SLOVENSKI STANDARD
SIST ISO 14635-2:2005

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Zobniki - FZG postopek preskuġanja - 2. del: FZG preskus za postopno ugotavljanje nosilnosti A10/16, 6R/120 za doloļ anje relativne obrabne trdnosti pri mazanju z visoko obremenljivimi (EP) olji

Gears -- FZG test procedures -- Part 2: FZG step load test A10/16, 6R/120 for relative scuffing load-carrying capacity of high EP oils

Engrenages -- Méthodes d'essai FZG -- Partie 2: Méthode FZG A10/16, 6R/120 à paliers de charge pour évaluer la capacité de charge au grippage des huiles à valeurs EP élevées

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Gears — FZG test procedures —

Part 2: FZG step load test A10/16, 6R/120 for relative scuffing load-carrying capacity of high EP oils

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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 14635-2 was prepared by Technical Committee ISO/TC 60, *Gears*, Subcommittee SC 2, *Gear capacity calculation*.

ISO 14635 consists of the following parts, under the general title *Gears — FZG test procedures*:

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

— *Part 2: FZG step load test A10/16, 6R/120 for relative scuffing load-carrying capacity of high EP oils*

Part 3, *FZG test method A/2,8/50 for semifluid gear greases*, is under preparation.

Introduction

The types of gear failures which may be influenced by the lubricant in use are scuffing, low-speed wear and the gear-surface fatigue phenomena known as micropitting and pitting. In the gear design process, these gear damages are taken into consideration by the use of specific lubricant and service-related characteristic values. For an accurate, field-related selection of these values, adequate lubricant test procedures are required. The FZG test procedures specified in this and the other parts of ISO 14635 can be regarded as tools for the determination of the lubricant-related characteristic values to be introduced into the load-carrying capacity calculation of gears.

FZG test method A/8,3/90 for the relative scuffing load-carrying capacity of oils described in ISO 14635-1 is typical for the majority of applications in industrial and marine gears. This part of ISO 14635 is related to the relative scuffing load-carrying capacity of oils of very high EP properties, as used for the lubrication of automotive driveline components. Other FZG test procedures for the determination of low-speed wear, micropitting and pitting load-carrying capacity of gears are already in a late state of development. They may be added later to ISO 14635 as further parts.

Gears — FZG test procedures —

Part 2:
FZG step load test A10/16, 6R/120 for relative scuffing load-carrying capacity of high EP oils

1 Scope

This part of ISO 14635 specifies a test method based on an FZG[1)] four-square test machine to determine the relative load-carrying capacity of high EP oils defined by the gear surface damage known as scuffing. This test method is useful for evaluating the scuffing load capacity potential of oils typically used with highly stressed cylindrical gearing found in many vehicle and stationary applications. It is not suitable for establishing the scuffing load capacity potential of oils used in highly loaded hypoid bevel gearing applications, for which purpose other methods are available in the industry.

NOTE This method is technically equivalent to CEC L-84-02.

2 Normative references

The following referenced documents are indispensable for the application 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, *Cylindrical gears — ISO system of accuracy — Part 1: Definitions and allowable values of deviations relevant to corresponding flanks of gear teeth*

ISO 4287, *Geometrical Product Specifications (GPS) — Surface texture: Profile method — Terms, definitions and surface texture parameters*

ISO 4964, *Steel — Hardness conversions*

ISO 5725-2, *Accuracy (trueness and precision) of measurement methods and results — Part 2: Basic method 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*

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

1) FZG = Forschungsstelle für Zahnräder und Getriebebau, Technische Universität München (Gear Research Centre, Technical University, Munich), Boltzmannstraße 15, D-85748 Garching, Germany.

3 Terms and definitions

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

3.1
scuffing
particularly severe form of gear tooth surface damage in which seizure or welding together of areas of tooth surface occur, owing to the absence or breakdown of a lubricant film between the contacting tooth flanks of mating gears, typically caused by high temperature and high pressure

NOTE 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.

3.2
scuffing load-carrying capacity
⟨of a lubricant⟩ maximum load which can be sustained under a defined set of conditions

NOTE It is the minimum load stage at which the failure criteria given in Clause 4 is reached. See Table 1.

