Ductile Iron Pipe Research Association

Strength and Durability for Life®

CORROSION CONTROL

Polyethylene Encasement

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Throughout more than 58 years of service in thousands of utilities in the United States and across the world, polyethylene encasement has proved an effective corrosion-protection system for millions of feet of Cast and Ductile Iron Pipe. V-Bio® Enhanced Polyethylene Encasement builds upon this proven method of corrosion control and provides the most advanced corrosion protection for Ductile Iron Pipe while still maintaining the ease of use we have come to expect from polyethylene encasement.

Polyethylene encasement involves simply wrapping the pipe with a tube or sheet of polyethylene immediately before installing the pipe. It is easy for construction crews to install on-site and is by far the most economical way to protect Ductile Iron Pipe. And, unlike cathodic protection systems and bonded coatings, polyethylene encasement is a passive protection system, so it requires no monitoring, maintenance, or supervision once installed.

This brochure will briefly present the history and development of polyethylene encasement, explain how it protects Ductile Iron Pipe, and highlight field investigations across the nation. It will also discuss polyethylene's advantages over other corrosion-protection methods, explain how to ascertain if protection is warranted, outline proper installation procedures, and briefly review cost considerations when choosing a corrosion-protection system for Ductile Iron Pipe.

History and Development

Polyethylene encasement was first used experimentally in 1951 by the Cast Iron Pipe Research Association (CIPRA)* and one of its member companies to protect a mechanical joint pipe assembly in a highly corrosive cinder fill in Birmingham, Alabama. When examined two years later, the unprotected parts of the pipe showed significant pitting due to corrosion. The glands, nuts, bolts, and portion of the pipe protected by polyethylene encasement were in excellent condition.

Also in the early 1950s, CIPRA began an ongoing testing program, burying bare and polyethylene-encased Cast Iron pipe specimens in highly corrosive muck in the Florida Everglades and later in a tidal salt marsh in Atlantic City, New Jersey. The success of these early installations led to the development of an extensive, ongoing research program that determined polyethylene encasement's efficacy in providing a high degree of corrosion protection for Cast and Ductile Iron Pipe in most soil environments.

By the late 1950s, successful results in CIPRA's research program led to the first use of polyethylene encasement in operating water systems in Lafourche Parish, Louisiana, and Philadelphia, Pennsylvania. And, in 1963, CIPRA continued its research with the burial of polyethylene-encased Ductile Iron Pipe specimens in test sites in the Everglades and Wisconsin Rapids, Wisconsin. Millions of feet of polyethylene-encased Cast and Ductile Iron Pipe have since been installed in thousands of operating water systems across the United States and throughout the world.

Due to polyethylene encasement's excellent success in actual field conditions, the first national standard, ANSI/AWWA C105/A21.5, was adopted in 1972. The American Society for Testing and Materials issued a standard for polyethylene (ASTM A674) in 1974. In 1981, Great Britain adopted a national standard. National and industry standards in several other countries followed. An international standard for polyethylene sleeving (ISO 8180) was adopted in 1985.

*The Cast Iron Pipe Research Association (CIPRA) became the Ductile Iron Pipe Research Association (DIPRA) in 1979.

Although most soil environments are not considered corrosive to Ductile Iron Pipe, soils in landfill sites such as the one pictured here are generally considered corrosive. Other typically corrosive environments include swamps, peat bogs, expansive clays, and alkali soils.

The material requirement called for in AWWA C105 Standard when it was issued in 1972 was 8-mil, low-density (LD) polyethylene. With the 1993 revision to this standard, the section on materials was expanded to include 4-mil, high-density, cross-laminated (HDCL) polyethylene.

HDCL polyethylene was first installed on an operating pipeline in Aurora, Colorado, in 1981. In 1982, DIPRA began investigating the corrosion protection afforded Ductile Iron Pipe by 4-mil HDCL polyethylene encasement at its Logandale, Nevada, test site. During the 1993 revision of AWWA C105, the A21 Committee reviewed the test data on 4-mil HDCL polyethylene and concluded that from all indications, it provided comparable protection of Ductile Iron Pipe to that afforded by the standard 8-mil LD polyethylene. Based on that conclusion, the A21 Committee elected to incorporate the 4-mil HDCL polyethylene into the standard.

With the 1993 revision of the standard, the section on materials was also updated to include Class B (colored) polyethylene to allow for color coding of potable/reclaimed/wastewater pipelines as required by many local/state regulatory agencies.

The 1999 revision of AWWA C105 included: (1) the deletion of 8-mil LD polyethylene film, (2) the addition of 8-mil linear low-density (LLD) polyethylene film, and (3) the addition of impact, tear-resistant and marking requirements for both materials (LLD and HDCL). The revision benefitted the user by reflecting an improved polyethylene material.

Since the standard was first published in 1972, the polyethylene film industry has made a number of technological advances. The LD film, which continues to serve the industry well, had become more difficult to obtain. Newer materials, such as LLD film, which replaced the LD film, are readily available, much stronger, and more resistant to damage. The material requirements for the LLD film were closely patterned after the Australian Standard for Polyethylene Sleeving for Ductile Iron Pipelines (AS 3680) where the material has been in use for several years.

Laboratory tests indicate that the 4-mil HDCL and the 8-mil LLD polyethylene may be more resistant to construction damage than the old 8-mil LD polyethylene. Tensile strength, impact strength and puncture resistance of the 4-mil HDCL and the 8-mil LLD polyethylene are typically greater because of inherent differences in the materials. Based on DIPRA's laboratory and field research, either the 8-mil LLD or the 4-mil HDCL polyethylene material is recommended in accordance with AWWA C105 Standard for corrosion protection of Ductile Iron Pipe in aggressive environments.

