



Standard Test Method for Determination of Cooling Characteristics of Quench Oils by Cooling Curve Analysis¹

This standard is issued under the fixed designation D 6200; 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 test method describes the equipment and the procedure for evaluation of a quenching oil's quenching characteristics by cooling rate determination.

1.2 This test is designed to evaluate quenching oils in a non-agitated system. There is no correlation between these test results and the results obtained in agitated systems.

1.3 The values in SI units are to be regarded as the standard. The values in parenthesis are provided for information only.

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:

D 1744 Test Method for Water in Liquid Petroleum Products by Karl Fischer Reagent²

E 220 Test Method for Calibration of Thermocouples by Comparison Techniques³

E 230 Specification for Temperature-Electromotive Force (EMF) Tables for Standardized Thermocouples³

2.2 SAE Standards:⁴

AMS 5665 Nickel Alloy Corrosion and Heat Resistant Bars, Forgings and Rings

2.3 Japanese Industrial Standards (JIS):⁵

JIS K 2242 - 1980 Heat Treating Oil

JIS K 6753 - 1977 Di-2-ethylhexyl Phthalate

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

¹ This test method is under the jurisdiction of ASTM Committee D02 on Petroleum Products and Lubricants and is the direct responsibility of Subcommittee D02.L0.06 on Nonlubricating Fluids.

Current edition approved Apr. 10, 2000. Published June 2000. Originally published as D 6200 – 97. Last previous edition D 6200 – 97.

² *Annual Book of ASTM Standards*, Vol 05.01.

³ *Annual Book of ASTM Standards*, Vol 14.03.

⁴ Available from Society of Automotive Engineers, International, 400 Commonwealth Dr., Warrendale, PA 15096-0001.

⁵ Available from Japanese Standards Association, 1 - 24, Akasaka 4, Minato - ku, Tokyo 107 Japan.

3.1.1 *cooling curve*—The cooling curve is a graphical representation of the cooling time (t) - temperature (T) response of the probe (see 7.3). An example is illustrated in Part B of Fig. 1.

3.1.2 *cooling curve analysis*—the process of quantifying the cooling characteristics of a heat treating oil based on the temperature versus time profile obtained by cooling a pre-heated metal probe assembly (see Fig. 2) under standard conditions.

3.1.3 *cooling rate curve*—The cooling rate curve is obtained by calculating the first derivative (dT/dt) of the cooling time - temperature curve. An example is illustrated in Part B of Fig. 1.

3.1.4 *heat treating oil*—a hydrocarbon containing product, often derived from petroleum base stock, that is used to mediate heat transfer between heated metal, such as austenitized steel, to control the microstructure that is formed upon cooling and also control distortion and minimize cracking which may accompany the cooling process.

3.1.5 *quench severity*—the ability of a quenching medium to extract heat from a hot metal.⁶

4. Summary of Test Method

4.1 Determine the nickel alloy probe assembly's cooling time versus temperature after placing the assembly in a furnace and heating to 850°C (1562°F) and then quenching in a heat treating oil. The temperature inside the probe assembly and the cooling times are recorded at selected time intervals to establish a cooling temperature versus time curve. The resulting cooling curve may be used to evaluate quench severity (see Note 1).

NOTE 1—For production testing, the furnace temperature of 815 to 857°C (1500 to 1575°F) may be used.

5. Significance and Use

5.1 This test method provides a cooling time versus temperature pathway which is directly proportional to physical properties such as the hardness obtainable upon quenching of a metal. The results obtained by this test may be used as a guide in heat treating oil selection or comparison of quench severities

⁶ Boyer, H.E. and Cary, P.R., *Quenching and Distortion Control*, ASM International, Materials Park, OH, 1988, p. 162.

