Advanced Applications for HDPE Pipe with New PE-RT Material

Wes Long

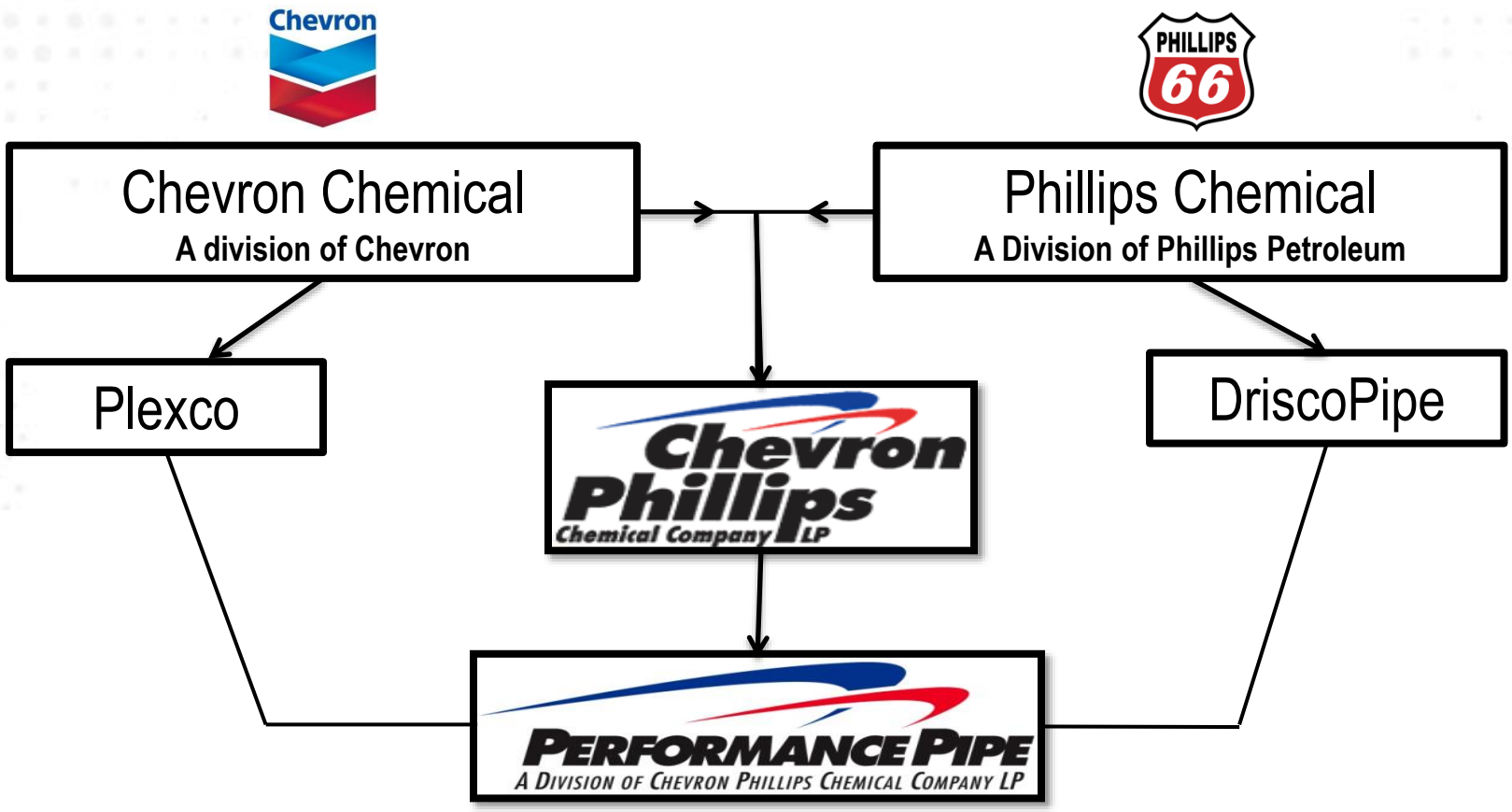
PERFORMANCE PIPE
A Division of Chevron Phillips Chemical Company LP

