

WL112 – Frequently Asked Questions

Contents

Why is ASTM D 1248 an obsolete standard for PE pipe materials?	1
What happened to ESCR?	1
Can a mandrel be used to check installed deflection of non-pressure pipes?	3
Have ASTM standards for fusion joining changed?	3
Does WL Plastics HDPE pipe need to be protected against UV deterioration?	3
Can WL Plastics HDPE pipe be used for compressed air service?	4
What is the status of AWWA standards updates for PE4710?	4
Are Rework (regrind) or Recycle Materials Used in HDPE Pipe?	5
Is NDE Inspection of HDPE Pipe or Butt Fusion Joints Reliable?	5

Why is ASTM D 1248 an obsolete standard for PE pipe materials?

ASTM D 1248 was originally published in 1952 to specify physical properties for PE molding and extrusion materials. It covered PE extrusion materials for a wide variety of extrusion applications including electrical, profiles, and pipe. As the PE piping industry developed, it became clear that by addressing so many applications, the format of ASTM D 1248 did not adequately characterize or include the properties that were necessary for PE piping materials; further, it also required properties that were not relevant for PE pipe.

To meet the need for a PE material standard especially for PE pipe and fittings, ASTM developed ASTM D 3350, which was first published in 1974. From 1974 until 1989, ASTM D 1248 and ASTM D 3350 were both used to specify PE pipe materials; however, maintaining consistency between the two standards proved increasingly difficult, such that in 1989, PE piping materials were removed from ASTM D 1248. Since then, ASTM D 3350 has served as the sole standard specification for PE plastics pipe and fittings materials.

ASTM D 1248 remains an active ASTM standard, but since 1989 it has not included requirements for PE pipe materials. Therefore, it is no longer possible for PE pipe materials to comply with ASTM D 1248.

The correct specification for PE pipe materials is ASTM D 3350, and per ASTM D 3350, PE compounds that previously would have been Type III, Class C, Category 5, Grade P34 are met by ASTM D 3350 cell classification 34XX4XC (X denotes ASTM D 3350 material properties not included in ASTM D 1248 prior to 1989). WL Plastics PE3608/PE3408 material per WL106A meets or exceeds ASTM D 3350 cell classification 345464C, which meets or exceeds pre-1989 ASTM D 1248 requirements.

References:

ASTM D 1248 *Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable*

ASTM D 3350 *Standard Specification for Polyethylene Plastics Pipe and Fittings Materials*

WL106A *PE3608/PE3408 Pipe Compound*

What happened to ESCR?

When the PE pipe industry began in the late 1950's, little was known about how PE materials would respond to sustained loads such as continuous internal pressure and earth embedment. It was originally thought that PE materials would

WL112 Frequently Asked Questions

behave much like metals where ductile tensile properties govern. But as PE pipes were placed in service, some PE materials began to develop cracks through the pipe wall that were not related to ductile tensile material properties. Because PE pipes are used in critical applications to transport natural gas, water and the like, brittle-like material cracking was a major concern. Research identified the brittle-like cracking as slow crack growth, SCG, which was initially thought to be related to environmental stress cracking.

An early test method for PE material resistance to environmental stress cracking was ASTM D 1693 that was first published in 1959. In this test method, material strips are bent and immersed in a chemical accelerant at elevated temperature. The time to the appearance of surface cracks is measured. But in the field, brittle-like cracking did not exhibit observable surface cracks or crazing and didn't involve a chemical accelerant. Further, as improved performance materials were developed and time to failure increased, it was discovered that ASTM D 1693 ESCR test specimens undergo stress relaxation (creep); that is, the bending stress applied to the specimen decays such that after several hundred hours, the remaining stress is too low to initiate stress cracking. As newer, more robust PE pipe materials were developed to combat brittle-like cracking they exhibited virtual immunity to ASTM D 1693 ESCR failure. What was needed was a new test to better model field conditions and avoid the stress decay and chemical accelerant issues that plague ESCR tests.

After extensive research and development, ASTM F 1473 was published in 1997. Named for the University of Pennsylvania where it was developed, the Pennsylvania Notch Test (PENT) applies a constant, sustained tensile load to a razor notched material specimen at elevated temperature. The time to specimen break is measured. Unlike the ASTM D 1693 ESCR test, ASTM F 1473 PENT more closely models pipe field conditions, and in fact, has been correlated to the material hydrostatic design basis, HDB, that is used to determine pipe pressure rating. In addition, an empirical correlation between PENT and pressure gas distribution service indicates that 25-35 hours PENT correlates to approximately 100 years in pressure gas distribution service.