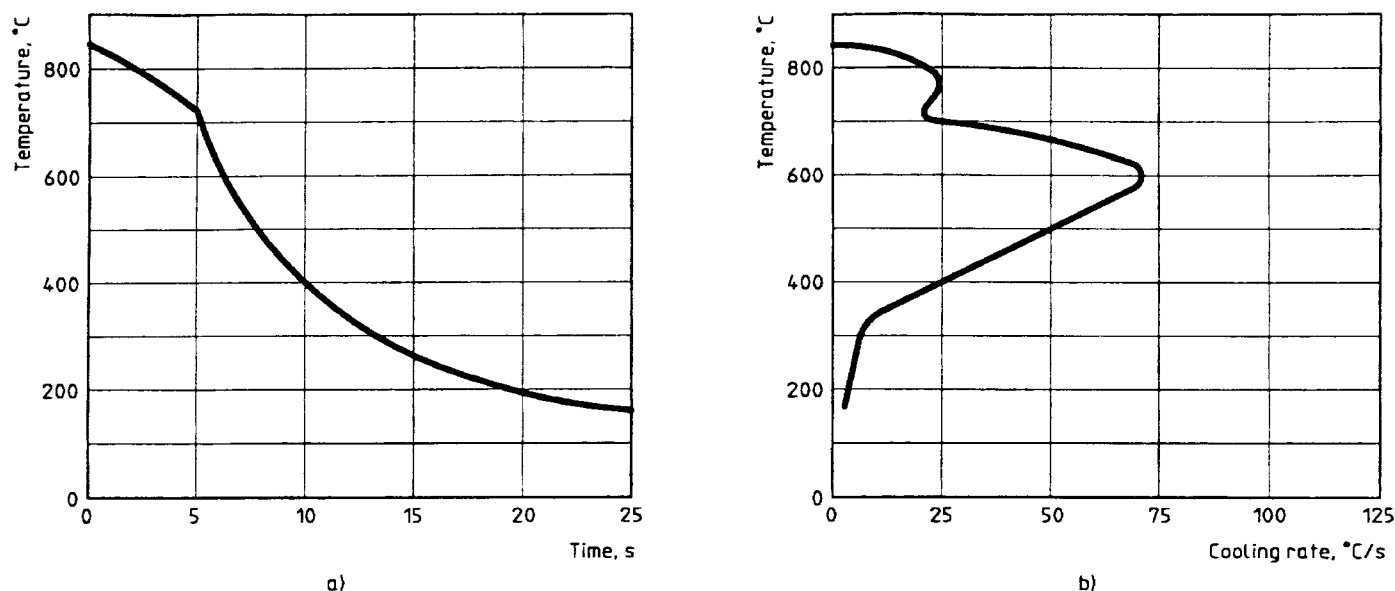
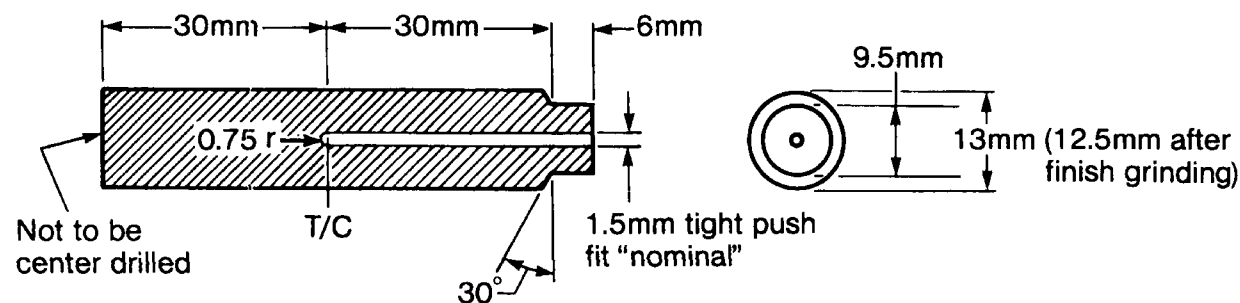
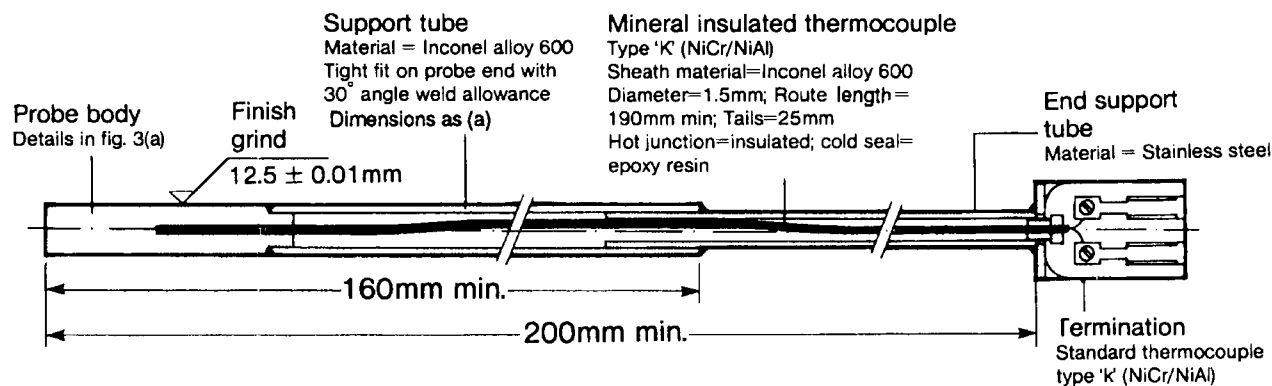
 D 6200


FIG. 1 Typical Temperature/Time and Temperature/Cooling Rate Plots For Test Probe Cooled in a Quenching Oil



(a) Probe details



(b) General assembly

FIG. 2 Probe Details and General Probe Assembly

of different heat treating oils, new or used.

6. Interferences

6.1 The presence of water in a heat treating oil has a major effect upon the results obtained with this test method. Water content of calibration fluids shall be confirmed by Test Method D 1744. If water is present above 0.01 %, the calibration fluid

shall be dried at a minimum temperature of 102°C (216°F) until Test Method D 1744 indicates water content at or below 0.01 %.

7. Apparatus

7.1 *Furnace*—Use a horizontal or vertical electrical resistance tube-type furnace capable of maintaining a constant