Designation: F3497 – 21

Standard Test Method for Evaluating the Oxidative Resistance of Polypropylene (PP) Piping Systems to Hot Chlorinated Water[1]

This standard is issued under the fixed designation F3497; 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 general requirements for evaluating the long-term, chlorinated water, oxidative resistance of polypropylene (PP) piping produced in accordance with Specification F2389 used in hot-and-cold water distribution systems by exposure to hot, chlorinated water. This test method outlines the requirements of a pressurized flow-through test system, typical test pressures, test-fluid characteristics, failure type, and data analysis.

NOTE 1—Other known disinfecting systems (chlorine dioxide, ozone, and chloramines) are also used for protection of potable water. Free-chlorine is the most common disinfectant in use today. A PPI research project examined the relative aggressiveness of free chlorine and chloramines on PEX pipes, both at the same 4.0 ppm concentration and the same test temperatures. The results of the testing showed pipe failure times approximately 40 % longer when tested with chloramines compared to testing with free chlorine, at the tested conditions. Based on these results, the data suggests that chloramines are less aggressive than free chlorine to PEX pipes. This note is provided for information regarding testing different disinfecting systems on PEX tubing using Test Method F2023. The PPI research project did not include testing of polypropylene piping.

NOTE 2—This test method is based on Test Method F2023 and results from this method can be used for direct comparison with previous results on PP piping materials tested in accordance with Test Method F2023.

1.2 This test method is applicable to PP piping systems used for transport of potable water containing free-chlorine for disinfecting purposes. The oxidizing potential of the test-fluid specified in this test method exceeds that typically found in potable water systems across the United States.

1.3 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard

1.4 The following precautionary caveat pertains only to the test method portion, Section 12, of this specification. *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D1600 Terminology for Abbreviated Terms Relating to Plastics

D2122 Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings

F412 Terminology Relating to Plastic Piping Systems

F2023 Test Method for Evaluating the Oxidative Resistance of Crosslinked Polyethylene (PEX) Pipe, Tubing and Systems to Hot Chlorinated Water

F2389 Specification for Pressure-rated Polypropylene (PP) Piping Systems

2.2 *ISO Standards:*[3]

ISO 9080 Thermoplastic Pipe for Transport of Fluids—Methods of Extrapolation of Hydrostatic Stress Rupture Data to Determine the Long Term Strength of Thermoplastic Pipe

ISO 13760 Plastic Pipe for the Conveyance of Fluids Under Pressure—Miner's Rule—Calculation Method for Cumulative Damage

2.3 *American Water Works Association (AWWA) Document:*[4]

1996 WATER:\STATS Survey

[1] This test method is under the jurisdiction of ASTM Committee F17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.40 on Test Methods.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from International Organization for Standardization (ISO), ISO Central Secretariat, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, https://www.iso.org.

[4] Available from American Water Works Association (AWWA), 6666 W. Quincy Ave., Denver, CO 80235, http://www.awwa.org.

2.4 *NSF/ANSI Standard:*[5]
NSF/ANSI 14 Plastic Piping System Components and Related Materials

3. Terminology

3.1 *Definitions:*

3.1.1 Definitions are in accordance with Terminology F412 and abbreviations are in accordance with Terminology D1600, unless otherwise indicated.

3.1.2 *brittle failure (Stage II), n*—failure in the pipe or tubing wall that is characterized by little or no material deformation in the failure area and is the result of a single crack emanating from the interior of the pipe or tubing to the outside surface typically resulting in a pinhole leak, see Fig. 1. For some materials, brittle failure could be indicated by weeping at the pipe surface. Brittle failures produced with this test method shall not be used for data analysis.

3.1.3 *ductile failure (Stage I), n*—failure in the pipe or tubing wall that is characterized by obvious localized deformation of the material visible with the unaided eye, see Fig. 1.

3.1.3.1 *Discussion*—Ductile failures produced with this test method shall not be used for data analysis.

3.1.4 *environmental or oxidative failure (Stage III), n*—failure in the pipe or tubing wall characterized by a large number of cracks emanating from the interior surface of the pipe or tubing wall, see Fig. 1. For some materials, oxidative failure could be indicated by weeping at multiple locations on the pipe surface.

3.1.4.1 *Discussion*—Stage III failures may also be identified by a color shift in the failure area. Identification of environmental or oxidative failure, when not obvious by inspection with the unaided eye, can be performed with a 25× microscope or other similar device yielding the same level of magnification. Only Stage III environmental or oxidative failures shall be used for data analysis. In some cases, thinning of the specimen wall prior to failure may result in localized stresses sufficiently high to induce micro-ductility at the leading edge of the fracture during final rupture. This micro-ductility does not indicate a mixed-mode failure which is evidenced by a combination of brittle and macroscopic ductile failure modes and these specimens are included as Stage III failures.

3.1.5 *hot-and-cold water distribution system, n*—a combination of components such as pipe or tubing, fittings, valves, and so forth, that when installed as a complete system, make up the interior water supply system of a commercial or residential structure.

3.1.6 *long-term oxidative resistance, n*—the extrapolated time-to-failure prediction as determined by analysis of time-to-failure test data by multiple linear regression utilizing. Where applicable, application of Miner's Rule in accordance with ISO 13760 can be used to estimate time-to-failure at several differing conditions of temperature or stress, or both.

3.1.7 *multiple linear regression, n*—a three coefficient mathematical model used to analyze time-to-failure data from different temperatures and stresses to extrapolate projected time-to-failure at selected temperatures or stresses.

3.1.8 *miner's rule, n*—a mathematical method for estimating the cumulative, irreversible damage that results from exposure to each of several differing conditions of stress or temperature, or both.

3.1.9 *nominal wall thickness*—the wall thickness of a pipe determined by dividing the nominal size (diameter) by the dimension ratio (DR).

3.1.10 *oxidation reduction potential (ORP), n*—a measure of the total oxidizing power of a solution by means of a platinum-redox electrode. For a further explanation of ORP see Appendix X2.

3.1.11 *unaided eye, n*—observable without visual enhancement beyond correction for normal vision.

4. Summary of Test Method

4.1 The PP piping or piping/fitting assemblies are exposed to pressurized test-fluid until failure. The fittings used are representative of actual fittings used in the PP system, or are fittings made from a material essentially inert to the effect of the test fluid. All time-to-fail data used for analysis shall be the

[5] Available from NSF International, P.O. Box 130140, 789 N. Dixboro Rd., Ann Arbor, MI 48105, http://www.nsf.org.

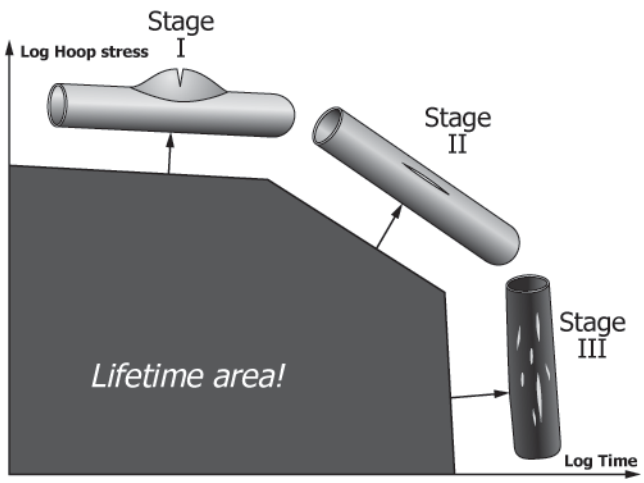

FIG. 1 Pictorial Illustration of Failure Types