3.3
FZG test condition A10/16,6R/120
test condition where A10 is the particular tooth form of the test gears, according to Tables 2 and 3, 16,6 is the speed at the pitch circle, in metres per second, “R” indicates the reverse direction of rotation (wheel drives pinion) and 120 is the initial oil temperature in degrees Celsius, from load stage 4 onward in the oil sump

3.4
failure load stage
load stage reached when the sum of the damage to the 16 pinion teeth exceeds 100 mm^2 in total area damaged

NOTE See Clause 4 and Table 1.

3.5
high EP oils
lubricants containing chemical additives appropriate for improving their scuffing load capacity

NOTE 1 EP = extreme pressure.

NOTE 2 These oils typically exceed the limits of the FZG test according to ISO 14635-1.

4 Failure criteria

Risk of scuffing damage varies with the properties of gear materials, the lubricant used, the surface roughness of tooth flanks, the sliding velocities and the load. Consequences of scuffing include a tendency to high levels of dynamic loading owing to an increase of vibrations, which usually leads to further damage by scuffing, pitting or tooth breakage.

Because of the particular gear design and test loads used, an interference area typically results at the tip of the pinion and root of the mating wheel. This area is usually about 1 mm in length (profile direction) on the pinion and across the entire face width. Examples of various levels of distress occurring with this test are shown in Annex A. The effect of the surface distress in these two regions is addressed as follows.

a) For the purpose of the visual rating for scuffing, the top 1 mm near the tip of the pinion is not included in the assessment until the damage extends below that level. The rated damage region is then expressed as the total area scuffed over all 16 pinion teeth (see Figure 1). The failure load stage is reached when the sum of the damage to the 16 pinion teeth exceeds 100 mm^2 in total area damaged.

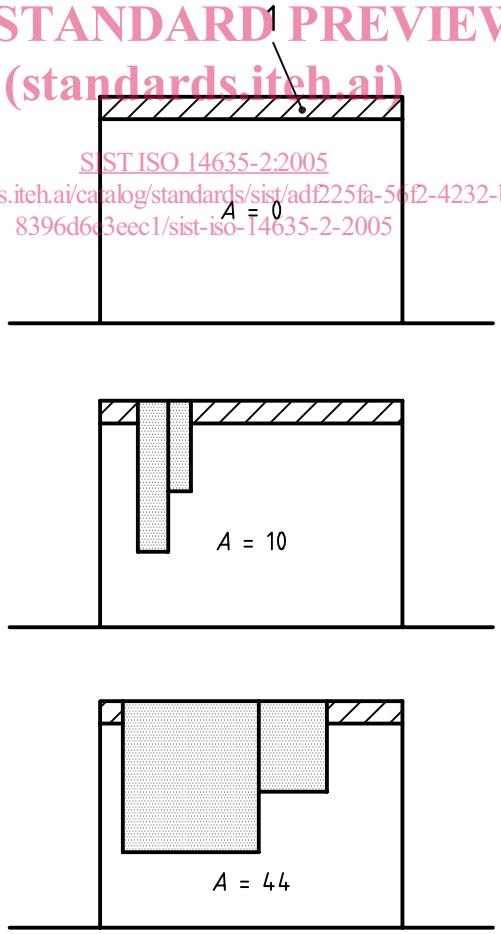
b) For a valid test, the wheel shall be visually checked for signs of excessive wear after each pass load stage, as this could alter the results of the test. If there is evidence of wear in the dedendum of the wheel, then the gear shall be weighed to the nearest milligram (0,001 g) [see Annex A, d)]. The test may be considered valid only if the loss in mass of the wheel is $\leqslant$ 20 mg: if the loss in mass of the wheel exceeds 20 mg, the test shall not be considered valid.

See Table 1.

Table 1 — Test criteria

Pinion failure area A mm^2	**Wheel wear** Δm mg	**Result**
$\leqslant$ 100	$\leqslant$ 20	PASS
$\leqslant$ 100	$>$ 20	INVALID [a]
$>$ 100	Not required	FAIL
[a] No statement on the scuffing load is possible.		

Area in square millimetres



Key

1 exclusion zone (1 mm)

Figure 1 — Schematic of distress rating for pinion