Standards for Polyethylene Encasement	
ANSI/AWWA C105/A21.5: United States	1972
ASTM A674: United States	1974
JDPA Z 2005: Japan	1975
BS6076: Great Britain	1981
ISO 8180: International	1985
DIN 30 674, Part 5: Republic of Germany	1985
A.S. 3680 and A.S. 3681: Australia	1989

How Polyethylene Encasement Protects Ductile Iron Pipe

At the trench, crew members encase Ductile Iron Pipe with a tube or sheet of polyethylene immediately before installing the pipe. The polyethylene acts as an unbonded film, which prevents direct contact of the pipe with the corrosive soil. It also effectively reduces the electrolyte available to support corrosion activity to any moisture that might be present in the thin annular space between the pipe and the polyethylene film.

Typically, some groundwater will seep beneath the wrap. Although the entrapped water initially has the corrosive characteris- tics of the surrounding soil, the available dissolved oxygen supply beneath the wrap is soon depleted and the oxidation process stops long before any damage occurs. The water enters a state of stagnant equilibrium, and a uniform environment exists around the pipe.

The polyethylene film also retards the diffusion of additional dissolved oxygen to the pipe surface and the migration of cor- rosion products away from the pipe surface.

Polyethylene encasement is not designed to be a watertight system. Yet, once installed, the weight of the earth backfill and surrounding soil prevents any significant exchange of groundwater between the wrap and the pipe.

As with any corrosion-protection system, proper installation is important to polyethylene encasement's success. Polyethylene encasement should be carefully installed following one of three installation methods outlined in ANSI/AWWA C105/A21.5.

How V-Bio® Enhanced Polyethylene Encasement Protects Ductile Iron Pipe

V-Bio® Enhanced Polyethylene Encasement

The development of V-Bio® Enhanced Polyethylene Encasement began in 2002 and the first installations for field testing were at DIPRA test sites in 2014. The goal of V-Bio® Enhanced Polyethylene Encasement was to address two concerns that had been raised over the years with the use of polyethylene encasement; the potential influence of anaerobic bacteria through micro-biologically influenced corrosion (MIC) and the possibility of corrosion occurring under intact polywrap.

V-Bio Enhanced Polyethylene Encasement consists of three layers of co-extruded linear low density polyethylene (LLDPE) film that are fused into one. The inner layer that will be in contact with the pipe is infused with a proprietary blend of an anti-microbial additive to mitigate MIC and a volatile corrosion inhibitor (VCI) to control galvanic corrosion underneath the wrap. V-Bio® Enhanced Polyethylene Encasement protects against corrosion without involving the consumption of either the anti-microbial or the volatile corrosion inhibitor, meaning its enhanced properties will not wear out.

V-Bio® Enhanced Polyethylene Encasement follows and meets all requirements of the AWWA C105 standard. It is installed the same way using the same methods as regular polyethylene encasement and as with any protective measure proper installation is vital to its success. With V-Bio® Enhanced Polyethylene Encasement it is essential to maintain intimate contact of the encasement to the pipe to optimize the performance of the infused additives.

Advantages of Polyethylene Encasement

Polyethylene's excellent dielectric properties enable it to effectively shield the pipe from low-level stray direct current. Also, because polyethylene provides a uniform environment for the pipe underneath the wrap, local galvanic corrosion cells are virtually eliminated as the oxygen is consumed. With the use of V-Bio® Enhanced Polyethylene Encasement galvanic corrosion cells are non-existent thanks to the corrosion inhibitor infused into the inner layer.

Pinholes in the loose wrapping material do not significantly diminish its protective ability. And, unlike bonded coatings, polyethylene has the ability to protect the pipe without the formation of concentration cells at coating holidays.

Polyethylene encasement is easy to install and requires no additional manpower or special equipment. Construction crew members simply slip the polyethylene over the pipe as they install it.

Compared to cathodic protection and bonded coatings, polyethylene and V-Bio® Enhanced Polyethylene Encasement is very inexpensive. The initial cost of material and installation is very low — only pennies per foot in most sizes. In fact, many utilities that install their own pipe assign no installation cost for the encasement, reporting that the material costs as little as a few cents per inch- diameter per foot for polyethylene encasement.

Both Polyethylene and V-Bio® Enhanced Polyethylene Encasement is are field- applied, so the pipe doesn't require special handling or packaging during shipment. And, because installation is on site, damage is less likely than on factory-applied coatings. If damaged, the polyethylene encasement is easy and simple to repair at the job site with polyethylene compatible adhesive tape.

Because polyethylene is a passive system of protection, it requires no expensive maintenance or monitoring and costs nothing to operate once installed

Polyethylene Encasement

- Is inexpensive.
- Is easy to install.
- Requires no additional manpower.
- Requires no maintenance or monitoring.
- Costs nothing to operate.
- Doesn't deteriorate underground.
- Is easily repaired with polyethylene adhesive tape if damaged.
- Doesn't require any special handling or packaging during shipment.
- V-Bio® Enhanced Polyethylene Encasement eliminates galvanic corrosion cells.
- Protects the pipe without the formation of concentration cells at coating holidays.

How to Identify Corrosive Environments

It is important to identify potentially corrosive environments prior to pipeline installation because, once a pipeline is installed, it is both costly and difficult to retrofit with corrosion protection measures.

Although Ductile Iron Pipe possesses good resistance to corrosion and needs no additional protection in most soils, experience has shown that external corrosion protection is warranted in certain soil environments. Examples include soils with low resistivities, anaerobic bacteria, differences in composition, and differential aeration around the pipe. Dissimilar metals and external stray direct currents may also necessitate additional corrosion protection.

