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Tool-life testing with single-point turning tools

Essais de durée de vie des outils de tournage à partie active unique

Reference number
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Contents

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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.

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.

International Standard ISO 3685 was prepared by Technical Committee ISO/TC 29, *Small tools*.

This second edition cancels and replaces the first edition (ISO 3685:1977), of which it constitutes a technical revision.

Annexes A, B, C, D, E, F and G form an integral part of this International Standard. Annex H is for information only.

Introduction

The adoption by both industry and testing bodies of the recommendations contained in ISO 3685:1977 created a demand for the publication of similar recommendations for other commonly used cutting processes.

Tool-life testing in milling is covered in ISO 8688-1:1989 and ISO 8688-2:1989. During the final stages of their preparation, it was recognized that there was a need to update the recommendations for single-point turning tools.

This International Standard contains recommendations which are applicable in both laboratories and manufacturing units. These recommendations are intended to unify procedures in order to increase reliability and comparability of test results when making comparisons of cutting tools, work materials, cutting parameters or cutting fluids. In order to come as close as possible to these aims, recommended reference materials and conditions are included and should be used as far as is practical.

In addition, the recommendations can be used to assist in finding recommended cutting data or to determine limiting factors and machining characteristics such as cutting forces, machined surface characteristics, chip form etc. For these purposes in particular, certain parameters, which have been given recommended values, may have to be used as variables.

The test conditions recommended in this International Standard have been designed for turning tests using steel and cast iron workpieces of normal microstructure, with solid high-speed steel tools or tools with cemented carbide or ceramic indexable inserts. However, with suitable modifications, this International Standard can be applied, for example, to turning tests on other work materials or with cutting tools developed for specific applications.

The specified accuracy given in the recommendations should be considered as a minimum requirement. Any deviation from the recommendations should be indicated in detail in the test report.

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Tool-life testing with single-point turning tools

1 Scope

This International Standard specifies recommended procedures for tool-life testing with high-speed steel, cemented carbide and ceramic single-point turning tools used for turning steel and cast iron workpieces. It can be applied in laboratory testing as well as in production practice.

In turning, cutting conditions may be considered under two categories:

a) conditions as a result of which tool deterioration is due predominantly to wear;

b) conditions under which tool deterioration is due mainly to other phenomena such as edge fracture or plastic deformation.

This International Standard is solely concerned with recommendations for testing which results predominantly in tool wear.

Testing for the second category of conditions above is to be subject to further study.

This International Standard establishes specifications for the following factors of tool-life testing with single-point turning tools: workpiece, tools, cutting fluid, cutting conditions, equipment, assessment of tool deterioration and tool life, test procedures and the recording, evaluation and presentation of results.

Further general information is given in annex A.

NOTE 1 This International Standard does not constitute an acceptance test and should not be used as such.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 185:1988, *Grey cast iron — Classification.*

ISO 229:1973, *Machine tools — Speeds and feeds.*

ISO 468:1982, *Surface roughness — Parameters, their values and general rules for specifying requirements.*

ISO 513:1991, *Application of hard cutting materials for machining by chip removal — Designation of the main groups of chip removal and groups of application.*

ISO 683-1:1987, *Heat-treatable steels, alloy steels and free-cutting steels — Part 1: Direct-hardening unalloyed and low-alloyed wrought steel in form of different black products.*

ISO 841:1974, *Numerical control of machines — Axis and motion nomenclature.*

ISO 883:1985, *Indexable hardmetal (carbide) inserts with rounded corners, without fixing hole — Dimensions.*

ISO 1940-1:1986, *Mechanical vibration — Balance quality requirements of rigid rotors — Part 1: Determination of permissible residual unbalance.*

ISO 2540:1973, *Centre drills for centre holes with protecting chamfer — Type B.*

ISO 3002-1:1982, *Basic quantities in cutting and grinding — Part 1: Geometry of the active part of cutting tools — General terms, reference systems, tool and working angles, chip breakers.*

ISO 4957:1980, *Tool steels.*

ISO 5610:1989, *Single-point tool holders for turning and copying, for indexable inserts — Dimensions.*

ISO 9361-1:1991, *Indexable inserts for cutting tools — Ceramic inserts with rounded corners — Part 1: Dimensions of inserts without fixing hole.*

ISO 9361-2:1991, *Indexable inserts for cutting tools — Ceramic inserts with rounded corners — Part 2: Dimensions of inserts with cylindrical fixing hole.*

3 Definitions

For the purposes of this International Standard, the following definitions apply.

3.1 tool wear: The change of shape of the tool from its original shape, during cutting, resulting from the gradual loss of tool material or deformation.

3.2 tool wear measure: A dimension to be measured to indicate the amount of tool wear.

3.3 tool-life criterion: A predetermined threshold value of a tool wear measure or the occurrence of a phenomenon.

3.4 tool life: The cutting time required to reach a tool-life criterion.

4 Workpiece

4.1 Work material

In principle, testing bodies are free to select the work materials according to their own interests. However, in order to increase the comparability of results between testing bodies, the use of one of the reference materials, steel C 45 in accordance with ISO 683-1 or cast iron grade 25 in accordance with ISO 185, is recommended. Detailed specifications of these materials are given in annex B. Within these specifications, materials may vary with a resulting effect on machinability. To minimize such problems the provision of a closer specified work material should be discussed with the supplier.

It is recommended that information concerning the work material such as grade, chemical composition, physical properties, microstructure, hardness, complete details of the processing route of the work material (e.g. hot rolled, forged, cast or cold drawn) and any heat treatment be given in the test report (see 4.2 and annex B).

In order to be able to compare results over reasonably long periods of time, it is recommended that testing bodies procure sufficiently large quantities of reference work material to cover their long term needs.

4.2 Standard conditions for the workpiece

All mill scale or casting skin shall be removed by clean-up cuts before testing, except when the effect of the scale is being tested.

The plastic formed surface of the shoulder, i.e. "the transient surface", and any other burnished or abnormally work-hardened surface on the workpiece which can come in contact with the test tool shall be removed with a sharp clean-up tool prior to testing in order to reduce as much as possible the residual sub-surface deformations due to the previous test. However, this does not include removal of the normally work-hardened surface on the test bar produced by the previous passes of the tool.

The length/diameter ratio of the workpiece shall be not more than the minimum ratio at which chatter occurs. The test shall be stopped when chatter occurs. A length/diameter ratio greater than 10 is not recommended.

The hardness of the work material shall be determined over the complete cross-section of one end of each test bar or tube.

Where hardness variations are expected to be significant, measurements shall be taken to ascertain that values fall within the prescribed limits.

The locations of measurement points and the method of measurement should be noted in the test report. It is recommended that the deviation within one batch of material be as small as possible. A realistic hardness value for the reference materials and similar materials is $\pm$ 5 % of the mean value.

The cutting test shall be conducted only in the range of diameters where the hardness lies within the limits given by the original hardness specification.

Quantitative metallography (as regards microstructure, grain size, inclusion count, etc.) of the work material is recommended but when this is not practical, photomicrographs shall be included in the test report. The magnification shall be in the range × 100 to × 500.

In machining tests carried out on production components, the fixing devices normally employed in the process shall be utilized.

The chuck and the spindle shall be stable and well balanced (for a method of evaluating the balance, see ISO 1940-1). When fixing the workpiece between a chuck or a faceplate and a centre, special care shall be taken to prevent any bending loads on the workpiece.

For diameters above 90 mm, the use of a faceplate is recommended.