oil to be tested and thus mixes air into the oil. In this way it is possible to test in the short term how oil behaves with regard to the absorption of air, oil-air dispersion, and surface foam as well as their regeneration under boundary conditions as exist in gear units.

2 Description of the testing instrument

The testing instrument is a closed housing to take one litre of the oil to be tested. In the housing with inside dimensions of 140 x 90 x 160 mm, two shafts are arranged vertically and supported in rolling bearings. The gears, serving to mix the oil with air, are fitted in the centre of the shafts.

Technical data of the spur gears:

Centre distance	a	=	50 mm
Module	m	=	2 mm
Facewidth	b	=	20 mm
Numbers of teeth	z_1, z_2	=	25

The gears are arranged with their shafts vertically in such a way that with an oil filling of one litre (1000 cm³) they dip into the oil to the centre of the teeth. In this way, an optimum amount of air is supplied to the oil. One of the two shafts is driven by a three-phase motor flanged to the housing upper part by means of a bell housing. Motor shaft and gear shaft are connected by means of a flexible coupling.

Technical data of the motor:

Power rating:	P	=	0.55 kW
Speed:	n	=	1400 ± 5 rpm

An opening is milled into the housing front and closed by means of a glass pane. The pane is provided with a scale from which the percentages of changes in oil volume can directly be read during the foaming test. The filling height of the oil sample before the test is started and after a starting temperature of 25 °C ± 0.5 °C has been reached is marked as the zero line.

At the housing back wall, a heater with a heating capacity of 160 Watt is installed by means of which large-surface heating of the lubricant is achieved with low specific heat load. The oil temperature is always measured by means of a resistance thermometer which is fitted into the housing and has a measuring range between 0 and 60 °C. The housing is provided with oil filler plug and oil drain valve for filling and draining.

A diagrammatic view of the testing instrument is shown in Figure 2.1. In addition, the testing instrument is shown in a photograph in Figure 2.2.

