INTERNATIONAL STANDARD

ISO 14104

Second edition
2014-06-01

Corrected version
2014-07-15

Gears — Surface temper etch inspection after grinding, chemical method

Engrenages — Contrôle par attaque chimique des zones surchauffées lors de la rectification

Reference number
ISO 14104:2014(E)

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

Published in Switzerland

Contents

Page

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 on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 60, *Gears*, Subcommittee SC 2, *Gear capacity calculation.*

This second edition cancels and replaces the first edition (ISO 14104:1995), of which it constitutes a technical revision with the following changes:

— use of a grey scale card to qualify varying degrees of surface temper damage;

— inclusion of sample photographs which are intended to provide the user of this International Standard with indications of typical surface temper damage.

This corrected version of ISO 14104:2014 incorporates the following corrections: additional recommendations in 2.5 and 3.5; editorial corrections to Tables 2 and 3; modification of the recommendation on abrasive pads and addition of a related warning in Clause 9.

Introduction

This International Standard explains the materials and procedures necessary to determine, evaluate, and describe localized overheating on ground surfaces. A system to describe and classify the indications produced during this inspection is included. However, specific acceptance or rejection criteria are not contained.

An industry-wide survey was conducted to establish common solutions in time that were acceptable to the greatest number of users. The safety and environmental precautions were included therein for those not familiar with storage, handling, use, and disposal of concentrated acids, alkalis, and solvents. These precautions, however, do not supersede the latest applicable requirements.

Gears — Surface temper etch inspection after grinding, chemical method

1 Scope

This International Standard specifies procedures and requirements for the detection and classification of localized overheating on ground surfaces by chemical etch methods.

The process described in this International Standard is typically used on ground surfaces; however, it is also useful for the detection of surface anomalies that result from post-heat treatment machining such as hard turning, milling, and edge breaking (deburring) processes. Surface metallurgical anomalies caused by carburization or decarburization are also readily detectable with this process.

Some methods which have been used in the past are no longer recommended. Specifications are intended to be changed to use the methods in this International Standard. These etching methods are more sensitive to changes in surface hardness than most hardness testing methods.

This International Standard applies to steel parts such as gears, shafts, splines, and bearings. It is not applicable to nitrided parts and stainless steels. Alternative methods should be considered.

NOTE This process, although at times called "nital etch", is not intended to be confused with other processes also known as "nital etch".

The surface temper etch procedure is to be performed after grinding and before additional finishing operations such as superfinishing, shot peening, and honing.

2 Equipment

2.1 Container materials.

Container materials shall not react with the solutions contained, nor damage the parts to be processed. All containers shall be labelled with the solution contained and covered when not in use. Containers should be labelled according to local regulations.

2.2 Inspection area.

The area to be inspected shall be sufficiently illuminated to be free of shadows and reflections. A minimum light intensity of 2 200 lx (~200 foot candles) at the inspection level is recommended.

2.3 Cleaner.

An alkaline cleaner, vapour degreaser, solvent wash, or equivalent cleaning process shall be used.

2.4 Timing device.

A suitable timing device shall be used for the uniform processing of all parts in a group.

2.5 Grey scale reference.

A suitable grey scale reference should be used, such as Tiffen Color Separation Guide and Gray Scale Q13 (small) or Q14 (large).[1)]

Figure 1 is an example of a suitable grey scale reference. Use of a sample part with known indications to exhibit surface tempering is also recommended.

Figure 1 is an approximate reproduction of a commercially available grey scale. The reproduction shown in this image is not accurate due to variance in graphic reproduction quality and is provided for reference only. It shall not be used for inspection in conformity with this International Standard.

The grey scale card should be replaced at regular intervals.

