



Standard Test Method for Nonmetallic Inclusion Level of Powder Forged (P/F) Steel Parts¹

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1. Scope

1.1 This test method covers a recognized metallographic method for determining the nonmetallic inclusion level of powder forged steel parts.

1.2 This test method also may be used to determine the nonmetallic inclusion content of powders intended for powder forging applications after they have been consolidated in a prescribed manner so that the core region where the assessment is to be carried out contains no porosity.

1.3 This test method is not suitable for determining the nonmetallic inclusion level of powder forged parts that have been forged such that the core region contains porosity or of those parts that contain additions of manganese sulphide. At the magnification used for this test method residual porosity is hard to distinguish from oxide inclusions. Too much residual porosity makes a meaningful assessment of the inclusion population impossible.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

E 3 Methods for Preparation of Metallographic Specimens²

E 768 Practice for Preparing and Evaluating Specimens for Automatic Inclusion Assessment of Steel²

3. Summary of Test Method

3.1 A section representing the core region of the part is cut from the powder forged part and mounted for metallographic grinding and polishing.

3.2 The polished sample is examined microscopically at a magnification of 100X and a note made of inclusions larger than a predetermined size.

3.3 The maximum Feret's diameter is used to determine inclusion size. A Feret's diameter is a caliper diameter as illustrated in Fig. 1.

¹ This test method is under the jurisdiction of ASTM Committee B-9 on Metal Powders and Metal Powder Products and is the direct responsibility of Subcommittee B09.11 on Near Full Density Powder Metallurgy Parts.

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² *Annual Book of ASTM Standards*, Vol 03.01.

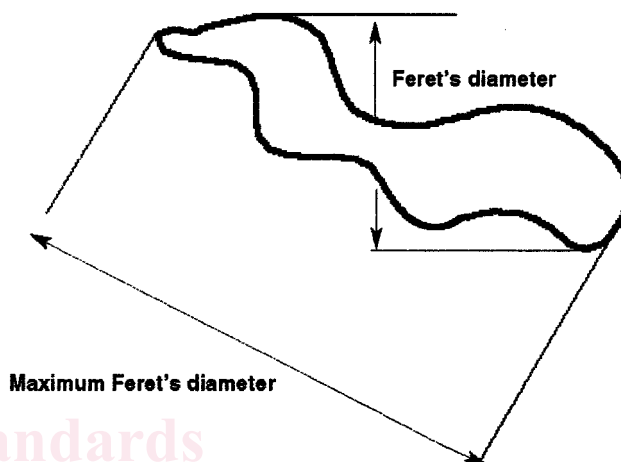


FIG. 1 Schematic illustration of Feret's diameter.

3.4 The fragmented nature of some inclusions means that their size determination is somewhat complicated. The concept of near neighbour separation is used in determining inclusion size. If an inclusion is within a certain distance of its neighbouring particles, it is considered a member of an inclusion cluster or agglomerate. Detected features within 30 μm of one another are considered part of the same inclusion. The concept is illustrated schematically in Fig. 2.

3.5 The nonmetallic inclusion level of the part is reported as the number of inclusions per 100 mm^2 greater than or equal to the predetermined size.

4. Significance and Use

4.1 The extensive porosity present in pressed and sintered ferrous materials masks the effect of inclusions on mechanical properties. In contrast, the properties of material powder forged to near full density are strongly influenced by the composition, size, size distribution, and location of nonmetallic inclusions.

4.2 The test for nonmetallic inclusions in powder forged steel parts is useful as the following:

4.2.1 Characteristic to classify or differentiate one grade of powder forged parts from another.

4.2.2 Means of quality comparison of powder forged parts, lot to lot.

4.3 Significant variations in nonmetallic inclusion content will occur if:

4.3.1 The powder used to form the parts does not meet