Designation: D6710 – 21

Standard Guide for Evaluation of Hydrocarbon-Based Quench Oil[1]

This standard is issued under the fixed designation D6710; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This guide covers information without specific limits, for selecting standard test methods for testing hydrocarbon-based quench oils for quality and aging.

1.2 The values stated in SI units are to be regarded as standard.

1.2.1 *Exception*—The units given in parentheses are for information only.

1.3 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D91 Test Method for Precipitation Number of Lubricating Oils

D92 Test Method for Flash and Fire Points by Cleveland Open Cup Tester

D94 Test Methods for Saponification Number of Petroleum Products

D95 Test Method for Water in Petroleum Products and Bituminous Materials by Distillation

D189 Test Method for Conradson Carbon Residue of Petroleum Products

D445 Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)

D482 Test Method for Ash from Petroleum Products

D524 Test Method for Ramsbottom Carbon Residue of Petroleum Products

D664 Test Method for Acid Number of Petroleum Products by Potentiometric Titration

D974 Test Method for Acid and Base Number by Color-Indicator Titration

D1298 Test Method for Density, Relative Density, or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method

D4052 Test Method for Density, Relative Density, and API Gravity of Liquids by Digital Density Meter

D4175 Terminology Relating to Petroleum Products, Liquid Fuels, and Lubricants

D4530 Test Method for Determination of Carbon Residue (Micro Method)

D6200 Test Method for Determination of Cooling Characteristics of Quench Oils by Cooling Curve Analysis

D6304 Test Method for Determination of Water in Petroleum Products, Lubricating Oils, and Additives by Coulometric Karl Fischer Titration

D7042 Test Method for Dynamic Viscosity and Density of Liquids by Stabinger Viscometer (and the Calculation of Kinematic Viscosity)

2.2 *ISO Standards:*[3]

ISO 9950 Industrial Quenching Oils—Determination of Cooling Characteristics—Nickel-Alloy Probe Test Method, 1995-95-01

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 For definitions of terms used in this guide, refer to Terminology D4175.

[1] This guide is under the jurisdiction of ASTM Committee D02 on Petroleum Products, Liquid Fuels, and Lubricants and is the direct responsibility of Subcommittee D02.L0.06 on Non-Lubricating Process Fluids.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

*A Summary of Changes section appears at the end of this standard

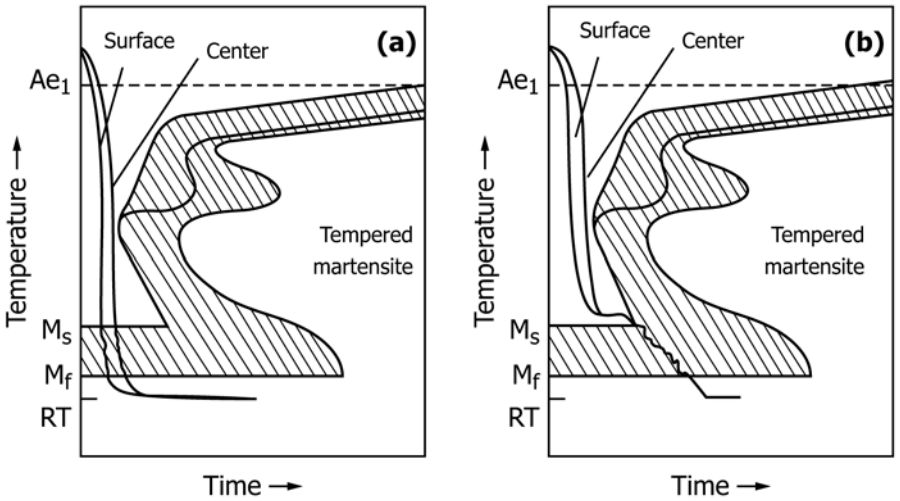

FIG. 1 (a) Conventional Quenching Cycle; (b) Martempering

Quench Processing

3.1.2 *austenitization, n*—heating a steel containing less than the eutectoid concentration of carbon (about 0.8 % by mass) to a temperature just above the eutectoid temperature to decompose the pearlite microstructure to produce a face-centered cubic (fcc) austenite-ferrite mixture.

3.1.3 *dragout, n*—solution carried out of a bath on the metal being quenched and associated handling equipment.

3.1.4 *martempering, n*—cooling steel from the austenitization temperature to a temperature just above the start of mertensite transformation (M_s) for a time sufficient for the temperature to equalize between the surface and the center of the steel, at which point the steel is removed from the quench bath and air cooled as shown in Fig. 1 (**1**).[4]

3.1.5 *protective atmosphere, n*—any atmosphere that will inhibit oxidation of the metal surface during austenitization, or it may be used to protect the quenching oil, which may be an inert gas such as nitrogen or argon or a gas used for a heat-treating furnace.

3.1.6 *quench media, n*—any medium, either liquid (water, oil, molten salt, or lead, aqueous solutions of water-soluble polymers or salt-brines) or gas or combinations of liquid and gas (air at atmospheric pressure, or pressurized nitrogen, helium, hydrogen) such as air-water spray, used to facilitate the cooling of metal in such a way as to achieve the desired physical properties or microstructure.

3.1.7 *quench severity, n*—the ability of a quenching oil to extract heat from a hot metal traditionally defined by the quenching speed (cooling rate) at 1300 °F (705 °C) which was related to a Grossmann H-Value or Quench Severity Factor (H-Factor) (**2**).

3.1.8 *quenching, n*—cooling process from a suitable elevated temperature used to facilitate the formation of the desired microstructure and properties of a metal as shown in Fig. 2.

3.1.9 *transformation temperature, n*—characteristic temperatures that are important in the formation of martensitic microstructure as illustrated in Fig. 2; A_e – equilibrium austenitization phase change temperature; M_s – temperature at which transformation of austenite to martensite starts during cooling; and M_f – temperature at which transformation of austenite to martensite is completed during cooling.

Cooling Mechanisms

3.1.10 *convective cooling, n*—after continued cooling, the interfacial temperature between the cooling metal surface and the quenching oil will be less than the boiling point of the oil, at which point cooling occurs by a convective cooling process as illustrated in Fig. 3.

3.1.11 *full-film boiling, n*—upon initial immersion of hot steel into a quench oil, a vapor blanket surrounds the metal surface as shown in Fig. 3. This is full-film boiling also commonly called vapor blanket cooling.

3.1.12 *Leidenfrost temperature, n*—the characteristic temperature where the transition from full-film boiling (vapor blanket cooling) to nucleate boiling occurs which is independent of the initial temperature of the metal being quenched as illustrated in Fig. 4 (**3**).

3.1.13 *nucleate boiling, n*—upon continued cooling, the vapor blanket that initially forms around the hot metal collapses and a nucleate boiling process, the fastest cooling portion of the quenching process, occurs as illustrated in Fig. 3.

3.1.14 *vapor blanket cooling, n*—See *full-film boiling* (3.1.11).

3.1.15 *wettability, n*—when a heated metal, such as the probe illustrated in Fig. 5, is immersed into a quenching medium, the cooling process shown in Fig. 6 occurs by initial vapor blanket formation followed by collapse, at which point the metal surface is wetted by the quenching medium (**4**).

Quench Oil Classification

3.1.16 *accelerated quenching oil, n*—also referred to as a fast or high-speed oil, these are oils that contain additions that

[4] The boldface numbers in parentheses refer to the list of references at the end of this standard.