Soils contaminated by coal mine wastes, cinders, refuse, or salts also are generally considered corrosive. So are certain naturally occurring environments, such as swamps, peat bogs, expansive clays, and alkali soils. And soils in wet, low-lying areas are generally considered more corrosive than those in well-drained areas.

Previously the 10 point soil evaluation procedure was recommended for identifying corrosive environments but it has been replaced with The Design Decision Model™. The DDM™ was developed jointly between DIPRA and Corrpro. It builds upon the proven 10 point system to provide the most accurate soil evaluation for Ductile Iron Pipe possible.

10-Point Soil Evaluation Procedure

Although several evaluation procedures have been used to predict conditions corrosive to underground piping, the 10-point soil evaluation procedure instituted by CIPRA in 1964 is most often recommended for Ductile Iron Pipe. Included in the Appendix to the ANSI/AWWA C105/A21.5 Standard, the 10-point system has proved invaluable in surveying more than 100 million feet of proposed pipeline installations to determine soil corrosivity.

The evaluation procedure is based upon information drawn from five tests and observations:

- Soil resistivity
- pH
- Oxidation-reduction (redox) potential
- Sulfides
- Moisture

For a given soil sample, each parameter is evaluated and assigned points according to its contribution to corrosivity. The points for all five areas are totaled, and if the sum is 10 or more, the soil is considered corrosive to Ductile Iron Pipe, and protective measures should be taken.

In addition, potential for stray direct current corrosion should also be considered as part of the evaluation. Notes on previous experience with underground structures in the area are also very important in predicting soil corrosivity.

It is important to note that the 10-point system, like any evaluation procedure, is intended as a guide in determining a soil's potential to corrode Ductile Iron Pipe. It should be used only by qualified engineers or technicians experienced in soil analysis and evaluation.

Soil Test Evaluation for Ductile Iron Pipe
(10-Point System)*

Soil Characteristics	Points
Resistivity (ohm-cm)**	
<1,500	10
≥1,500–1,800	8
>1,800—2,100	5
>2,100—2,500	2
>2,500—3,000	1
>3,000	0
pH	
0–2	5
2–4	3
4–6.5	0
6.5–7.5	0***
7.5–8.5	0
>8.5	3
Redox Potential	
> + 100 mv	0
+50 to +100 mv	3.5
0 to +50 mv	4
Negative	5
Sulfides	
Positive	3.5
Trace	2
Negative	0
Moisture	
Poor drainage, continuously wet	2
Fair drainage, generally moist	1
Good drainage, generally dry	0

*Ten points–corrosive to Ductile Iron Pipe. Protection is indicated.

**Based on water-saturated soil box. This method is designed to obtain the lowest–and most accurate–resistivity reading.

***If sulfides are present and low (<100 mv) or negative redox-potential results are obtained, 3 points should be given for this range.

Note: DIPRA recommends that the soil sample used in the 10-point evaluation be taken at pipe depth rather than at the surface. Soil corrosivity readings can vary substantially from the surface to pipe depth.

The Design Decision Model™

The DDM™ is a risk matrix concept that incorporates an evaluation of the likelihood of corrosion along a proposed Ductile Iron Pipeline route and the consequences that may result from a corrosionrelated problem. In this way, a utility is provided with a recommendation for corrosion control that is best suited for the particular installation under design. Recommendations range from simply installing the Ductile Iron Pipe as-manufactured with its protective standard shop coating and annealing oxide layer, to encasing the pipe in polyethylene, to providing cathodic protection currents to control the rate of corrosion.

Figure 1 shows that the recommendations for corrosion control result from obtaining a point count for both Likelihood and Consequence Factors. Entering the graph at the appropriate points, a color-coded intersection is found that establishes the appropriate corrosion mitigation recommendation. As enumerated in Figure 1, the methods include:

1. Installing the pipe as-manufactured with its protective standard shop coating/annealing oxide system.
2. Encasing the pipe in polyethylene.
3. Encasing the pipe in polyethylene or encasing the pipe and providing bonded joints.
4. Encasing the pipe in polyethylene and providing bonded joints or providing life-extension cathodic protection currents, with or without encasement.
5. Cathodic protection.

Likelihood Factors

Using the 10-Point System as described in Appendix A of ANSI/AWWA C105/A21.51 as a basis, the DDM™ evaluates the following factors in determining the likelihood that corrosion could be a problem for a proposed Ductile Iron Pipeline:

- Resistivity
- Sulfides
- Moisture Content
- Redox Potential
- Ground Water Influence
- Bi-metallic Considerations
- pH
- Known Corrosive Environments
- Chlorides

Of the above, resistivity, pH, redox, sulfides, and moisture content are criteria that carry over from the 10-Point Soil Evaluation System that the Ductile Iron Pipe industry has used for decades. For a discussion of the importance of these factors in contribution to a corrosion cell, please refer to Appendix A of ANSI/AWWA C105/A21.5.

Consequence Factors

Consequence factors relate to operational reliability and the difficulties that may exist in affecting a repair to a Ductile Iron Pipeline. The following core factors are used to establish those consequences:

- The diameter of the pipe.
- The location of the pipe.
- The depth of cover.
- Whether an alternative supply of water is available.

These factors are used to evaluate access to the pipe at a particular location and the relative difficulty in affecting repairs. Access can be categorized as good, with minimal traffic considerations, typical excavation depths, the availability of an alternative supply of water, etc., or increasingly more difficult where depth of cover, right-of-way considerations, utility congestion, or unstable soil conditions may have an impact on repair efforts.

