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SURFACE VEHICLE RECOMMENDED PRACTICE

An American National Standard

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Methods of Measuring Case Depth

Foreword—This Document has not changed other than to put it into the new SAE Technical Standards Board Format. References were added as Section 2. Definitions were changed to Section 3. All other section numbers have changed accordingly.

1. Scope—Case hardening may be defined as a process for hardening a ferrous material in such a manner that the surface layer, known as the case, is substantially harder than the remaining material, known as the core. The process embraces carburizing, nitriding, carbonitriding, cyaniding, induction, and flame hardening. In every instance, chemical composition, mechanical properties, or both are affected by such practice.

This testing procedure describes various methods for measuring the depth to which change has been made in either chemical composition or mechanical properties. Each procedure has its own area of application established through proved practice, and no single method is advocated for all purposes.

Methods employed for determining the depth of case are either chemical, mechanical, or visual, and the specimens or parts may be subjected to the described test either in the soft or hardened condition. The measured case depth may then be reported as either effective or total case depth on hardened specimens, and as total case depth on unhardened specimens.

It should be recognized that the relationship between case depths as determined by the different methods can vary extensively. Factors affecting this relationship include case characteristics, parent steel composition, quenching conditions, and others. It is not possible to predict, in some instances for example, effective case depth by chemical or visual means. It is important, therefore, that the method of case depth determination be carefully selected on the basis of specific requirements, consistent with economy.

2. References

2.1 Applicable Publication—The following publication forms a part of the specification to the extent specified herein. Unless otherwise indicated the latest revision of SAE publications shall apply.

2.1.1 ASM INTERNATIONAL PUBLICATION—Available from: ATTN: MSC/Book Order, ASM International, PO Box 473, Novelty, OH 44072-9901.

"The Application of M_S Points to Case Depth Measurement," by E. S. Rowland and S. R. Lyle, ASM Transactions, Vol. 37 (1946) pp. 26–47.

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3. Definitions

3.1 Effective Case Depth—The perpendicular distance from the surface of a hardened case to the furthest point where a specified level of hardness is maintained. The hardness criterion is 50 HRC normally, but see Table 1 under 5.1.

Effective case depth should always be determined on the part itself, or on samples or specimens having a heat-treated condition representative of the part under consideration.

3.2 Total Case Depth—The distance (measured perpendicularly) from the surface of the hardened or unhardened case to a point where differences in chemical or physical properties of the case and core no longer can be distinguished.

4. Chemical Methods

4.1 General—This method is generally applicable only to carburized cases, but may be used for cyanided or carbonitrided cases. The procedure consists in determining the carbon content (and nitrogen when applicable) at various depths below the surface of a test specimen. This method is considered the most accurate for measuring total case depth on carburized cases.

4.2 Procedure for Carburized Cases—Test specimens shall normally be of the same grade of steel as parts being carburized. Test specimens may be actual parts, rings, or bars and should be straight or otherwise suitable for accurate machining of surface layers into chips for subsequent carbon analysis.

Test specimens shall be carburized with parts or in a manner representative of the procedure to be used for parts in question. Care should be exercised to avoid distortion and decarburization in cooling test specimens after carburizing. In cases where parts and test specimens are quenched after carburizing, such specimens should be tempered at approximately 600 to 650 °C (1100 to 1200 °F) and straightened to 0.04 mm (0.0015 in) max total indicator reading (TIR) before machining is attempted. The time at temperature should be minimized to avoid excessive carbon diffusion.

Test specimens must have clean surfaces and shall be machined dry in increments of predetermined depth. The analysis of machined chips will then accurately reveal the depth of carbon penetration. Chosen increments usually vary between 0.05 and 0.25 mm (0.002 and 0.010 in) depending upon the accuracy desired and expected depth of case.

Chips from each increment shall be kept separate and analyzed individually for carbon content by an accepted method. Total case depth is considered to be the distance from the surface equivalent to the depth of the last increment of machining whose chips analyze to a carbon content 0.04% higher than that of the established carbon content of the core.

Specialized electron microprobe analyses on carefully prepared cross-sections represent an alternate procedure with potentially greater accuracy and speed, and is recommended when equipment is available.

5. Mechanical Methods

5.1 General—This method is considered to be one of the most useful and accurate of the case depth measuring methods. It can be effectively used on all types of hardened cases, and is the preferred method for determination of effective case depth. The use of this method requires the obtaining and recording of hardness values at known intervals through the case. For determination of effective case depth, the 50 HRC criterion is generally used. The sample or part is considered to be through hardened when the hardness level does not drop below the effective case depth hardness value. In some instances involving flame and induction hardened cases, it is desirable to use a lower hardness criterion. Suggested hardness levels are tabulated in Table 1 for various nominal carbon levels.