

ISO/FDIS_14635-3:2023(E)

ISO/TC_60/SC_2

Secretariat: DIN

Date: 2023-01-25/02-28

Gears — FZG test procedures —

Part 3:

FZG test method A/2,8/50 for relative scuffing load-carrying capacity and wear characteristics of semifluid gear greases

iTeh STANDARD PREVIEW
(standards.iteh.ai)

Engrenages — Méthodes d'essai FZG —

ISO/FDIS 14635-3

Partie 3: Méthode FZG A/2,8/50 pour évaluer la capacité de charge au grippage et les caractéristiques d'usure des graisses d'engrenages semi-fluides

FDIS stage

ISO/FDIS 14635-3:2023(E)

© ISO 2023

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
E-mail: copyright@iso.org
Website: www.iso.org

Published in Switzerland

iTeh STANDARD PREVIEW
(standards.iteh.ai)

ISO/FDIS 14635-3

<https://standards.iteh.ai/catalog/standards/sist/859b309a-ff19-4d8c-b5c2-d6787399b4e8/iso-fdis-14635-3>

Contents

Forewordv

Introductionvii

Part 3: FZG test method A/2.8/50 for relative scuffing load-carrying capacity and wear characteristics of semifluid gear greases1

1 Scope1

2 Normative references1

3 Terms and definitions1

4 Brief description of method5

4.1 General5

4.2 Precision5

5 Test materials5

5.1 Test gears5

5.2 Cleaning fluid6

6 Apparatus9

6.1 FZG spur gear test rig9

6.2 Heating device9

6.3 Revolution counter9

6.4 Weight measurement9

7 Preparation of apparatus11

8 Test procedure12

9 Reporting of results13

Annex A (informative) Test report15

Annex B (informative) Additional test procedure for the investigation of extended wear characteristics of the lubricant17

Annex C (informative) Checklist for maintenance of FZG gear test rig18

Bibliography24

Foreword — v

Introduction — vii

1 — Scope — 1

2 — Normative references — 1

3 — Terms and definitions — 1

4 — Brief description of method — 4

4.1 — General — 4

4.2 — Precision — 4

5 — Test materials — 4

5.1 — Test gears — 4

5.2 — Cleaning fluid — 4

6 — Apparatus — 6

6.1 — FZG spur gear test rig — 6

6.2 — Heating device — 7

ISO/FDIS 14635-3:2023(E)

6.3	Revolution counter	7
6.4	Weight measurement	7
7	Preparation of apparatus	8
8	Test procedure	9
9	Reporting of results	10
Annex A (informative) Test report 12		
Annex B (informative) Additional test procedure for the investigation of extended wear characteristics of the lubricant 13		
B.1	General	13
B.2	Test procedure	13
B.3	Reporting results	13
Annex C (informative) Checklist for maintenance of FZG gear test rig 14		
C.1	How to recognize malfunction	14
C.1.1	Distribution of scuffing marks	14
C.1.2	Tooth contact pattern	14
C.1.3	Tests with reference oil	14
C.1.4	Other indications	14
C.2	Parts that need maintenance	14
C.2.1	Test gear box	14
C.2.1.1	Shafts	14
C.2.1.2	Bearings	15
C.2.1.3	Keys	15
C.2.1.4	Spacer rings	15
C.2.1.5	Gear box and front cover	15
C.2.1.6	Seals	15
C.2.2	Connecting shafts and flanges	15
C.2.2.1	Load coupling	15
C.2.2.2	Torque measuring device	15
C.2.2.3	Load coupling support bearing	15
C.2.2.4	Torsion shaft	15
C.2.2.5	Flanges	16
C.2.3	Slave gear box	16
C.2.3.1	Slave gears	16
C.2.3.2	Lubrication	16
C.2.4	Other parts	16
C.2.4.1	Heating	16
C.2.4.2	Flexible coupling	16
C.2.4.3	Motor	16
C.3	Approximate time intervals	16
Bibliography 18		

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 60, Gears, Subcommittee SC 2, Gear capacity calculation.