Overview

Pipe Design With New PE-RT Resin

Case Studies

Company Formation - 50/50 JV



Performance Pipe

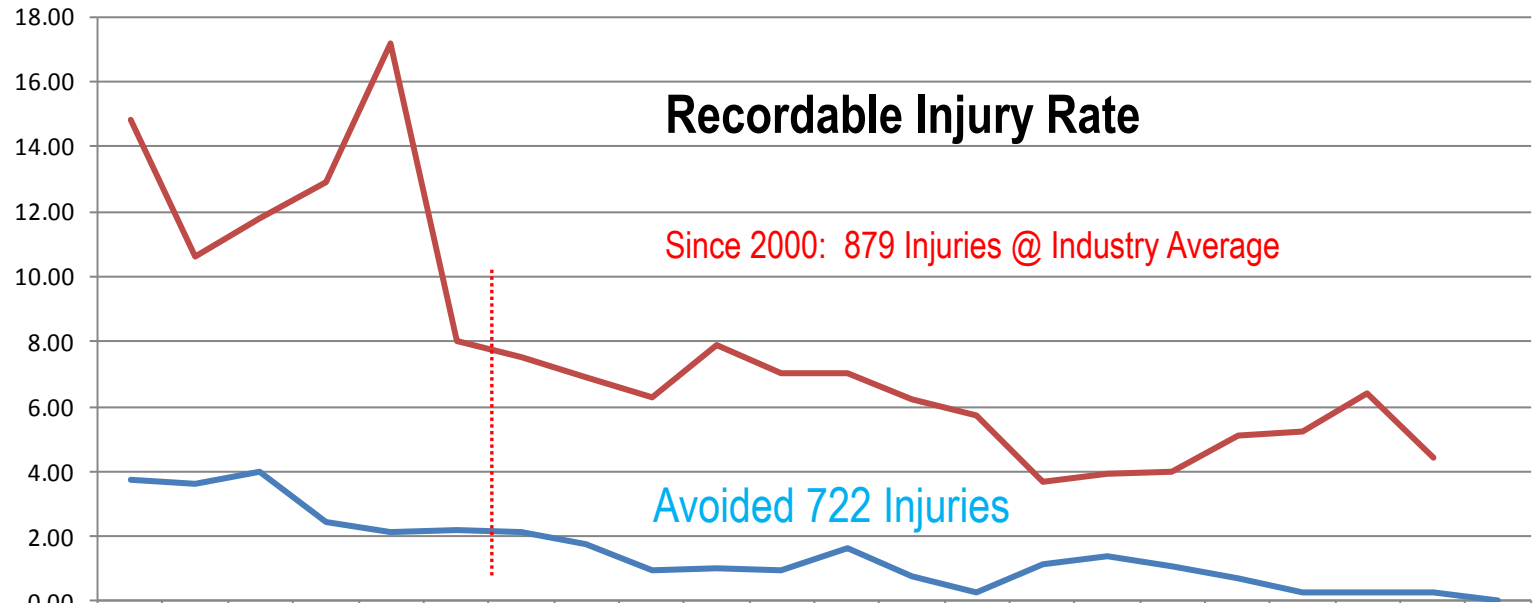
- Largest PE Pressure Pipe Manufacturer in North America
  - 7 Pipe Extrusion Plants
  - One Molded Fittings Plant
- Over 50 Years Experience
- Vertically integrated within Chevron Phillips
- 100% traceability

Reno, Nevada Plant

Plant and Office Locations

Performance Pipe & Industry RIR Trend

RIR = Number of OSHA recordable injuries & Illnesses per 200,000 man-hours worked.



	'95	'96	'97	'98	'99	'00	'01	'02	'03	'04	'05	'06	'07	'08	'09	'10	'11	'12	'13	'14	'15	'16
OSHA Reported Avg. RIR	14.8	10.6	11.8	12.9	17.2	8.00	7.50	6.90	6.30	7.90	7.00	7.00	6.20	5.70	3.70	3.90	4.00	5.10	5.20	6.40	4.40	
Perf Pipe Actual RIR	3.76	3.59	4.00	2.45	2.12	2.17	2.11	1.77	0.97	1.02	0.98	1.63	0.75	0.25	1.15	1.37	1.07	0.70	0.28	0.28	0.28	0.00
Perf Pipe Total Recordables	46	44	49	30	26	27	25	19	10	10	9	14	6	2	8	9	7	5	2	2	2	0

Since 2000: 157 Actual Injuries

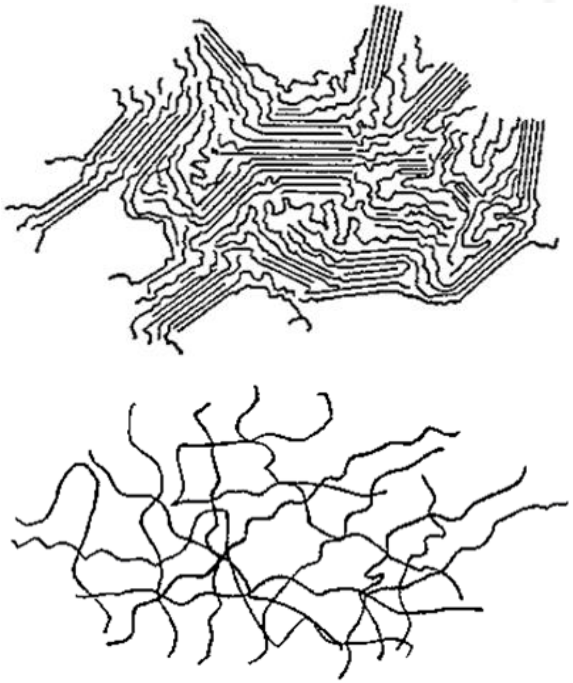
Voluntary Protection Programs
An OSHA Cooperative Program