ASTM D 3350 includes a cell classification for slow crack growth resistance per ASTM D 1693 ESCR or ASTM F 1473 PENT. The highest ESCR requirement is a 4 which is >600 hours ESCR per ASTM D 1693. A 4 is also the lowest PENT per ASTM F 1473 of >10 hours. ASTM D 3350 includes higher PENT SCG resistance requirements where 5 = >30 hours, 6 = >100 hours, and 7 = >500 hours. For ASTM D 3350 SCG resistance requirements above 4, ASTM D 1693 ESCR stress relaxation typically precedes surface cracking; that is, ESCR >600 hours actually represents non-failure, meaning that materials that exceed 600 hours will just as likely exceed 10,000 hours.

ASTM F 1473 PENT performance per ASTM D 3350 is also identified in the PE material designation code as the second digit in PE3408, PE3608, and PE4710. WL Plastics uses only PE3608 and PE4710 materials per WL106A and WL106B respectively. These high performance PE pressure piping materials greatly exceed ASTM D 3350 SCG resistance requirements per ASTM D 1693 ESCR such that it is not meaningful to include ESCR resin performance information. However, these materials are differentiated by ASTM F 1473 PENT performance; therefore, SCG resistance per ASTM F 1473 PENT is presented in WL106A for PE3608 material and in WL106B for PE4710 material. It is to be noted that PPI TR-4 lists WL Plastics PE3608 and PE4710 materials as meeting or exceeding PE3408 requirements for those specifications that call out PE3408 material.

In summary, ASTM F 1473 PENT has replaced ASTM D 1693 ESCR. WL Plastics modern high performance PE3608 and PE4710 materials are characterized and differentiated by ASTM F 1473 PENT SCG resistance, but not by ASTM D 1693 ESCR.

References

ASTM D 1693 *Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics*

ASTM F 1473 *Standard Test Method for Notch Tensile Test to Measure the Resistance to Slow Crack Growth of Polyethylene Pipes and Resins*

ASTM D 3350 *Standard Specification for Polyethylene Plastics Pipe and Fittings Materials*

WL106A *PE3608/PE3408 Pipe Compound*

WL106B *PE4710 Pipe Compound*

Can a mandrel be used to check installed deflection of non-pressure pipes?

It is not practical to check the installed deflection of OD controlled solid wall pipes with a mandrel. To check deflection with a mandrel, a known ID dimension is a prerequisite. However, ASTM F714 and AWWA C906 specifications for large diameter, OD controlled solid wall HDPE pipe do not specify ID dimensions, and the OD and wall thickness dimensioning specifications, toe-in allowance, and internal fusion bead make it impractical if not virtually impossible to determine an ID, and therefore, impractical if not impossible to test for installed deflection by pulling a sized mandrel through the pipe bore. Therefore, WL Plastics does not recommend using a fixed diameter mandrel (sewer ball) to check the installed deflection of ASTM F 714 or AWWA C906 pipe.

ASTM F 714 or AWWA C906 pipe may be checked for installed deflection by measuring vertical ID at a location before installation, and then measuring vertical ID at the same location after installation to determine deflection at that location. Another method would be to use traveling laser measuring equipment to measure horizontal and vertical ID at a location, and determine ovality and deflection at that location.

References

ASTM F 714 *Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter*

AWWA C906 *Polyethylene (PE) Pressure Pipe and Fittings, 4 In. (100 mm) Through 63 In. (1,600 mm), for Water Distribution and Transmission*

Have ASTM standards for fusion joining changed?

Yes. In December 2006, ASTM published a new standard for fusion joining PE pipe and fittings, ASTM F 2620, and in May, 2007, ASTM D 2657 was republished with a revision that removed PE pipe and fitting joining from ASTM D 2657. Specifications that reference ASTM D 2657 for fusion joining should be changed to ASTM F 2620.

References

ASTM D 2657 *Standard Practice for heat Fusion Joining of Polyolefin Pipe and Fittings*

ASTM F 2620 *Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings*

Does WL Plastics HDPE pipe need to be protected against UV deterioration?

PE pipe products are protected against deterioration from exposure to ultraviolet light and weathering effects with antioxidants, and thermal and UV stabilizers. UV stabilization formulations for black products and for solid color (non-black) products are different.

WL Plastics black HDPE pipe with and without stripes contains 2-3% carbon black to shield the pipe against UV degradation. HDPE pipe containing 2-3% carbon black is suitable for indefinite long-term surface or above grade use or storage without cover or other measures to protect black product from direct exposure to UV energy. Long term exposure of black HDPE pipe to UV from sunlight is not a concern.