This second edition cancels and replaces the first edition (ISO 14635-3:2005), of which it constitutes a minor revision in accordance with ISO Directives, Part 1. The changes are as follows:

The main changes are as follows:

- ~~ISO 1328-1:1995, Cylindrical gears — ISO system of accuracy — Part 1: Definitions and allowable values of deviations relevant to corresponding flanks of gear teeth¹~~ has been dated as this document still refers to accuracy grade;
- ~~replacement of ISO 4287, Geometrical Product Specifications (GPS) — Surface texture: Profile method — Terms, definitions and surface texture parameters~~ which has been withdrawn and replaced by ISO 21920-2, Geometrical product specifications (GPS) — Surface texture: Profile — Part 2: Terms, definitions and surface texture parameters;
- ~~replacement of ISO 4964, Steel — Hardness conversions~~ which has been withdrawn and similar information can be found in ISO 18265, Metallic materials — Conversion of hardness values;
- ~~updating replacement of some~~ bibliography entries ~~which were withdrawn~~, and changes from dated to undated references ~~where no specific reason requires the dated reference (see Bibliography footnotes)~~;
- ~~Table 1, Table 1~~, description "pitch line velocity (v_w)" has been replaced by "circumferential velocity at the pitch line" to harmonize the wording with ~~the~~ ISO 6336-series;
- ~~Table 1, Table 1~~, symbol for "specific sliding" has been corrected according to ISO 21771;

¹ Cancelled and replaced by ISO 1328-1:2013.

ISO/FDIS 14635-3:2023(E)

- ~~Table 2, Table 2~~, grinding: unit for "generating stroke drive" has been corrected;
- ~~Table 3, Table 3~~, information on the load coupling has been harmonized with ISO 14635-1;
- ~~Clause 9, Clause 9~~, the reporting value of the specific weight loss has been corrected.

A list of all parts in the ISO 14635 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html ~~www.iso.org/members.html~~.

iTeh STANDARD PREVIEW
(standards.iteh.ai)

ISO/FDIS 14635-3

<https://standards.iteh.ai/catalog/standards/sist/859b309a-ff19-4d8c-b5c2-d6787399b4e8/iso-fdis-14635-3>

Introduction

The types of gear failure which can be influenced by the lubricant are scuffing, low-speed wear and the gear fatigue phenomena known as micro- and macropitting. In the gear design process, these types of gear damage are taken into consideration by the use of specific lubricant and service-related characteristic values. In order to provide a reasonable estimate of performance in service, adequate lubricant test procedures are required. The FZG² test procedures described in ISO 14635-1, ISO 14635-2 and ISO 14635-3 can be regarded as tools for the determination of relative scuffing performance of lubricants. Characteristic values can be introduced into the load-carrying capacity calculation of gears. ISO 14635-1 FZG test method, A/8,3/90 for relative scuffing load-carrying capacity of oils, is useful for the majority of applications in industrial and marine gears. ISO 14635-2, FZG step load test A10/16, 6R/120, is related to the relative scuffing load-carrying capacity of high EP oils as used, e.g. for the lubrication of automotive driveline components such as manual transmissions. ISO 14635-3 FZG test method A/2,8/50 describes a test procedure for the determination of the relative scuffing load-carrying capacity and wear characteristics of semi-fluid greases used for enclosed gear drives. Other FZG test procedures for the determination of low-speed wear, micro- and macropitting load capacity of gears are currently being considered for standardization. They can be added later to ISO 14635 as further parts.

It has been assumed by the compilers of this test method that anyone using the method will either be fully trained and familiar with all normal engineering and laboratory practice, or will be under the direct supervision of such a person. It is the responsibility of the operator to ensure that all local legislative and statutory requirements are met.

When the rig is running, there are long-loaded shafts and highly stressed test gears turning at high speed and precaution must needs to be taken to protect personnel. It is also necessary to provide protection from noise.

ISO/FDIS 14635-3

<https://standards.iteh.ai/catalog/standards/sist/859b309a-ff19-4d8c-b5c2-d6787399b4e8/iso-fdis-14635-3>

² FZG = Forschungsstelle für Zahnräder und Getriebebau, Technische Universität München (Gear Research Centre).

Gears — FZG test procedures —

Part 3: FZG test method A/2,8/50 for relative scuffing load-carrying capacity and wear characteristics of semifluid gear greases

1 Scope

This document specifies a test method based on a FZG³ four-square test machine for determining the relative load-carrying capacity of semi-fluid gear greases defined by the gear surface damage known as scuffing.