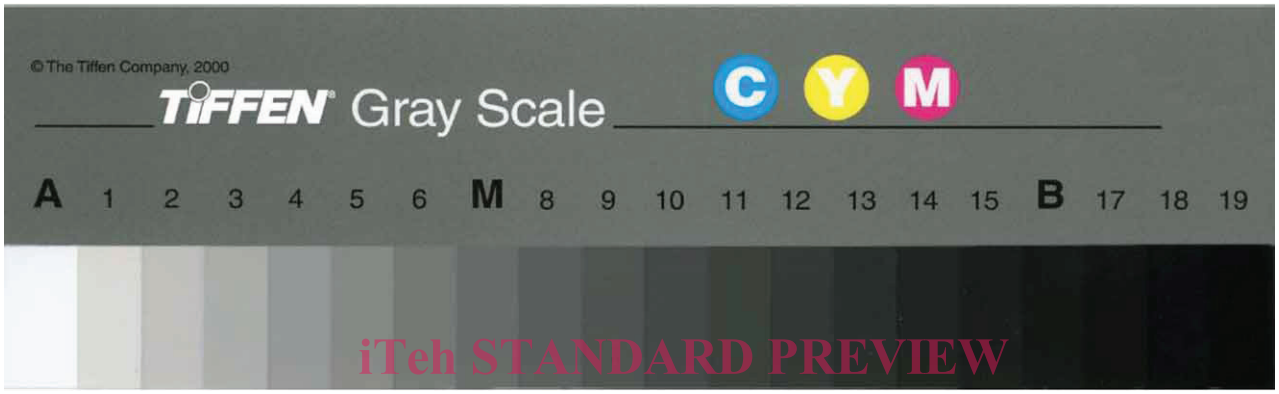

Figure 1 — Gray scale card (reprinted with the permission of The Tiffen Company)

3 Reagents

All chemicals shall be technical grade or better.

3.1 Cleaning materials, which ensure removal of all dirt, grit, grease, and oil, to obtain a "water break"-free surface. A "water break"-free surface is one which maintains a continuous water film for a minimum period of 15 s after having been rinsed in clean water at a temperature below 40 °C.

3.2 Nitric acid.

See Tables 2 and 3.

3.3 Hydrochloric acid.

See Tables 2 and 3.

3.4 Alcohol, methanol or denatured ethanol, clean and free of contaminants such as oil.

3.5 Water, clean and free of contaminants. Distilled water preferred, but not required.

3.6 Alkaline solution, a solution such as 4 % to 6 % sodium hydroxide in water with a minimum pH value of 10, or equivalent.

1) Tiffen Gray Scale is the trade name of a product supplied by Tiffen. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of the product name. Equivalent products may be used if they can be shown to lead to the same results.

3.7 **Rust-preventive oil**, suitable for displacing water, and which does not mask the results of etching.

4 Procedure

4.1 General

As shown in Figure 2, clean the part first (see 4.2 and Table 1) then etch it using one of the procedures shown in either Table 2 or Table 3, whichever is appropriate for the type of steel being inspected. Unless otherwise specified, selection of the specific procedure shall be at the supplier's option.

Table 1 — Examples of cleaning methods

Type of contaminant	Method of cleaning
Dyes and inks	Alcohol, methyl ethyl ketone, or equivalent
Oil and grease	Vapour degreasing
Soaps	Alkaline cleaner (60 °C to 80 °C) or ultrasonic cleaner