MERRITT ISLAND, FL

27 Years

24-inch Cast Iron pipe encased in loose 8-mil polyethylene.
Installed 1963. Inspected 1990.
Soil Analysis:
- Description: Gray and black loamy sand.
- Resistivity: 1,120 ohm-cm (10)*
- pH: 7.1 (3)
- Redox: -20 mv (5)
- Sulfides: Positive (3.5)
- Moisture: Saturated (2)

Soil Condition: Corrosive (23.5)
Condition of Pipe and Encasement: Excellent

WATERFORD, MI

20 Years

8-inch Ductile Iron Pipe encased in loose 8-mil polyethylene
Installed 1975. Inspected 1995.
Soil Analysis:
- Description: Black and gray silty clay
- Resistivity: 960 ohm-cm (10)
- pH: 7.5 (3)
- Redox: +23 mv (3.5)
- Sulfides: Positive (3.5)
- Moisture: Saturated (2)

Soil Condition: Corrosive (22)
Condition of Pipe and Encasement:Excellent

PHILADELPHIA, PA

30 Years

12-inch Cast Iron Pipe encased in loose 8-mil polyethylene.
Installed 1959. Inspected 1989.
Soil Analysis:
- Description: Landfill area-brownish red clayey silts and dark gray organic clays with organic materials and petroleum and paper wastes
- Resistivity: 2,400 to 5,600 ohm-cm (2)
- pH: 3.9 to 6.2 (3)
- Redox: +67 to +69 mv (3.5)
- Sulfides: Positive (3.5)
- Moisture: Moist to saturated (2)

Soil Condition: Corrosive (14)
Condition of Pipe and Encasement: Very good

OGDEN, UT

10 Years

16-inch Ductile Iron Pipe encased in loose 8-mil polyethylene
Installed 1979. Inspected 1989.
Soil Analysis:
- Description: Dark gray silty clay
- Resistivity: 192 ohm-cm (10)
- pH: 7.9 (0)
- Redox: -165 mv (5)
- Sulfides: Positive (3.5)
- Moisture: Saturated (2)

Soil Condition: Corrosive (20.5)
Condition of Pipe and Encasement: Excellent

*Numbers in parentheses indicate point count per Soil Test Evaluation procedure outlined in Appendix A of ANSI/AWWA C105/A21.5. See table on page 7 of this brochure for explanation.

MITCHELL, SD

18 Years

12-inch Cast Iron pipe encased in loose 8-mil polyethylene.
Installed 1963. Inspected 1981.
Soil Analysis:
- Description: Brown clay and sand with cinders present.
- Resistivity: 840 ohm-cm (10)
- pH: 7.1 (0)
- Redox: +450 mv (0)
- Sulfides: Trace (2)
- Moisture: Moist (1)

Soil Condition: Corrosive (13)
Condition of Pipe and Encasement: Excellent

DETROIT, MI

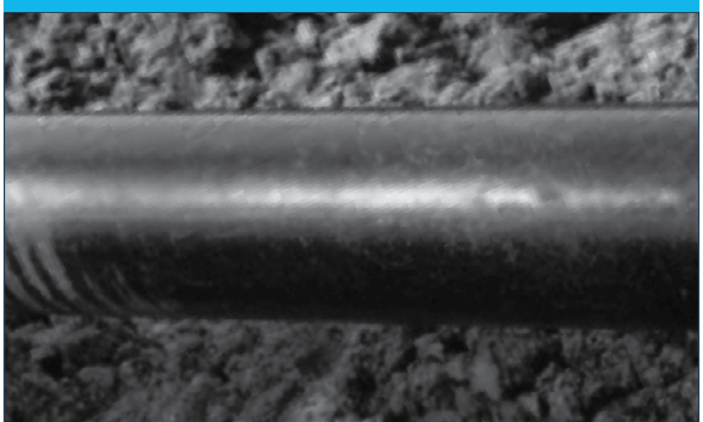
21 Years

8-inch Ductile Iron Pipe encased in loose 8-mil polyethylene.
Installed 1974. Inspected 1995.
Soil Analysis:
- Description: Gray and black silty clay
- Resistivity: 1,320 ohm-cm (10)
- pH: 7.4 (3)
- Redox: -113 mv (5)
- Sulfides: Positive (3.5)
- Moisture: Saturated (2)

Soil Condition: Corrosive (23.5)
Condition of Pipe and Encasement: Excellent

OMAHA, NE

15 Years



12-inch Cast Iron pipe encased in loose 8-mil polyethylene.
Installed 1974. Inspected 1989.
Soil Analysis:
- Description: Gray clay
- Resistivity: 600 ohm-cm (10)*
- pH: 7.4 (3)
- Redox: +90 mv (3.5)
- Sulfides: positive (3.5)
- Moisture: Wet (2)

Soil Condition: Corrosive (22)
Condition of Pipe and Encasement: Excellent

CHARLESTON, SC

21 Years

24-inch Ductile Iron Pipe encased in loose 8-mil polyethylene.
Installed 1967. Inspected 1988.
Soil Analysis:
- Description: Gray sand and clay with organic muck in reclaimed marsh subjected to fluctuating water table due to coastal tidal effect.
- Resistivity: 560 ohm-cm (10)
- pH: 6.9 (3)
- Redox: -132 mv (5)
- Sulfides: Positive (3.5)
- Moisture: Saturated (2)

Soil Condition: Corrosive (23.5)
Condition of Pipe and Encasement: Excellent

*Numbers in parentheses indicate point count per Soil Test Evaluation procedure outlined in Appendix A of ANSI/AWWA C105/A21.5. See table on page 7 of this brochure for explanation.