This method is useful for evaluating the scuffing load capacity potential of semi-fluid gear greases of NLGI classes 0 to 000, typically used with highly stressed gearing for enclosed gear drives. It can only be applied to greases giving a sufficient lubricant flow in the test gear box of the FZG test machine.

NOTE The test method is technically equivalent to DIN Fachbericht 74.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 1328-1:1995⁴, *Cylindrical gears — ISO system of accuracy — Part 1: Definitions and allowable values of deviations relevant to flanks of gear teeth*

ISO 5725-2, *Accuracy (trueness and precision) of measurement methods and results — Part 2: Basic methods for the determination of repeatability and reproducibility of a standard measurement method*

ISO 14635-1, *Gears — FZG test procedures — Part 1: FZG test method A/8,3/90 for relative scuffing load-carrying capacity of oils*

ISO 6743-6, *Lubricants, industrial oils and related products (class L) — Classification — Part 6: Family C (Gears)*

ISO 12925-1, *Lubricants, industrial oils and related products (class L) — Family C (Gears) — Part 1: Specifications for lubricants for enclosed gear systems*

ISO 18265, *Metallic materials — Conversion of hardness values*

ISO 21920-2, *Geometrical product specifications (GPS) — Surface texture: Profile — Part 2: Terms, definitions and surface texture parameters*

ASTM D 235, *Specification for Mineral Spirits (Petroleum Spirits) (Hydrocarbon Dry Cleaning Solvent)*

DIN 51818, *Lubricants; consistency classification of lubricating greases; NLGI grades*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at <https://www.iso.org/obp>

Field Code Changed

³FZG = Forschungsstelle für Zahnräder und Getriebebau, Technische Universität München (Gear Research Centre, Technical University, Munich).

⁴ Cancelled and replaced by ISO 1328-1:2013.

ISO/FDIS 14635-3:2023(E)

— IEC Electropedia: available at <https://www.electropedia.org/>

Field Code Changed

3.1

scuffing

particularly severe form of gear tooth surface damage in which seizure or welding together of areas of tooth surface occurs, owing to insufficient or breakdown of lubricant film between the contacting tooth flanks of mating gears, typically caused by a combination of high temperature, high pressure and other factors

Note 1-to entry:- Scuffing is most likely when surface velocities are high. It can also occur at relatively low sliding velocities when tooth surface pressures are high enough either generally or, because of uneven surface geometry and loading, in discrete areas.

Note 2-to entry:- Care should be taken that scuffing does not occur and is polished away before ending the running time at the higher load stages.

3.2

wear

continuous removal of material occurring when two surfaces roll and slide against one another

3.3

scuffing load-carrying capacity

(of a lubricant) maximum load which can be sustained under a defined set of conditions

3.4

FZG test condition A/2,8/50

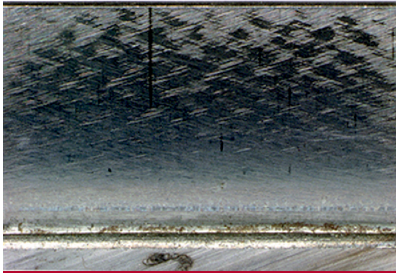
test condition where A is the particular tooth form of the test gears, according to [Table 1, 2](#), 2,8 is the speed at the pitch circle in metres per second (m/s), and 50 is the initial lubricant temperature in degrees Celsius, from load stage 4 onward in the lubricant sump

3.5

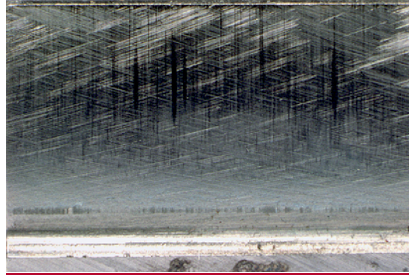
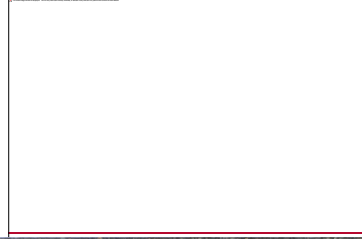
failure load stage

load stage reached when the summed total width of scuffing damage on the active flank area of the 16 pinion teeth exceeds one gear tooth width, i.e. 20 mm-

