AS 2197—1978

Australian Standard

MICROGRAPHIC ASSESSMENT OF THE NON-METALLIC INCLUSION CONTENT IN WROUGHT STEEL

The following scientific, industrial and governmental organizations and departments were officially represented on the committee entrusted with the preparation of this standard:

Bureau of Steel Manufacturers of Australia
Commonwealth Aircraft Corporation
Confederation of Australian Industry
Department of Defence
Federated Chamber of Automotive Industries
Institute of Steel Service Centres of Australia
Metal Trades Industry Association of Australia
Railways of Australia Committee
Society of Automotive Engineers— Australia
Telecom Australia
University of New South Wales (School of Metallurgy)

This standard, prepared by Committee MT/18, Metallography, was approved by the Metals Standards Board on behalf of the Council of the Standards Association of Australia on 31 May 1978, and was published on 1 November 1978.

This standard was issued in draft form for public review as DR 76060.

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METHOD FOR THE MICROGRAPHIC ASSESSMENT OF THE NON-METALLIC INCLUSION CONTENT IN WROUGHT STEEL

First published 1978

PUBLISHED BY STANDARDS AUSTRALIA
(STANDARDS ASSOCIATION OF AUSTRALIA)
1 THE CRESCENT, HOMEBUSH, NSW 2140

ISBN 0 7262 1526 0

PREFACE

This standard was prepared by the Association's Committee on Metallography to provide a method for the micrographic assessment of the non-metallic inclusion in wrought steel products by comparison with standard diagrams.

The method specified is in general agreement with ISO 4976*, but deviates in regard to sampling and the rating number system. The committee considered the practicability of including the standard sectioning of bars during the sampling process as given in ISO 4967, but decided against its inclusion, since it was considered impractical because of variations in the cross-sectional microstructure of wrought steel. In regard to the rating number system, classification '0' has been introduced to cover fields of observation where no inclusions of a particular class are observed and classification '6' to cover inclusions greater than 5. In addition, the requirement for examination of each polished test piece has been reduced from 100 fields to 30 fields in order to reduce the time involved in performing a test.

Attention is drawn to Appendix B, Jernkontoret and ASTM Standard Diagrams, and it is emphasized that there is no direct comparison between Plate 1 (Jernkontoret) and Plate 2 (ASTM).

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* ISO 4967 Steel — Determination of Content of Non-metallic Inclusions — Micrographic Method using Standard Diagrams.

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METHOD FOR THE MICROGRAPHIC ASSESSMENT OF THE NON-METALLIC INCLUSION CONTENT IN WROUGHT STEEL

FOREWORD

The method of comparison of micrographic images with standard diagrams may result in significantly different inclusion content being reported from operator to operator. Results obtained by the method outlined in this standard should therefore only be considered as semi-quantitative. It should be noted that the results obtained are not directly related to those obtained by quantitative methods such as chemical analysis which is often used for oxygen and sulphur contents to give a measure of the oxide and/or sulphur content present.

Other methods available which give quantitative results include manual point or line counting, and automatic scanning methods.

METHOD

1 SCOPE. This standard describes a method for the micrographic assessment of the non-metallic inclusion content in wrought steel products by comparison with standard diagrams.

NOTES:
1. This standard does not set limits for the inclusion content of steels. These limits are normally specified in the product specification or determined by agreement.
2. Supplementary information necessary to complete the method is set out in Appendix A.

2 DEFINITION. For the purpose of this standard the following definition applies:

Non-metallic inclusion—non-metallic compounds and mixtures in steel resulting from the entrapment of deoxidation products or exogenous materials, such as refractories and hot topping compounds, or from the precipitation of sulphides prior to, or during, solidification.

NOTE: Inclusion type, shape, size and distribution will vary greatly depending on the grade of steel, method of deoxidation, size and shape of the ingot, amount of reduction received, and the position in the ingot from which the sample is taken.

3 PRINCIPLE. Inclusions in longitudinal sections in rolled or forged steels are assessed by comparison with magnified images of polished test pieces with standard diagrams which form the Jernkontoret chart (or JK chart).

These diagrams correspond to fields of view of 0.8 mm taken from a longitudinal section and observed at a magnification of 100 ×. According to the shape and distribution of the inclusions, the standard diagrams are divided into four main groups, bearing references A, B, C and D. The method of designation is based on the morphology of the inclusion and not on the constitution of the inclusion as follows:

Group A . . . . . sulphide type
Group B . . . . . alumina type
Group C . . . . . silicate type
Group D . . . . . globular oxide type

NOTE: Each main group on the JK chart consists of two sub-groups, each made up of five diagrams representing increasing contents of inclusions. These divisions into sub-groups are merely intended to give examples of different thicknesses of non-metallic particles.

The diagrams on the JK chart are given in Appendix B. Plate I is taken from the Jernkontoret method and Plate II from ASTM.

Results from the use of Plate I should not be compared directly with those obtained from Plate II. These diagrams are numbered 1 to 5 in Plate I and 0.5 to 2.5 in Plate II, the numbers increasing with the surface area of inclusions, e.g. diagram A2 indicates the shape of the inclusions observed under the microscope is in accordance with Group A and that their distribution and quantity is in accordance with number 2.

4 PREPARATION OF TEST PIECES. To enable inclusions to be observed in the longitudinal direction of working, wrought steel products are to be sectioned in such a manner that the surface of test pieces examined shall be at right angles to the worked face and parallel to the direction of greatest elongation.

During the preparation of a test piece every care shall be taken to avoid the tearing out or deformation of inclusions, contamination of the polished surface, or rounding of the edges.

Unless otherwise specified, test pieces shall be selected from locations which are relevant to the application of the products and be of a size so as to permit a polished face having an area of not less than 200 mm^2 .

NOTES:
1. For the assessment of a product which has received a large reduction during processing, e.g. strips, it may be necessary to take several test pieces from adjacent locations as a single test.
2. Where applicable, and by agreement, several ingots or several bars and billets from one heat may be examined to obtain an average field rating for that heat of steel.
3. When a rating is required to represent a large batch of steel from an ingot or a heat it is preferable to record a few fields on a large number of test pieces rather than a large number of fields on a few test pieces. In such cases, it is preferable to assess the 'worst field rating' (see Clause 6.1).

5 PROCEDURE. The entire polished surface shall be examined in the unetched condition using a magnification of 100 × and an actual field diameter of 0.8 mm. Any error in the magnification and in