SYRACUSE, NY

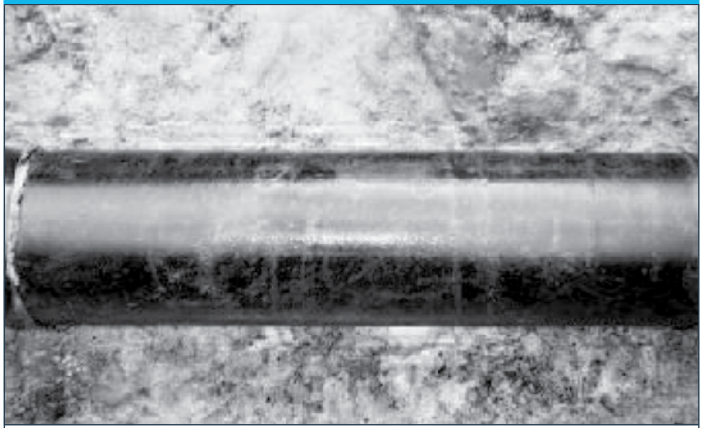
15 Years

8-inch Ductile Iron Pipe encased in loose 8-mil polyethylene.
Installed 1988. Inspected 2003.
Soil Analysis:
- Description: Dark, organic brown clay
- Resistivity: 410 ohm-cm (10)
- pH: 6.9 (3)
- Redox: -40 mv (5)
- Sulfides: Positive (3.5)
- Moisture: Saturated (2)

Soil Condition: Corrosive (23.5)
Condition of Pipe and Encasement: Excellent

FAYETTEVILLE, AR

30 Years



12-inch Gray Iron pipe encased in loose 8-mil polyethylene
Installed 1973. Inspected 2003.
Soil Analysis:
- Description: Dark gray clay
- Resistivity: 1,600 ohm-cm (8)
- pH: 6.8 (3)
- Redox: -100 mv (5)
- Sulfides: Positive (3.5)
- Moisture: Saturated (2)

Soil Condition: Corrosive (21.5)
Condition of Pipe and Encasement: Excellent

JACKSON, MS

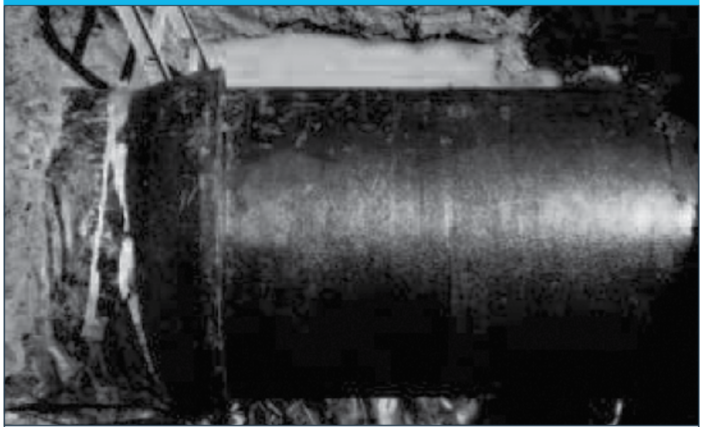
9 Years

8-inch Ductile Iron Pipe encased in loose 8-mil polyethylene.
Installed 1977. Inspected 1986.
Soil Analysis:
- Description: Mixture of organic clay and brown silty clay
- Resistivity: 880 ohm-cm (10)
- pH: 4.4 (0)
- Redox: -150 mv (5)
- Sulfides: Positive (3.5)
- Moisture: Saturated (2)

Soil Condition: Corrosive (20.5)
Condition of Pipe and Encasement: Excellent

LITTLE ROCK, AR

14 Years



30-inch Ductile Iron Pipe encased in loose 8-mil polyethylene
Installed 1972. Inspected 1986.
Soil Analysis:
- Description: Dark reddish and grayish brown clay
- Resistivity: 600 ohm-cm (10)
- pH: 6.9 (3)
- Redox: +40 mv (4)
- Sulfides: Trace (2)
- Moisture: Saturated (2)

Soil Condition: Corrosive (21)
Condition of Pipe and Encasement: Excellent

*Numbers in parentheses indicate point count per Soil Test Evaluation procedure outlined in Appendix A of ANSI/AWWA C105/A21.5. See table on page 7 of this brochure for explanation.

MONTGOMERY, AL

20 Years

36-inch Ductile Iron Pipe encased in loose 8-mil polyethylene.
Installed 1982. Inspected 2002.
Soil Analysis:
- Description: Reddish brown clayey sand
- Resistivity: 172 ohm-cm (10)*
- pH: 8.7 (3)
- Redox: +30 mv (4)
- Sulfides: Negative (0)
- Moisture: Saturated (2)

Soil Condition: Corrosive (19)
Condition of Pipe and Encasement: Excellent

LAFOURCHE PARISH, LA

40 Years

4-inch Cast Iron pipe encased in loose 8-mil polyethylene.
Installed 1958. Inspected 1998.
Soil Analysis:
- Description: Gray clay with black organics
- Resistivity: 520 ohm-cm (10)
- pH: 6.3 (0)
- Redox: -50 mv (5)
- Sulfides: Positive (3.5)
- Moisture: Saturated (2)