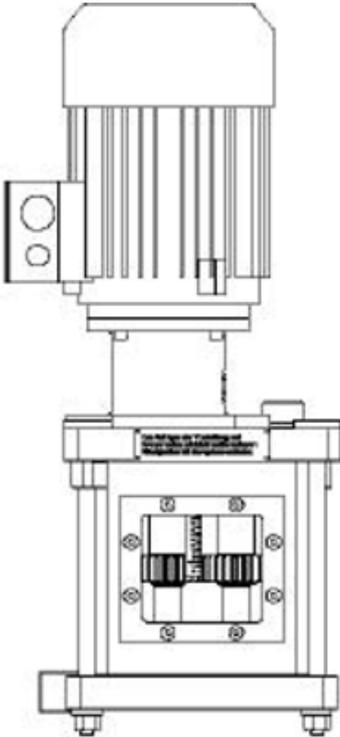


Fig. 2.1: Diagrammatic view of the testing instrument

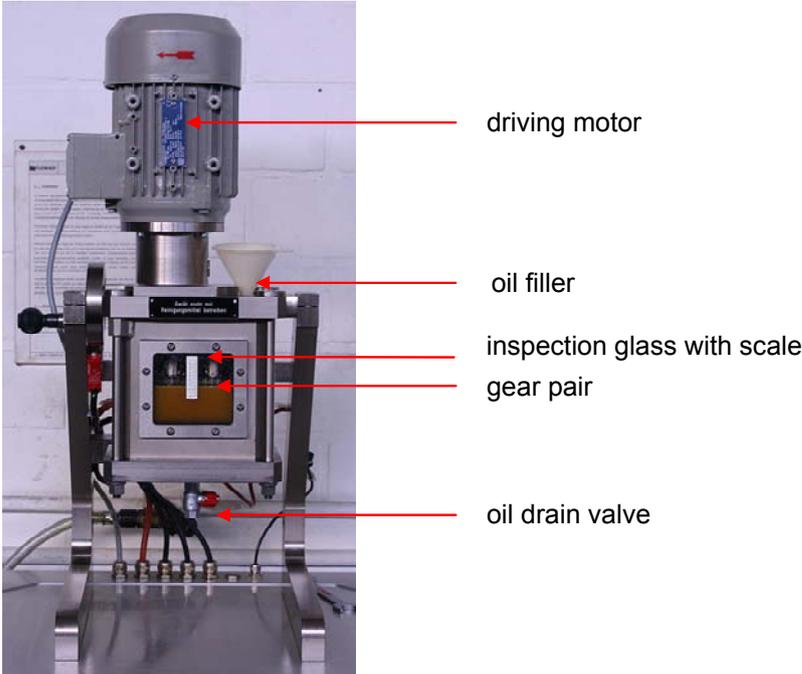


Fig. 2.2: General view of the testing instrument

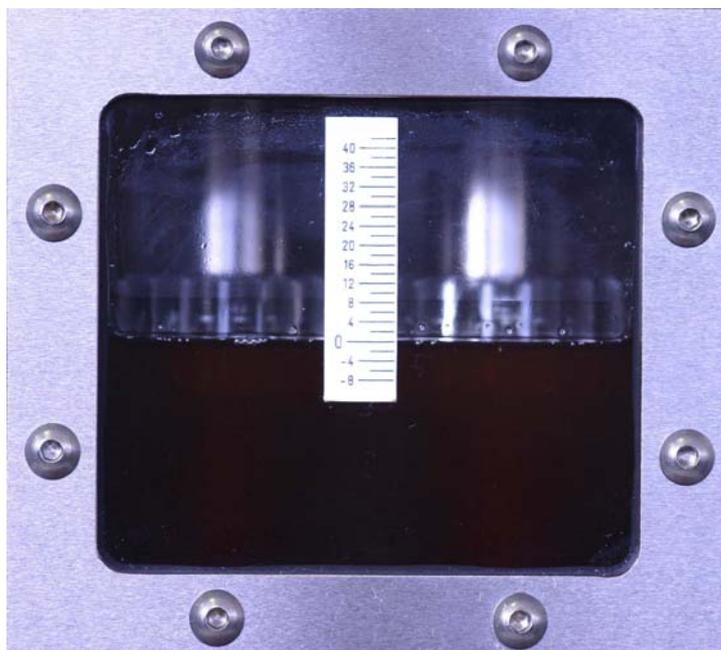


Fig. 2.3: View into the oil-filled working chamber of the testing instrument showing the gear teeth and the scale with indication in volume percent

The photos in Figures 2.4 and 2.5 show by way of example different conditions of gear oil during a foaming test.

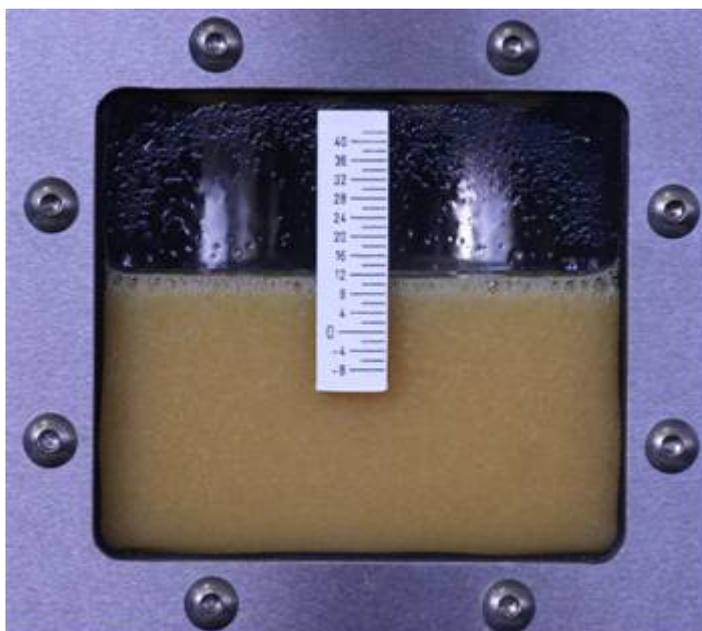


Fig. 2.4: Example "Condition of the oil 1 minute after stopping the motor"

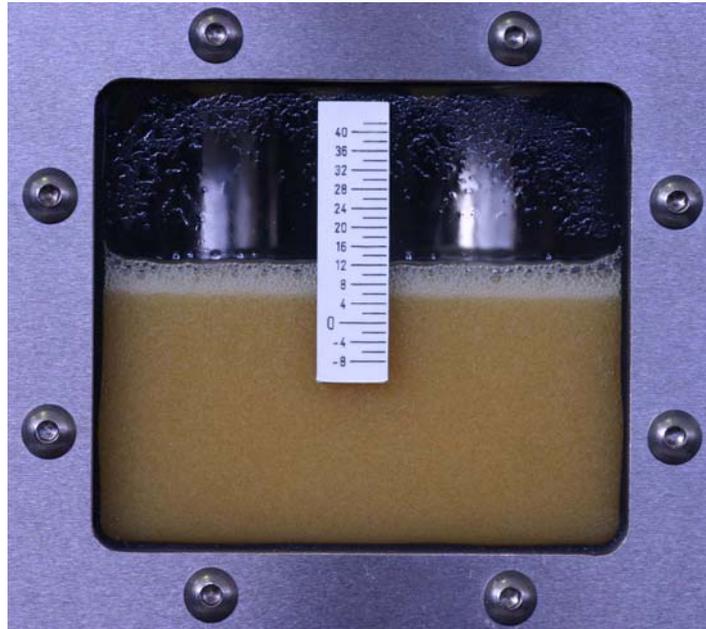


Fig. 2.5: Example "Change in the condition 5 minutes after stopping the motor"

The Flender foam tester can be acquired by purchase from the company Strama-MPS in Straubing.

