AMERICAN NATIONAL STANDARD

ASME
PTC 12.3-1997
(Revision of ASME PTC
12.3-1977)

Performance Test Code on Deaerators

REAFFIRMED 2024

PERFORMANCE
TEST
CODES



The American Society of
Mechanical Engineers

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FOREWORD

(This Foreword is not part of ASME PTC 12.3-1997.)

On September 1, 1989, the Board on Performance Test Codes (BPTC) voted to reactivate the Performance Test Code Committee, PTC 12.3, to undertake the revision of PTC 12.3-1977, the Performance Test Code on Deaerators. Shortly thereafter, the Committee was reconstituted, and had its first meeting on May 22–23, 1991, with 3 of the original members on the new Committee.

One of the requirements for the satisfactory operation of the boiler feed system in a steam plant is high quality boiler feedwater, free from dissolved oxygen and carbon dioxide.

To meet the dissolved oxygen requirements of the steam generator, improvements in the design of mechanical deaerators have been made. Design requirements demand extreme reliability of oxygen testing of boiler feedwater.

This Code was approved by the PTC 12.3 Committee on May 31, 1996. It was then approved and adopted by the Council as a Standard practice of the Society by action of the BPTC on October 25, 1996. This Performance Test Code was also approved as an American National Standard by the ANSI Board of Standards Review on February 6, 1997.

NOTICE

All Performance Test Codes MUST adhere to the requirements of PTC 1, GENERAL INSTRUCTIONS. The following information is based on that document and is included here for emphasis and for the convenience of the user of this Code. It is expected that the Code user is fully cognizant of Parts I and III of PTC 1 and has read them prior to applying this Code.

ASME Performance Test Codes provide test procedures which yield results of the highest level of accuracy consistent with the best engineering knowledge and practice currently available. They were developed by balanced committees representing all concerned interests. They specify procedures, instrumentation, equipment operating requirements, calculation methods, and uncertainty analysis.

When tests are run in accordance with this Code, the test results themselves, without adjustment for uncertainty, yield the best available indication of the actual performance of the tested equipment. ASME Performance Test Codes do **not** specify means to compare those results to contractual guarantees. Therefore, it is recommended that the parties to a commercial test agree **before starting the test and preferably before signing the contract** on the method to be used for comparing the test results to the contractual guarantees. It is beyond the scope of any code to determine or interpret how such comparisons shall be made.

PERSONNEL OF PERFORMANCE TEST CODE COMMITTEE NO. 12.3 ON DEAERATORS

(The following is the roster of the Committee at the time of approval of this Code.)

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The PTC 12.3 Committee wishes to acknowledge the contributions of Robert J. Beckwith and the late James S. Poole. It is with regret that Mr. Poole did not live to see the result of his efforts for which the Committee is most grateful.

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SECTION 0 — INTRODUCTION

0.1

Deaerating equipment is designed to remove the dissolved oxygen and carbon dioxide in boiler feedwater to reduce corrosion in boilers and associated equipment. Normally, dissolved oxygen levels of 7 μg/L (ppb) or less can be achieved. A deaerator is designed to heat feedwater to the temperature of saturated steam at the pressure within the deaerator.

0.2

Deaerators, or deaerating heaters, may utilize many different designs. In general, there is a first stage which involves spraying water into the steam space where it is heated and partially deaerated. Water is discharged from spray nozzles or other spray devices as thin films, sheets or droplets. This stage removes more than 90% of the dissolved oxygen.

Venting of gases removed from the water may occur through an external shell and tube condenser or through an internal direct-contact vent condenser in the upper steam space on the deaerator. The condensing of steam in the apparatus reduces its pressure progressively, as it travels upward, to a minimum pressure in the area of the vent condenser. Noncondensable gases plus a small amount of steam pass through the vent.

The falling water, containing some dissolved gases, may be directed to a second stage which may be a tray section where it is mixed with, and mechanically scrubbed by, the heating steam. Thin films of water, formed by water overflowing the lips of the trays, are deaerated further by the incoming steam.

Alternatively, the second stage may be a steam scrubber and/or reboiler. Here the water mixes with the incoming heating steam, with the water becoming slightly superheated during the heating and scrubbing process. Some flashing takes place as it is discharged into the steam space where final deaeration takes place.

There are other types of deaerators which use sprays or spray pipes of various types with various types of packing such as packing rings, saddles, etc., on their own or in combination. There are also "integral" and other types of deaerators.

Deaerators may be designed to operate at any pressure.

0.3

Accurate measurements of dissolved oxygen are not obtained easily. Some test methods and procedures, while satisfactory for chemical control of the feedwater, are inadequate for guarantee-acceptance purposes. The fact that there are many test methods available and wide choices of apparatus and procedures which may be employed further complicates this problem. With the magnitude of permissible error of the test defined, it becomes apparent that the test method, test apparatus, and test procedure must be integrated and evaluated so that reliable measurement can be achieved. On-line analyzers and colorimetric test methods do not meet the methodology of measurement uncertainty per PTC 19.1. The test methods and procedures described herein do meet the methodology of PTC 19.1

The Test described in Subsection 4.2 is the referee method because it provides a method which has been studied and tested for accuracy and reliability.

0.4

Before formulating a test to determine the performance of deaerators, the Performance Test Code on General Instructions (PTC-1) should be studied and followed in detail. In particular, before any test is undertaken, the test objectives shall be defined and agreed by the parties to the test.

The Code on Definitions and Values (PTC-2) defines technical terms and numerical constants which are used throughout this Code with the meanings and values therein established.

The PTC 19 Series Supplements (Instruments and Apparatus Supplements) gives descriptions of, and standard directions for, the use and calibration of measuring devices, including an estimate of the level

of accuracy obtainable. These supplements provide guidance on the application of some of the specialized techniques used in this code.

SECTION 1 — OBJECT AND SCOPE

1.1 Object

The purpose of this Code is to provide rules and test procedures that are to be used to determine the performance of deaerators with regard to the following:

(a) residual dissolved oxygen in the deaerated water,

(b) terminal temperature difference (TTD), if any, between the deaerated water and the saturated steam temperature corresponding to the pressure in the steam zone adjacent to the interface between the steam and the collected deaerated water.

1.2 Scope

1.2.1 This Code applies to deaerating heaters and deaerators equipped with either shell-and-tube or direct contact, vent-condensing sections.

1.2.2 The Code describes the test method and procedures for the determination of dissolved oxygen in water for deaerating equipment at concentrations up to 75 μg/L (ppb). This Code also describes the method for determining the terminal temperature difference (TTD).

Other methods of dissolved oxygen measurement are included in Appendices A, B and C. These may be used as an adjunct to the Code.

1.3 Uncertainty

An uncertainty analysis of the test method for determination of dissolved oxygen in the deaerated water and terminal temperature difference is provided. This uncertainty procedure serves as a guide for pretest and post-test uncertainty calculations when the Code is used. The expected test uncertainty for dissolved oxygen is ± 2.6 μg/L (ppb) and for terminal temperature difference is ± 0.6°C (± 1°F). These values were determined in accordance with methods described in PTC 19.1.