Soil Condition: Corrosive (20.5)
Condition of Pipe and Encasement: Excellent

LATHAM, NY

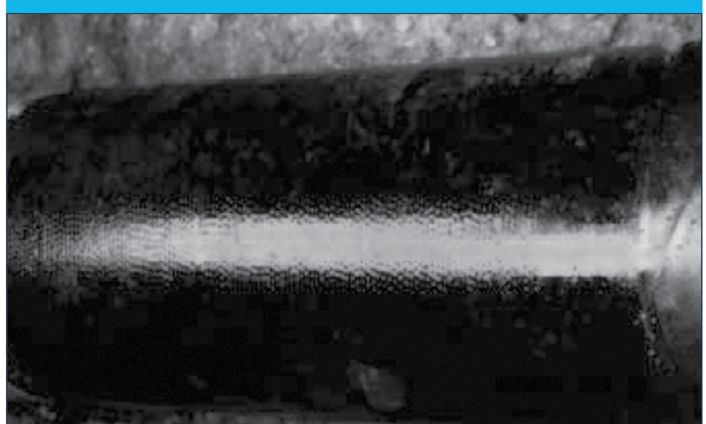
36 Years

6-inch Ductile Iron Pipe encased in loose 8-mil polyethylene.
Installed 1962. Inspected 1998.
Soil Analysis:
- Description: Dark brown stiff clay
- Resistivity: 600 ohm-cm (10)
- pH: 7.1 (0)
- Redox: +200 mv (0)
- Sulfides: Negative (0)
- Moisture: Saturated (2)

Soil Condition: Corrosive (12)
Condition of Pipe and Encasement: Excellent

ST. GEORGE, UT

16 Years



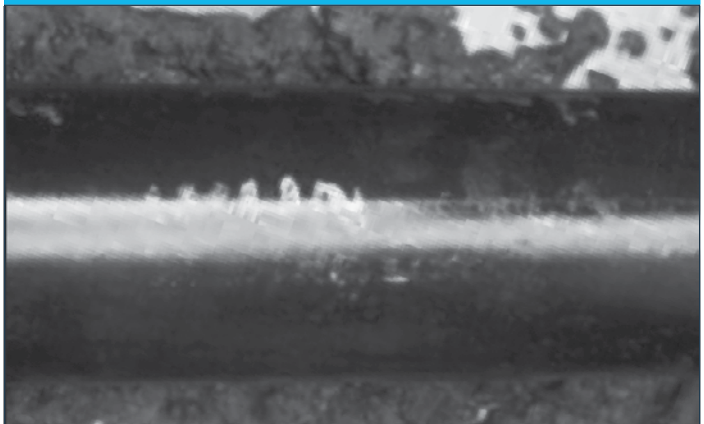
12-inch Ductile Iron Pipe encased in loose 8-mil polyethylene.
Installed 1968. Inspected 1984.
Soil Analysis:
- Description: Dark gray clayey silt
- Resistivity: 720 ohm-cm (10)
- pH: 7.3 (0)
- Redox: +110 mv (0)
- Sulfides: Negative (0)
- Moisture: Saturated (2)

Soil Condition: Corrosive (12)
Condition of Pipe and Encasement: Excellent

*Numbers in parentheses indicate point count per Soil Test Evaluation procedure outlined in Appendix A of ANSI/AWWA C105/A21.5. See table on page 7 of this brochure for explanation.

CITY OF ORANGE, CA

18 Years



6-inch Cast Iron pipe encased in loose 8-mil polyethylene.
Installed 1969. Inspected 1987.
Soil Analysis:
- Description: Brown silty clay
- Resistivity: 640 ohm-cm (10)
- pH: 6.3 (0)
- Redox: +170 mv (0)
- Sulfides: Negative (0)
- Moisture: Saturated (2)

Soil Condition: Corrosive (12)
Condition of Pipe and Encasement: Excellent

ST. LOUIS, MO

13 Years

12-inch Ductile Iron Pipe encased in loose 8-mil polyethylene.
Installed 1973. Inspected 1986.
Soil Analysis:
- Description: Sticky gray-brown clay
- Resistivity: 600 ohm-cm (10)
- pH: 6.7 (0)
- Redox: +150 mv (0)
- Sulfides: Negative (0)
- Moisture: Moist (1)

Soil Condition: Corrosive (11)
Condition of Pipe and Encasement: Excellent

NANTICOKE, ON, CANADA

16 Years

16-inch Ductile Iron Pipe encased in loose 8-mil polyethylene.
Installed 1977. Inspected 1993.
Soil Analysis:
- Description: Brown, gray, and black silty clay
- Resistivity: 960 ohm-cm (10)
- pH: 7.3 (3)
- Redox: -18 mv (5)
- Sulfides: Positive (3.5)
- Moisture: Saturated (2)

Soil Condition: Corrosive (23.5)
Condition of Pipe and Encasement: Very good

FARMINGTON/SHIPROCK, NM

20 Years

16-inch Ductile Iron Pipe encased in loose 8-mil polyethylene.
Installed 1968. Inspected 1988.
Soil Analysis:
- Description: Light brown clayey silt with some gravel and rock
- Resistivity: 400 ohm-cm (10)
- pH: 7.7 (0)
- Redox: +146 mv (0)
- Sulfides: Trace (2)
- Moisture: Saturated (2)

Soil Condition: Corrosive (14)
Condition of Pipe and Encasement: Excellent

*Numbers in parentheses indicate point count per Soil Test Evaluation procedure outlined in Appendix A of ANSI/AWWA C105/A21.5. See table on page 7 of this brochure for explanation.

Proper Installation of Polyethylene Encasement

As with any corrosion-protection system, proper installation is important to polyethylene encasement's success. Care taken during installation is as important as the installation method itself. The few known failures of polyethylene-encased Cast and Ductile Iron Pipe have generally been due to improper installation or poor workmanship. The ANSI/AWWA C105/A21.5 Standard outlines three methods of installing polyethylene sleeving. Methods A and B use polyethylene tubes, and Method C uses polyethylene sheets. Method A uses one length of polyethylene tube, overlapped at the joints, for each length of pipe. Because installation is faster and easier, most utilities and contractors choose some form of Method A. Method B uses a length of polyethylene tube for the barrel of the pipe and a separate length of polyethylene tube or sheet for the joints. The national standard does not recommend Method B for bolted-type joints unless an additional layer of polyethylene is provided over the joint area as in Methods A and C. In Method C, each section of pipe is completely wrapped with a flat polyethylene sheet.