Solid color (non-black) products are compounded with sacrificial UV stabilizers that protect the pipe against deterioration by absorbing UV energy. However, when UV stabilizers are depleted, solid color (non-black) pipe will be susceptible to degradation from further exposure to UV energy. For this reason, WL Plastics solid color (non-black) piping products should not exceed about 3 years exposure to UV energy from sunlight during storage or use. Where extended storage or use is anticipated, solid color (non-black) products should be covered or measures should be taken to protect solid color products from direct exposure to UV energy. Solid color (non-black) products are intended for installation underground or in areas that do not continuously expose the pipe to direct UV energy.

Products that are stored for extended periods may be affected by other environmental conditions or obsolescence due to improvements in materials or processes. Surface and above grade storage or use should be such that the pipe is not unreasonably exposed to harmful mechanical, environmental or chemical effects. For example, moving equipment, floods

WL112 Frequently Asked Questions

or storms may damage the pipe and some chemicals could have deleterious effects if spilled onto the pipe or soils upon which the pipe rests. See PPI TR-19 for chemical resistance information.

References

PPI TR-19 *Chemical Resistance of Thermoplastic Piping Materials*

Can WL Plastics HDPE pipe be used for compressed air service?

HDPE piping is regularly used for underground compressed gas service such as for natural and LP gas, and for transporting compressed gases such as air, carbon dioxide, hydrogen sulfide, nitrogen, etc. Years of service have shown that HDPE is a reliable product for these applications. Transporting natural gas under pressure is usually governed by federal regulations. Transporting other compressed gases including compressed air is allowable, but with restrictions.

Compressed gas applications require consideration of chemical and temperature effects, and installation so that the possibility of mechanical damage is remote. Under internal pressure, gaseous oxygen in compressed air has an oxidizing chemical effect compared to more benign gasses such as carbon dioxide or nitrogen. Other oxidizing gases can have similar effects. While oxidation may not reduce service life, which is usually governed by the onset of slow crack growth, when SCG does eventually occur, oxidation increases the rate of crack growth through the material. If the compressed gas or air contains compressor oils, the oils can deposit on the pipe ID and permeate into the pipe. Permeation (chemical solvation) can reduce material strength and require additional environmental design factor reduction. Elevated temperature will accelerate chemical effects.

WL Plastics recommends that compressed air service be limited to dry, oil-free compressed air. Pressure ratings are reduced 50% if the compressed air contains oil. Compressed air may need to be cooled before entering HDPE pipe. Hot compressed air directly from the compressor may exceed HDPE elevated temperature pressure limits (140°F/60°C or lower). See WL118 *Pressure Rating* for pressure rating and environmental design factor information.

With regard to installation, compressed gas lines have an increased risk of mechanical damage if the line is exposed, and are usually subject to greater ambient temperature variations. If an exposed PE compressed gas line were to be severed, the energy released is not only the energy from internal pressure, but also all of the energy that was used to compress the gas. The sudden release of this energy can be explosive and extremely dangerous. Flexible PE pipes, especially smaller sizes, can whip about uncontrollably and cause damage, injury or death. Therefore, compressed gas lines must be fully restrained by burial underground, with structural mechanical restraints that restrict pipe movement in the event of mechanical damage, and by installation in locations there is little or no potential for mechanical damage. The installation should also limit pipe temperature to 80°F (27°C) or below. Although black PE pipe is indefinitely protected against UV deterioration, PE compressed air pipe should not be exposed to direct sunlight because sunlight heating can increase pipe temperature to well above 80°F (27°C), which reduces pipe strength and accelerates chemical effects.

References

WL118 *Pressure Rating*

What is the status of AWWA standards updates for PE4710?

As of May 2011, AWWA has approved and published AWWA C901 and revisions to AWWA C906 to incorporate PE4710 compounds are progressing through the AWWA standards approval process.

AWWA C901-08 – effective October 1, 2008, covers ½” through 3” sizes and 9 pressure-rated PE materials including PE4710. Pipe and tubing pressure class ratings are consistent with HDB and HDS ratings for the PE materials. AWWA C901’s inclusion of PE4710 is AWWA approval of PE4710 for water service.

AWWA C906 – Revisions to AWWA C906-07 are progressing through the AWWA standards approval process. Revisions to incorporate PE4710 and other updates have been approved by the AWWA Polyolefins Committee and are awaiting approval by the AWWA Standards Council. Publication is anticipated in early 2010.

WL112 Frequently Asked Questions

References

ANSI/AWWA C901-08 *Polyethylene (PE) Pressure Pipe and Tubing, ½ In. (13 mm) Through 3 In. (76 mm), for Water Service*

ANSI/AWWA C906-07 *Polyethylene (PE) Pressure Pipe and Fittings, 4 In. (100 mm) Through 63 In. (1,600 mm), for Water Distribution and Transmission*

Are Rework (regrind) or Recycle Materials Used in HDPE Pipe?