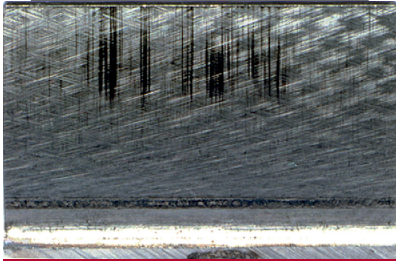
Note 1-to entry:- For examples of failure, see [Figure 1](#), [Figure 1](#). Examples of tooth flank changes due to continuous wear are given in [Figure 2](#), [Figure 2](#). Continuous wear is not a failure ~~criteria~~ criterion for the test.



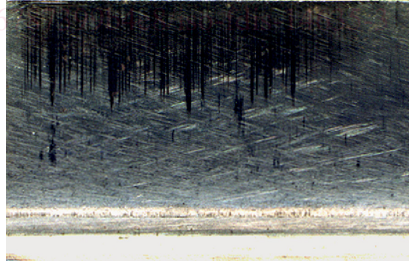
a) Marks, no failure



b) Marks, no failure



c) Approx. 5 mm failure marks

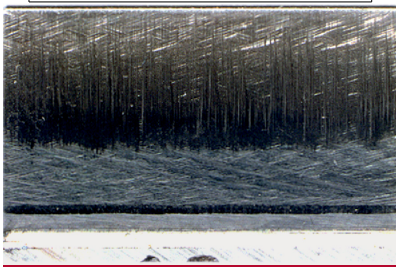


d) Approx. 15 mm failure marks

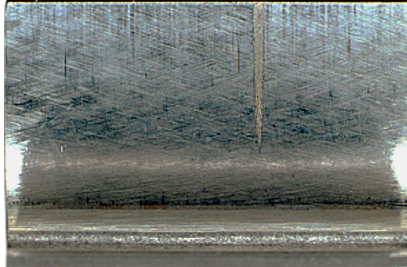
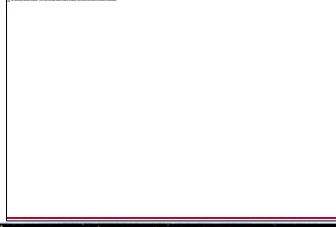
iTeh STANDARD PREVIEW
(standards.iteh.ai)

ISO/FDIS 14635-3

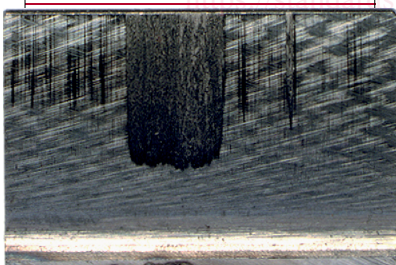
<https://standards.iteh.ai/catalog/standards/sist/859b309a-f19-4d8c-b5c2-d6>



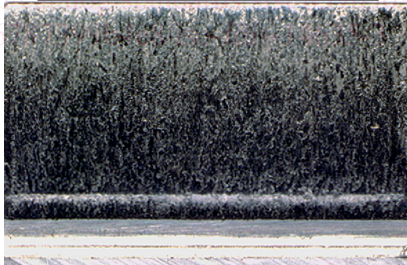
e) 20 mm failure marks



f) Approx. 2 mm failure marks



g) Approx. 6 mm failure marks



h) 20 mm failure marks

NOTE This figure describes the typical pinion tooth flank changes occurring in FZG scuffing type tests. Changes in the original surface condition (criss-cross grinding) can be described by their physical appearance. One and the same type of flank damage can be described in different places in the world by using different terminology (e.g. “scuffing”, “scoring” and “severe wear”). In order to avoid misinterpretation of the pinion tooth flank changes occurring during the test, typical examples of non-failure and failure are given.

NOTE — This figure describes the typical pinion tooth flank changes occurring in FZG scuffing type tests. Changes in the original surface condition (criss-cross grinding) can be described by their physical appearance. One and the same type of flank damage can be described in different places in the world by using different terminology (e.g. “scuffing”, “scoring” and “severe wear”). In order to avoid misinterpretation of the pinion tooth flank changes occurring during the test, typical examples of non-failure and failure are given.

Figure 1 — FZG A-type gear tooth face changes (flank damages)