ANSI/AWS A4.3-93 (R2006)
An American National Standard

Standard Methods for Determination of the Diffusible Hydrogen Content of Martensitic, Bainitic, and Ferritic Steel Weld Metal Produced by Arc Welding

American Welding Society

Key Words—Diffusible hydrogen, gas chromatography, mercury displacement, arc welding, steel, shielded metal arc welding, gas metal arc welding, flux cored arc welding, submerged arc welding

ANSI/AWS A4.3-93 (R2006)
An American National Standard

Approved by the
American National Standards Institute
November 12, 1992

Standard Methods for Determination of the Diffusible Hydrogen Content of Martensitic, Bainitic, and Ferritic Steel Weld Metal Produced by Arc Welding

Supersedes ANSI/AWS A4.3-86

Prepared by the
American Welding Society (AWS) A5 Committee on Filler Metal

Under the Direction of the
AWS Technical Activities Committee

Approved by the
AWS Board of Directors

Abstract

A standard 25 × 12 × 80 mm test specimen and method of preparation are set forth, along with two standard methods of diffusible hydrogen analysis, mercury displacement and gas chromatography. The methods are suitable for shielded metal arc welding, gas metal arc welding, flux cored arc welding, and submerged arc welding using welding conditions and electrodes given in several applicable American Welding Society filler metal specifications.

American Welding Society
550 N.W. LeJeune Road, Miami, FL 33126

Foreword

This foreword is not part of ANSI/AWS A4.3-93 (R2006), *Standard Methods for Determination of the Diffusible Hydrogen Content of Martensitic, Bainitic, and Ferritic Steel Weld Metal Produced by Arc Welding*, but is included for informational purposes only.

This document (A4.3-93) refers to an IIW draft standard for measurement of diffusible hydrogen in several places, including the foreword and the appendix. This referenced IIW draft became the basis for ISO 3690:2000.

A number of test methods for determining weld metal diffusible hydrogen have been used over the years. In particular, media for collecting hydrogen have included glycerin, paraffin, and mercury, with glycerin being by far the most popular in the United States. A previous AWS A5 Task Group, chaired by R. A. LaFave, investigated the collection of hydrogen over glycerin in 1982–1983. That Task Group concluded that, whereas collection of hydrogen over glycerin is simple and inexpensive, the results suffer from severe variability. This is due in part to the solubility of water, atmospheric gases, and hydrogen in glycerin.

Collection of hydrogen over glycerin, when using very low hydrogen weld metals, has also been shown to give null readings, while collection over mercury using the method of ISO 3690 was giving readings greater than zero. The method of ISO 3690 is only suitable for coated electrodes. Recognizing this, the International Institute of Welding (IIW) has been developing a draft standard with a larger specimen size suitable for other welding processes but still using collection of hydrogen over mercury as the reference method. This draft has also introduced analysis by gas chromatography as giving results equal to those of collection over mercury.

The AWS A5 Task Group, in 1983 and 1984, chaired by D. J. Kotecki, considered adopting the method of the IIW draft standard. However, after round robin testing employing the IIW specimen size and other sizes, the Task Group rejected the IIW specimen size for two reasons. First, the small size required reorientation of the test specimen depending upon welding heat input. Second, the small size resulted in hydrogen volumes almost too small to measure when very low hydrogen weld metals were tested. As a result, the Task Group selected a specimen size appropriate to generating a significant volume of hydrogen gas for measurement and not requiring specimen reorientation for welding heat input within the realm of electrode classifications envisioned for use with this standard.

This is the first revision of this specification as shown below:

ANSI/AWS A4.3-86, *Standard Methods for Determination of the Diffusible Hydrogen Content of Martensitic, Bainitic, and Ferritic Steel Weld Metal Produced by Arc Welding*.

Comments and suggestions for the improvement of this standard are welcome. They should be sent to the Secretary, AWS A5 Committee on Filler Metal, American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126. Official interpretations of any of the technical requirements of this standard may only be obtained by sending a request, in writing, to the Managing Director, Technical Services Division, American Welding Society. A formal reply will be issued after it has been reviewed by the appropriate personnel following established procedures.

Table of Contents

Page No.

List of Tables

List of Figures

Standard Methods for Determination of the Diffusible Hydrogen Content of Martensitic, Bainitic, and Ferritic Steel Weld Metal Produced by Arc Welding

1. Scope

This standard prescribes a standard weld test assembly, a standard method of test specimen preparation, and two standard methods of analysis for determination of diffusible hydrogen from martensitic, bainitic, and ferritic steel weld metals. The methods of preparation are suitable for shielded metal arc, gas metal arc, flux cored arc, and submerged arc welding processes. Extension of the methods of preparation to other processes, such as gas tungsten arc or plasma arc welding, are possible.

It is not the intent of this standard directly herein to classify arc welding electrodes, fluxes, and gases according to the hydrogen content of welds produced from them. However, it is the intent of this standard that it be used as the standard test method for classification purposes to be referenced in individual filler metal specifications prepared by the AWS Committee on Filler Metal and its subcommittees.

In addition to its use for electrode classification purposes, it is the intent of this standard that it be used for quality conformance testing of arc welding electrodes, fluxes, and gases.

It is recommended that this standard be used for developing and reporting research results so that the results may be directly compared with those from other laboratories.

For purposes of electrode classification and quality conformance testing, any requirement established based on the use of this standard must also be based on a reference atmospheric condition. If a reference condition is not specified in conjunction with diffusible hydrogen requirements in the individual consumable standards, the recommended reference condition in 6.6 shall be used.

2. Units of Measure

At the present time, U.S. customary units of measurement are normally the primary units of AWS documents, including the standards and specifications prepared by the Committee on Filler Metal. However, these units are awkward for expressing hydrogen values, whereas the S.I. units are not. Furthermore, the practice of reporting diffusible hydrogen values in S.I. units is practically universal, including within the United States.

Therefore, the S.I. units of measurement are chosen as the primary units of measurement for this standard, except for welding parameters specified by filler metal specifications. U.S. customary units are included parenthetically, except for diffusible hydrogen values and for measurements directly used in computing diffusible hydrogen values. Only S.I. units are, in practice, used for diffusible hydrogen values and for measurements directly used in computing them.

3. Preparation of Weld Test Assemblies

3.1 Test Assembly Dimensions. Each weld test assembly shall consist of a starting weld tab, a test specimen at the center, and a run-off weld tab, all held in a copper clamping fixture (Figures 1A, 1B, and 2). Four such weld test assemblies shall constitute a complete test. The material for all three pieces of a weld test assembly shall be nonrimming quality steel of grade ASTM A36 or SAE 1020. In case of dispute, ASTM A36 steel shall be used as referee material. All three pieces for a weld test assembly shall have a cross section of 25 mm (wide)