WL Plastics does not use recycled plastic materials in any WL Plastics piping products. Recycled plastic materials come from products that were manufactured, left the factory, were used, and were then recovered from waste. Recycled plastic materials are typically plastics containers and packaging such as bags, bottles, etc. Plastic containers and packaging materials are designed to protect contents during shipping and sometimes during use, but are then to be discarded, hopefully recycled. Recycled plastic materials are not intended for long-term service, and may be compounded with additives that promote degradation in landfills.

WL Plastics piping products are manufactured in accordance with industry standards for piping products that transport hazardous and non-hazardous liquids and gases in pressure and non-pressure service applications. These piping products are expected to perform for many decades. Recycled materials that are intended for short-term service, and that may be designed disintegrate in a short period of time are not suitable for WL Plastics piping products. Recycled plastic materials do not and cannot meet piping material specifications in any of the industry standards used for WL Plastics piping products. ASTM, AWWA, API and FM standards used for PE pressure and non-pressure pipe do not permit the use of recycled plastic materials. See WL116 for the pipe manufacturing standards used for WL Plastics piping products.

All of the industry standards used by WL Plastics for PE piping products allow the use of rework (regrind) material. Rework material is virgin PE material that was processed, but did not meet specifications such as dimensions, surface finish, etc., or product samples taken during production for quality tests. Rework materials never leave the manufacturing plant. WL Plastics generally does not accept product returns because returned product may have been exposed to conditions that could compromise product performance if used in new pipe.

WL Plastics thermoplastic PE materials can be reprocessed into new pipe without performance loss. Each WL Plastics plant has specialized equipment to process rework material into small chips that can be mixed with virgin material to produce new pipe. Although 100% rework material pipe has been shown to have the same performance as 100% virgin material pipe, WL Plastics combines a low percentage of rework material with unprocessed virgin material because an excessive amount of rework can affect dimensional stability.

References

WL116 *WL Plastics Pipe Standards*

Is NDE Inspection of HDPE Pipe or Butt Fusion Joints Reliable?

Currently, no NDE (non-destructive evaluation) method has been able to reliably demonstrate an ability to detect flaws in HDPE pipe or lack of fusion in HDPE butt fusion joints. This includes ultrasonic NDE methods such as TOFD (time of flight diffraction) and PA (phased array), microwave methods such as Evisive, and X-Ray methods. Although various NDE methods may be able to “see” features in HDPE pipe or butt fusion joints, there are no reliable means to determine if a feature is benign or deleterious. Industry organizations including PPI, ASTM and ASME are working diligently to develop tests and methods to assure reliable NDE results, but to date, no NDE technique including TOFD, PA, Evisive and X-ray is a proven reliable method for NDE inspection of HDPE pipe or HDPE butt fusion joints.

WL112 Frequently Asked Questions



The HDPE industry has sought reliable NDE technologies for over four decades without success. It is not easy. If it were, NDE issues would have been solved long ago. Claims made by proponents of some proprietary NDE techniques that their technique can find voids or other defects in HDPE pipe or fusion joints have not proved to be valid. Valid claims are substantiated by documented independent peer-reviewed research, not marketing papers from the developer of the proprietary technique.

For business reasons that are wholly unrelated to the technical status of NDE techniques including time of flight diffraction (TOFD), phased array (PA), and microwave (Evisive), WL Plastics may elect to allow its products to be scanned at its facilities, and WL Plastics may elect to accept or not accept the results of any NDE scan. However, such elections are solely for business reasons and do not constitute any acceptance or inference by WL Plastics of the technical validity of these NDE Techniques, and do not constitute any acceptance or inference by WL Plastics of the validity of any scan result of any WL Plastics product.

References

WL125 *WL Plastics Terms and Conditions of Sale*

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CASPER PLANT: 2075 North Pyrite • P. O. Box 1120 • Mills, WY 82644 • **Customer Service: 307-472-6000** • Fax: 307-472-6200
CEDAR CITY PLANT: 4660 W. Highway 56 • P. O. Box 627 • Cedar City, UT 84721 • **Customer Service: 435-867-8908** • Fax: 435-865-2703
ELIZABETHTOWN PLANT: 2151 West Park Road • Elizabethtown, KY 42702 • **Customer Service: 270-765-1020** • Fax: 270-765-1030
BOWIE PLANT: 1110 Old Wise Road • PO Box 32 • Bowie, TX 76230 • **Customer Service: 940-872-8300** • Fax: 940-872-8304
CROSSFIELD PLANT: PO Box 860 • 1030 Western Drive • Crossfield, AB T0M 0S0 Canada • **Customer Service: 403-946-0202** • Fax: 403-946-0252