3 Carrying out the test

First, a quantity of one litre of the oil to be tested is filled into the housing of the testing instrument via the oil filler hole. Prior to filling in the oil, the inside of the housing must be thoroughly cleaned, since contaminants or oil residues of former tests will have an influence on foaming.

By means of a heater, the oil is slowly heated to a test temperature of $25\text{ °C} \pm 0.5\text{ °C}$ in such a way that the testing instrument has approximately the same temperature (temperature equilibrium). It proved worthwhile to heat the oil to a temperature higher by 2 to 3 °C and then let the oil temperature drop to the test temperature of 25 °C. When the test temperature is reached, the oil level must be checked (zero line) and possibly corrected.

The real test is started by starting the motor for a running time of 5 minutes \pm 3 seconds. When the drive has been shut down, the increase in volume must be determined making a distinction between oil-air dispersion and surface foam. It turned out that the first reading for higher viscous oils does not always exactly represent the increase in volume because oil is still running down on the internal walls. Therefore, a second reading is taken after one minute. From this point of time it is possible to make a clear distinction between oil-air dispersion and surface foam. Over a period of 90 minutes, readings of the development of the foam are taken at fixed intervals and documented in a form sheet (see enclosure).

The values for total increase in volume, oil-air dispersion, and surface foam must be entered in the specified columns. As soon as the surface foam does no longer constitute a closed area, i.e. tears open, or forms foam isles, the surface foam volume is determined at 1%. In addition to the foam percentages, the oil temperature is recorded at least every 30 minutes.

Before the next test can be made, the lubricant must be drained and the oil chamber thoroughly cleaned. To prevent corrosion in the testing instrument it is recommended to drain the oil and clean the chamber only until shortly before the new test is started. For cleaning, the foam tester must be disassembled and the individual parts must be cleaned separately. We recommend using Castrol Techniclean AS 40 for cleaning.

At present, the description of the testing instrument and the test procedure of the Flender Foaming Test are part of a standardization project which will be published as **ISO standard 12152**.

4 Evaluation and assessment of the foaming characteristics

The time rate of foam development is shown in a chart (enclosure), where the curves of the oil-air dispersion and the surface foam are outlined over the rest period. The increase in volume caused by the rise of the oil temperature (approx. 2 to 3 °C) is below 0.5% even in case of oils with higher viscosity and thus can be neglected.

Assessment criteria which can be derived from the depiction are the volumes of the oil-air dispersion and the surface foam as well as their times of regeneration. In comparative tests, the charts can be directly used for assessment.

For the evaluation of the foaming characteristics, two criteria are to be considered:

1. The **percentage increase in the oil volume one minute after stopping the testing instrument** (oil-air dispersion + foam) is rated as follows:

up to	5%	good foaming characteristics
up to	10%	satisfactory foaming characteristics
up to	15%	still acceptable foaming characteristics
above	15%	unacceptable foaming characteristics

2. The **percentage increase in the volume of the oil-air dispersion five minutes after stopping the testing instrument** is rated as follows:

up to	4%	good air release property
up to	7%	satisfactory air release property
up to	10%	still acceptable air release property
above	10%	unacceptable air release property

The two criteria are equal. The more critical result is decisive for the rating of the oil.

Oils with a percentage total increase in volume **above 15%** one minute after stopping the motor or a percentage increase in volume of the oil-air dispersion **above 10%** five minutes after stopping the motor are **not recommended** for use in industrial gear units since they have a negative influence on the load carrying capacity of the gear teeth.

5 Literature

ISO/DIS 12152 Lubricants, industrial oils and related products – Determination of the foaming characteristics and air release properties of industrial gear oils by using a cylindrical gear testing instrument – Flender Foaming Test procedure

6 Enclosures

Example of a test report

**Test of the foaming characteristics and air release properties of gear oils on a cylindrical gear test rig
(Flender Foaming Test)
acc. to ISO/DIS 12152 and GG-V 425 Rev. 1
(Evaluation acc. to GG-V 425 Rev. 1)**

Page 1 of 3

Sample number: _____ ISO VG: _____

Sample designation: _____

Date of receipt of sample: _____

Date of test: _____

Order number: _____

Client: _____

Notes: _____

The analyses on which this test report is based have been made in accordance with the test procedures currently in force.