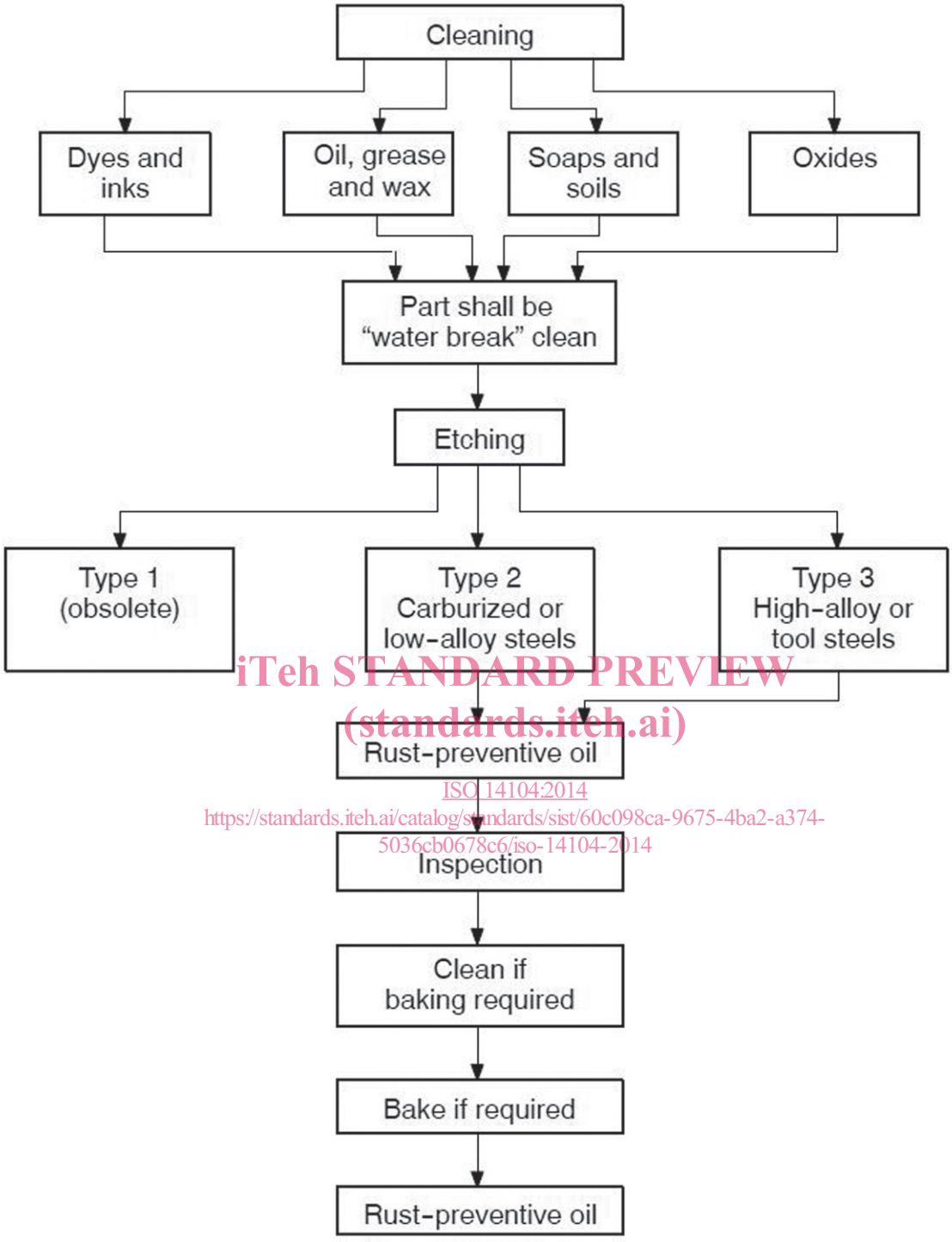

Figure 2 — Procedure flow chart

4.2 Cleaning

Proper cleaning is mandatory for parts to be etched and inspected. Satisfactory cleaning will be evidenced by the absence of "water breaks" on the clean parts after immersion in water. The cleaning procedure shall be chosen by the supplier. The exact method depends on the type of contaminant present. Table 1 lists contaminants and corresponding methods of cleaning in common use.

Additional processes can be required to remove residues from the parts prior to etching. Thorough cleaning of parts prior to etching is imperative in order to obtain good results. Improper cleaning will

result in non-uniform discoloration and staining which can lead to difficult interpretation of etching results. A typical (recommended) cleaning procedure consists of:

— vapour degreasing or solvent cleaning;

— abrasive cleaning: select particle size, media, and blasting procedure to maintain surface finish and dimensions; avoid damage and handle parts with clean white gloves;

— alkaline or ultrasonic clean;

— rinsing in water and examining for water breaks after cleaning. If water break occurs, reclean and re-examine for water break until water break free.

Table 2 — Type 2 etching

Step[a]	Process	Solution[b]	Recommended time[c]	Remarks
1	Nitric acid etch[d] Grey scale Tank 7(M) to 11, Swab 7(M) to 15	Nitric acid, 1,5 % to 5 % (by volume): — in alcohol — in water	 30 s to 60 s 10 s to 30 s	Exact time to develop black oxide film will vary; time should be established and reproduced.
2	Rinse	Water	As required	Removes acid
3	Alcohol dip[e]	Alcohol	Dip	Removes water
4	Bleach[d] Grey scale Tank 6 to 10, Swab 2 to 10	Hydrochloric acid, 2 % to 6 % (by volume): — in alcohol — in water	30 s to 60 s	Part should be immersed for a sufficient time to cause a uniform brownish-grey colour on the part; exact bleaching time should be established by test and reproduced.
5	Rinse	Water	As required	Removes acid
6	Neutralize	Alkali solution with pH of 10 minimum	10 s to 60 s	Agitate parts while immersed.
7	Rinse	Water	As required	Removes caustic solvents
8	Dry[fg]	Alcohol or hot water	Dip and dry	Removes water
9	Oil	Rust-preventive	As required	Prevents corrosion and aids in colour contrast

a Uniform agitation of the parts while immersed in the respective baths and rinses is required to avoid a spotty etching condition as well as to accomplish complete neutralization. Multiple rinses can be used in steps 2, 5, and 7.

b All solutions are used at ambient temperature.

c It is permissible to deviate from these recommended times.

d Areas with close tolerances which do not require surface temper etch inspection should be suitably masked to avoid damage and stock removal. Approximately 0,003 mm of stock per surface is removed by etching each time this process is performed.

e Step 3 is optional if step 1 is acid in alcohol.

f Typical procedures include alcohol dip or hot water rinse at 65 °C minimum, followed by contaminant-free air blast.

g Step 8 is not mandatory if in step 9 a water-displacing oil is used.