ANSI/AWWA C105/A21.5 Installation Methods

Method A

In this method, which is preferred by most utilities and contractors, one length of polyethylene tube, overlapped at the joints, is used for each length of pipe.

Method B

A length of polyethylene tube is used for the barrel of the pipe and separate length of polyethylene tube or sheets are used for the joints. Note: Method B is not recommended for bolted type joints unless additional layer of polyethylene is provided over the joint area as in Methods A and C.

Method C

Each section of pipe is completely wrapped with a flat polyethylene sheet.

Modified Method A for Normal Dry Trench Conditions

Step 1
Cut a section of polyethylene tube approximately two feet longer than the pipe section. Remove all lumps of clay, mud, cinders, or other material that might have accumulated on the pipe surface during storage. Slip the polyethylene tube around the pipe, starting at the spigot end. Bunch the tube accordion-fashion on the end of the pipe. Pull back the overhanging end of the tube until it clears the pipe end.

Step 2
Take up slack in the tube along the barrel of the pipe to make a snug, but not tight, fit. Fold excess polyethylene back over the top of the pipe.

Step 3
Dig a shallow bell hole in the trench bottom at the joint location to facilitate installation of the polyethylene tube. Lower the pipe into the trench and make up the pipe joint with the preceding section of pipe.

Step 4
Move the cable to the bell end of the pipe and lift the pipe slightly to provide enough clearance to easily slide the tube. Spread the tube over the entire barrel of the pipe. Note: Make sure that no dirt or other bedding material becomes trapped between the wrap and the pipe.

Step 5
Make the overlap of the polyethylene tube by pulling back the bunched polyethylene from the preceding length of pipe and securing it in place. Note: The polyethylene may be secured in place by using tape or plastic tie straps.

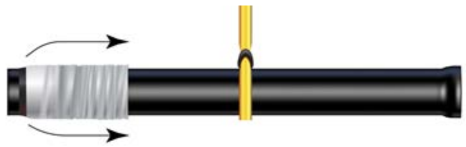
Step 6
Overlap the secured tube end with the tube end of the new pipe section. Secure the new tube end in place.

Step 7
Repair all small rips, tears, or other tube damage with adhesive tape. If the polyethylene is badly damaged, repair the damaged area with a sheet of polyethylene and seal the edges of the repair with adhesive tape.

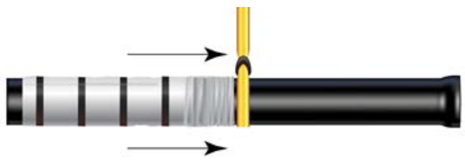
Step 8
Carefully backfill the trench according to the procedures in AWWA C600 Standard. To prevent damage during backfilling, allow adequate slack in the tube at the joint. Backfill should be free of cinders, rocks, boulders, nails, sticks, or other materials that might damage the polyethylene. Avoid damaging the polyethylene when using tamping devices.

Alternate Method A for Wet Trench Conditions

In wet, sloppy trench conditions, the pipe should be completely covered by the polyethylene tube before it is lowered in to the trench. This alternate method is illustrated below.

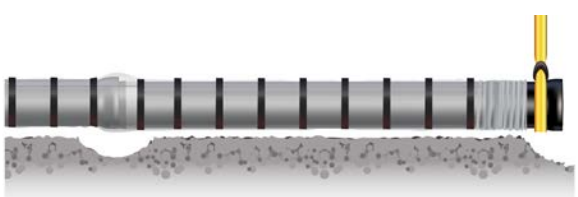


Step 1
Cut the polyethylene tube to a length approximately two feet longer than that of the pipe section. Slip the tube over the pipe.



Step 2
Spread the tube over the entire barrel of the pipe, pushing back both ends of the tube until they clear both pipe ends. Make sure the tube is entered on the pipe to provide a one-foot overlap each end.

Step 3
Take up slack in the tube to make a snug, but not tight, fit. (see previous page.) Circumferential wraps of tape or plastic tie straps should be placed at 2-foot intervals along the barrel of the pipe to help minimize the space between the polyethylene and the pipe. Wrap a piece of tape or plastic tie strap completely around the pipe at each end to seal the polyethylene, leaving ends free to overlap the adjoining sections of pipe.



Step 4: Lower pipe into the trench and make up the pipe joint. Be careful not to damage the polyethylene when handling or jointing the pipe. Complete the installation following dry condition Steps 4,5 (taking care to seal ends of overlap by wrapping tape or plastic tie straps completely around the pipe at each end), 8, and 9 on previous page. **Note: When lifting polyethylene-encased pipe, use a fabric-type sling or suitable padded cable or chain to prevent damage to the polyethylene.**

If you have any problems or questions about installing polyethylene encasement, contact DIPRA or one of its member companies.

Appurtenances

Pipe-Shaped Appurtenances
Cover bends, reducers, offsets, and other pipe-shaped appurtenances in the same manner as the pipe.

Odd-Shaped Appurtenances
Wrap odd-shaped appurtenances such as valves, tees, and crosses with a flat sheet or split length of polyethylene tube by passing the sheet under and then over the appurtenance and bringing it together around the body of the appurtenance. Make seams by bringing the edges of the polyethylene together, folding over twice, and taping them down.

Joints
Overlap joints as in normal installation; then tape the polyethylene securely in place at valve stems and other penetrations. When bolted-type joints are used, care should always be taken to prevent bolts or other sharp edges of the joint configuration from penetrating the wrap.

