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Standard Test Method

Evaluation of the Carburization of Alloy Tubes Used for Ethylene Manufacture

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Foreword

This NACE standard establishes a standard test procedure for pack bed carburization of alloys used for ethylene manufacture. The pack bed carburization procedure is specified in this standard because it is simple to perform. The test specimen geometry chosen reflects the intent of the procedure to be used for evaluation of carburization of furnace tube alloys intended for ethylene manufacture.

This standard also establishes two recommended methods—combustion analysis and chemical etching—for measuring the relative carburization of alloys for tubes intended for service in ethylene manufacture, or for assessing the performance of these tubes after service. Application procedures for the two methods are defined in detail. The combustion analysis method is preferred because it is quantitative. The chemical etching method is simpler and less expensive, but is only semiquantitative. Other methods considered and the reasons they are not recommended are discussed in Appendix A (nonmandatory).

The carburization measurement methods in this standard may be used independently from the pack bed carburization procedure when assessing the condition of tubes after service or when other carburization procedures have been performed.

This standard is intended to assist designers, operators, producers, fabricators, users, and testing laboratories in the selection of furnace tube alloys used for ethylene manufacture.

This standard was originally prepared in 1983 by Task Group T-5B-11, a component of Unit Committee T-5B on High-Temperature Materials Performance. It was reaffirmed in 2002 by Specific Technology Group (STG) 37, "Process Industry—High Temperature." It was revised in 2006 by Task Group (TG) 124 to include a standard pack bed carburization procedure. It was revised in 2014 by TG 124. TG 124 is administered by STG 37. This standard is issued by NACE International under the auspices of STG 37.

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.

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Contents

Section 1: General

1.1 This standard was developed to address a need for a standardized method to test the relative carburization of various furnace tube alloys used for ethylene manufacture. MTI[(1)] Publication No. 52[1] provides definitive guidelines for developing standard carburization testing methods for broader applications, and procedures for measuring the test result, but does not specify a standard method. This NACE standard defines a standard pack bed carburization procedure and standard methods for measurement of the relative carburization of alloy tubes intended for use in ethylene manufacture.

1.2 The pack bed carburization procedure is specified because of its ease of application. Gas carburization procedures require a more complex apparatus. This procedure is designed so that alloys may be carburized without the use of expensive or complicated laboratory equipment. The user of this procedure is cautioned that the pack bed carburization procedure does not duplicate the carburizing conditions in the furnace tubes used for ethylene manufacture. However, it has been shown to be a reliable procedure that produces a standard carburizing environment suitable for the evaluation of the relative carburization of alloys.

1.3 Tubular segments are specified as the test specimens to ensure that the test specimens have similar macrostructures, microstructures, and geometry to those typically used in furnaces for ethylene manufacture. A standard reference test specimen shall be used for each set of carburization exposures. The reference test specimen shall be alloy UNS N08810 (alloy 800H).

1.4 Carburization data for proprietary alloys and for standard alloys such as UNS J94204 have generally been developed by tube suppliers. Because of variations in testing and measuring methodologies, attempts to compare carburization data from one supplier to another for specific temperature ranges have not always provided consistent results. Standardization of the carburization procedure and measurement methods allows data from different suppliers to be compared. Furthermore, by using a standard reference alloy with each set of exposures, differences in test severity between suppliers are apparent. This ensures a standard method is used to rank the carburization of alloys used for ethylene manufacture and provides a means to evaluate any disparities involved in interpreting supplier carburization data.

1.5 The carburization procedure and measurement methods established by this standard should not be inferred to provide any information regarding the possible consequences of carburization in general or for any particular furnace design. Nor should they be inferred to provide a basis for projecting the remaining service life of partially or fully carburized tubes. The test results should not be used for direct extrapolation to actual service in ethylene manufacturing plants. It is the responsibility of the user of this standard to determine the applicability of the data.

1.6 Users of carburization data determined by these methods are responsible for developing their own criteria for applying the data to their needs. In addition to the carburization test results, other relevant material properties should be considered in evaluating the suitability or relative performance of alternative tube alloy for service in ethylene manufacture.

1.7 The evaluation of mechanical properties and the extent to which they might be affected by various degrees of carburization are not within the scope of this standard.

1.8 This standard does not purport to address all the safety concerns associated with this carburization procedure. It is the responsibility of the user of this standard to establish appropriate safety and health practices.

Section 2: Definitions

2.1 *Carburization* is the absorption and diffusion of carbon in iron or an iron-based alloy in contact with a suitable carbonaceous environment at elevated temperature.

(1) Materials Technology Institute (MTI), 1215 Fern Ridge Parkway, Suite 206, St. Louis, MO 63141-4405.
(2) Unified Numbering System for Metals and Alloys (UNS). UNS numbers are listed in *Metals & Alloys in the Unified Numbering System,* 10th ed. (Warrendale, PA: SAE International and West Conshohocken, PA: ASTM International, 2004).