Signature of the inspector

Name of the inspector in block letters

This test report consists of 3 pages (inclusive of this one) and only refers to the tested items. According to DIN EN ISO 17 025 it is not allowed to duplicate this test report without the consent of the testing laboratory.

Name and address of the testing laboratory

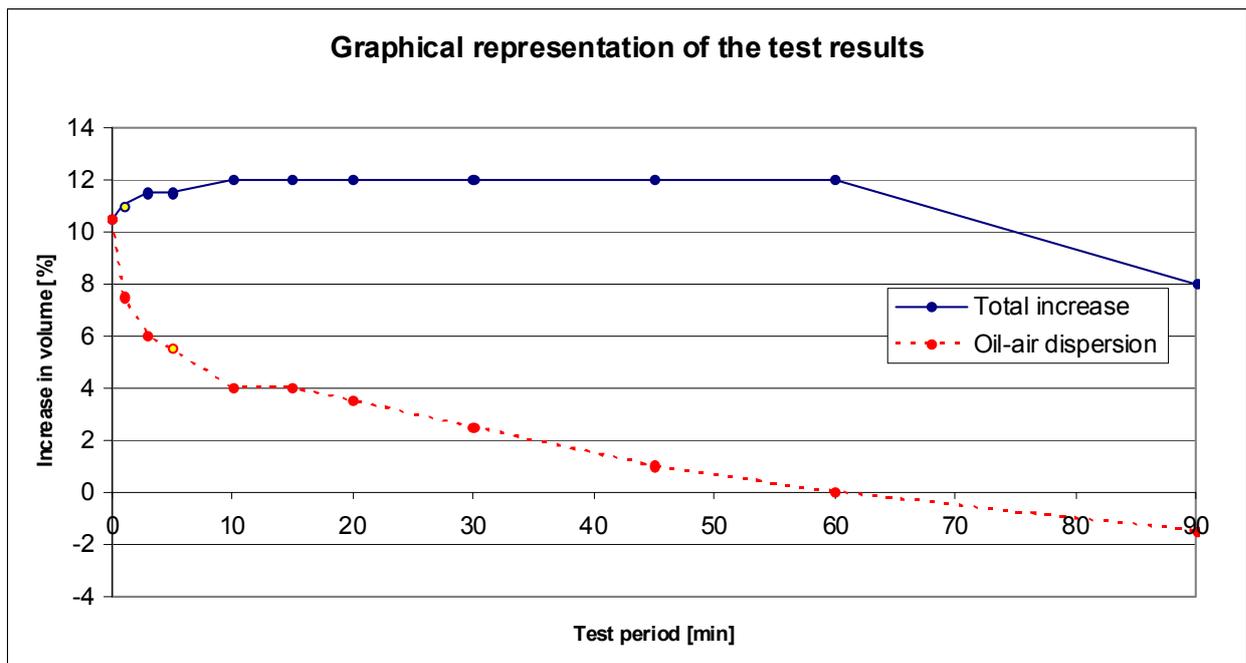
**Test of the foaming characteristics and air release properties of gear oils on a cylindrical gear test rig
(Flender Foaming Test)
acc. to ISO/DIS 12152 and GG-V 425 Rev. 1
(Evaluation acc. to GG-V 425 Rev. 1)**

Sample number: _____ ISO VG: _____

Sample designation: _____

Time after stop of motor [min]	Temperature [°C]	Volume changes [%]					Rating
		Total increase	oil-air dispersion	surface foam	Limit ^{*1}		
					Total increase	oil-air dispersion	
before start	25,3						
0		10,5	10,5	0,0			
1		11,0	7,5	3,5	≤ 15		passed
3		11,5	6,0	5,5			
5		12,0	5,5	6,5		≤ 10	passed
10		12,0	4,0	8,0			
15		12,0	4,0	8,0			
20		12,0	3,5	8,5			
30	28,3	12,0	2,5	9,5			
45		12,0	1,0	11,0			
60	26,8	12,0	0,0	12,0			
90	25,8	8,0	-1,5	9,5			
Total evaluation:							passed

*) Limits according to current "Specification for the approval of gear oils for FLENDER gear units"



**Test of the foaming characteristics and air release properties of gear oils on a cylindrical gear test rig
(Flender Foaming Test)
acc. to ISO/DIS 12152 and GG-V 425 Rev. 1
(Evaluation acc. to GG-V 425 Rev. 1)**

Sample number: _____ ISO VG: _____

Sample designation: _____