Branches, Blowoffs, Air Valves
To provide openings for branches, blowoffs, air valves, and similar appurtenances, make an X-shaped cut in the polyethylene and temporarily fold back the film. After installing the appurtenance, tape the slack securely to the appurtenance and repair the cut and any other damaged areas in the polyethylene with tape.

Service Taps
The preferred method of tapping polyethylene-encased Ductile Iron Pipe involves wrapping two or three layers of polyethylene adhesive tape completely around the pipe to cover the area where the tapping machine and chain will be mounted. Then install the corporation stop directly through the tape and polyethylene. After the tap is made inspect the entire circumferential area for damage and make any necessary repairs.

Recommended Tapping Method

To perform the preferred method of tapping polyethylene-encased Ductile Iron Pipe, wrap two or three layers of polyethylene-compatible adhesive tape completely around the pipe to cover the area where the tapping machine and chain will be mounted.

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Mount the tapping machine on the pipe area covered by the polyethylene tape. Then make the tap and install the corporation stop directly through the tape and polyethylene.

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After making the direct service connection, inspect the entire circumferential area for damage and make any necessary repairs.

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Tips for Proper Installation

1. Quality of installation is more important than the actual sequence followed.
2. Don't leave the polyethylene outside in the sun for long periods before installation.
3. When lifting polyethylene-encased pipe with a backhoe, use a fabric-type "sling" or padded cable to protect the polyethylene.
4. Be sure to remove all lumps of clay, mud, cinders, etc., on the pipe surface before you encase the pipe.
5. Take care to keep soil or bedding material from becoming trapped between the pipe and the polyethylene.
6. When installing polyethylene encasement below the water table or in areas subject to tidal action, seal as thoroughly as possible both ends of each polyethylene tube with polyethylene adhesive tape or plastic tie straps at the joint overlap. Additionally, place circumferential wraps of tape or plastic tie straps at 2-foot intervals along the barrel of the pipe to help minimize the space between the polyethylene and the pipe.

Recommended Polyethylene Tube and Sheet Sizes for Ductile Iron Pipe

Nominal Pipe Diameter (in).	Minimum Polyethylene Width (in.)	
	Flat Tube	Sheet
3	14	28
4	14	28
6	16	32
8	20	40
10	24	48
12	27	54
14	30	60
16	34	68
18	37	74
20	41	82
24	54	108
30	67	134
36	81	162
42	81	162
48	95	190
54	108	216
60	108	216
64	121	242

Cost Considerations

Polyethylene encasement is more cost effective when compared to alternative corrosion-control systems like bonded coatings and cathodic protection.

According to costs outlined in a 1985 U.S. Army Corps of Engineers Technical Report, installing a 16-mil thick coating of coal tar epoxy is five times the cost of installing polyethylene encasement. And, this figure doesn't include the additional costs of packaging, handling, transportation, and inspection.

Compared to polyethylene encasement, cathodic protection is very expensive to install. According to the same Corps of Engineers' report, the cost to install an impressed-current cathodic protection system on 12-inch Ductile Iron Pipe is five times the cost of polyethylene encasement. The cost to install a sacrificial-anode system is approximately 30 times the cost of polyethylene. These figures don't include the ongoing maintenance expense required by both systems, which, over the life of the systems, are often much greater than initial design and installation costs.

Conclusion

There is no perfect system of corrosion protection for buried metallic pipelines. Failures have been documented with all types of corrosion-protection systems, including cathodic protection. Cathodic protection is very expensive to install and maintain and can also damage nearby pipelines through stray current interference. Bonded coatings are also expensive. Plus, they can be easily damaged during shipping, handling, and installation and are costly and difficult to repair in the field.

Polyethylene encasement also has limitations — and it is not universally applicable for all Ductile Iron Pipelines where corrosion protection is warranted. There are instances where it is not feasible to install polyethylene encasement due to unusual construction conditions. Additionally, in certain high-density stray current environments and in a "uniquely severe environment," as defined in Appendix "A" of ANSI/AWWA C105/A21.5, the sleeving alone might not provide the degree of protection needed. In such cases, DIPRA sometimes recommends alternative methods of corrosion protection. And, as with all corrosion control methods, the success of polyethylene encasement is dependent upon proper installation procedures.

Since the early 1950s, DIPRA has researched numerous methods of corrosion protection for Gray and Ductile Iron Pipe, including hundreds of investigations in the laboratory, in field test sites, and in operating water systems throughout the United States. New types of polyethylene, various external pipe coatings, and the use of select backfill have also been investigated. More than 58 years of experience have demonstrated polyethylene encasement's effectiveness in protecting Cast and Ductile Iron Pipe in a broad range of soil conditions. Properly installed polyethylene encasement can effectively eliminate the vast majority of corrosion problems encountered by most utilities. Based on numerous laboratory and field test results, DIPRA continues to recommend polyethylene encasement as the most economical and effective method of protecting Ductile Iron Pipe in most corrosive environments.

For Further Information

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- T.M. Walski, "Cost of Water Distribution System Infrastructure Rehabilitation, Repair, and Replacement," Technical Report EL-85-5. U.S. Army Corps of Engineers, Department of the Army, Washington, D.C., March 1985.
- W. Harry Smith, "Corrosion Prevention with Loose Polyethylene Encasement," Water & Sewage Works, May 1982.
- L. Gregg Horn, "The Design Decision Model™ For Corrosion Control of Ductile Iron Pipeline," Ductile Iron Pipe Research Association, Birmingham, AL.

For more information contact DIPRA or any of its member companies.

Ductile Iron Pipe Research Association

An association of quality producers dedicated to the highest pipe standards through a program of continuing research and service to water and wastewater professionals.

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