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Standard Test Method

Standard Test Method for Measuring Deposit Mass Loading ("Deposit-Weight-Density") Values for Boiler Tubes by the Glass-Bead-Blasting Technique

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Foreword

This standard test method was developed to document the procedures used in determining the amount of deposit accumulation on a boiler tube surface, commonly expressed as the deposit-weight-density (DWD) value, via the glass-bead-blasting (GBB) technique. The GBB technique for determining DWD values is suitable for removing a wide variety of boiler deposit types, but it is especially useful when deposition is tightly adherent and would be difficult to discharge completely via other mechanical or chemical cleaning processes (as specified in Method A and Method B of ASTM[(1)] D 3483[1]). Typically, the GBB technique allows for complete deposit removal in a very short time frame, without the risk of error induced by incomplete removal of tightly adherent scale or excessive loss of the metal substrate during the cleaning process.[2]

This standard is for use specifically by those involved in providing technical assessments concerning boiler cleanliness, such as university/corporate research laboratories, independent research/engineering consulting firms, or those in the chemical cleaning industry. This standard is intended to be used to obtain accurate deposit-loading data, which may be pertinent to establishing the necessity of chemically cleaning boiler systems to avoid boiler tube failure incidents (such as those related to under-deposit corrosion and tube metal overheating) and to track the rate of deposit growth over time.

This standard was originally prepared in 1999 by NACE Work Group T-7H-6f, as assigned by the T-7H-6 Task Group on "Failure Analysis—Boiler Waterside," which was a component of Unit Committee T-7H, "Corrosion and Its Control in Steam-Generating Systems." It was reaffirmed in 2006 and 2012 by Specific Technology Group (STG) 11, "Water Treatment," and is published by NACE International under the auspices of STG 11.

In NACE standards, the terms *shall*, *must*, *should*, and *may* are used in accordance with the definitions of these terms in the NACE Publications Style Manual. The terms *shall* and *must* are used to state a requirement and are considered mandatory. The term *should* is used to state something good and is recommended, but is not considered mandatory. The term *may* is used to state something considered optional.

(1) ASTM International, 100 Barr Harbor Dr., West Conshohocken, PA 19428-2959.

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Section 1: General

1.1 This standard describes a simple test method that employs GBB equipment to remove boiler waterside deposits on a piece of tubing removed from a representative area of a boiler. The test specimens are cut from a sample tube, weighed before and after the cleaning process, and the amount of deposit per surface area is estimated by measuring the weight loss of the tube sample test piece after deposit removal via GBB and dividing by the surface area of the test piece. The DWD value that is obtained by this method is typically expressed in mg/cm^2 or g/ft^2 units, and is defined as the weight of the deposit per boiler tube surface area.(2) Currently, DWD values are commonly expressed in g/ft^2 units. Procedures for test specimen processing, dimensional analysis techniques, sources of potential interferences, and a sample DWD report calculation sheet are included.

1.2 Measurement of deposit accumulation obtained by this test method should not be the sole source of information used to decide on the necessity of chemically cleaning a boiler. Although producing an accurate DWD value may be an important factor to aid in evaluating boiler cleanliness (and there are references in the literature[3,4,5] that utilize DWD data to assist in establishing chemical cleaning guidelines as a function of boiler pressure), other details should be considered. For example, the chemical composition and relative thickness of the specific waterside scale formed on the heat transfer surface are key parameters that must be taken into account in the process of making a decision to clean a boiler system to avoid tube failure. In addition, specific boiler design, heat flux patterns, and operating conditions have significant influence on the amount of deposit loading that can be sustained prior to the occurrence of overheating and other deposit-related failure processes.

1.3 Caution should be used in the interpretation of high-DWD values obtained from tubes subject to extreme temperature conditions (beyond the oxidation limit of the steel). This is because the DWD value produced may be unusually high as a result of the presence of excessive magnetite scale via in situ oxidation. As such, deposit-loading estimates of superheater tubes, reheater tubes, or water-bearing tubes subject to excessive heat flux may actually reflect the presence of heavy in situ oxides rather than transported and deposited water-formed scale constituents. No attempt to differentiate between water-formed scale and in situ oxidation products is made; the overall deposit weight per surface area is estimated with this test method. Other techniques (such as X-ray diffraction, microchemical analysis of deposit layers, metallography, etc.) may be needed to ascertain the relative distribution of deposit constituents and the influence of severe oxidation (excessive magnetite) on the DWD value.

Section 2: Test Equipment and Apparatus

2.1 A commercial GBB cabinet shall be used to perform this test. Various commercial units that have a glass viewing window incorporated within an enclosed blast cabinet are available. Typical operating requirements are compressed air at 690 kPag (100 psig) with a minimum 0.34 m^3/min (12 ft^3/min) flow rate.

2.2 Medium-size glass beads, 150 to 250 μm diameter range (60 to 100 mesh size) shall be used in the blast cabinet.

2.3 A dry-cutting band saw machine, portable band saw, or other appropriate dry-cutting device shall be used to cut the test specimens from boiler tube sample segments.

2.4 An analytical laboratory balance accurate within a minimum of 0.01 g in the range of 200 to 600 g capacity (or larger capacity) shall be used.

2.5 A small flexible ruler or measuring tape with gradations of 1.0 mm or 1/16 in shall be used.

2.6 A point micrometer with a 0 to 25 mm (0 to 1.0 in) range, 0.025 mm (0.0010 in) increments, contact points with 15° included angle, or similar, may be used to estimate deposit thickness (via before/after-cleaning measurements) and on the cleaned specimens to estimate general corrosion loss and to assess pit depths.

2.7 An instant-film copy camera, 35 mm or digital image camera, or other photographic system may be used to record deposit appearance and other features.

2.8 Engineering graph paper may be utilized to estimate surface area of the test specimen.

(2) 1 g/ft^2 is equivalent to 1.075 mg/cm^2.