SHARP
Safety & Health Achievement Recognition Program
Consultation: An OSHA Cooperative Program

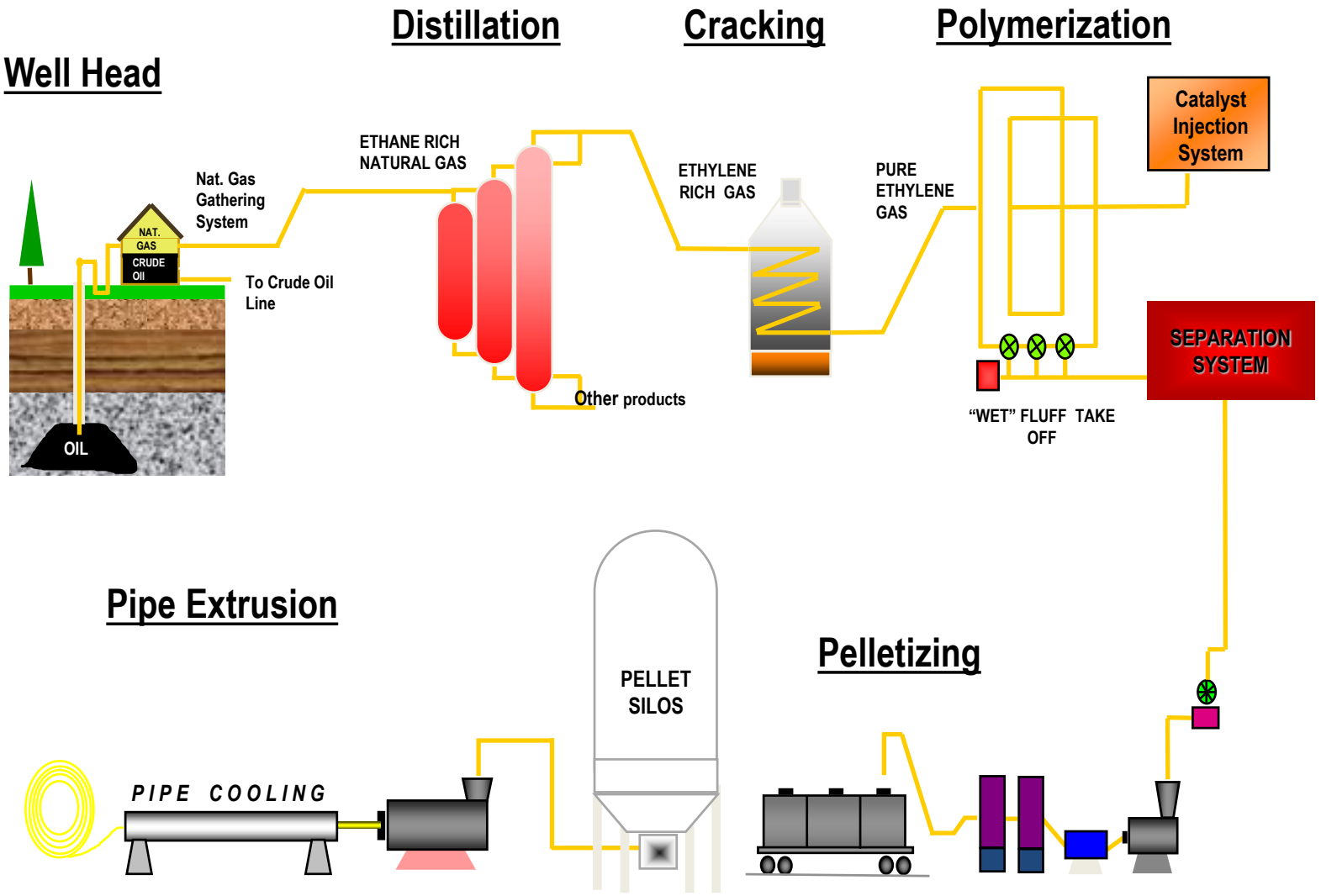
FFLAG
Fitness For Life Around Grant County

What is Polyethylene?

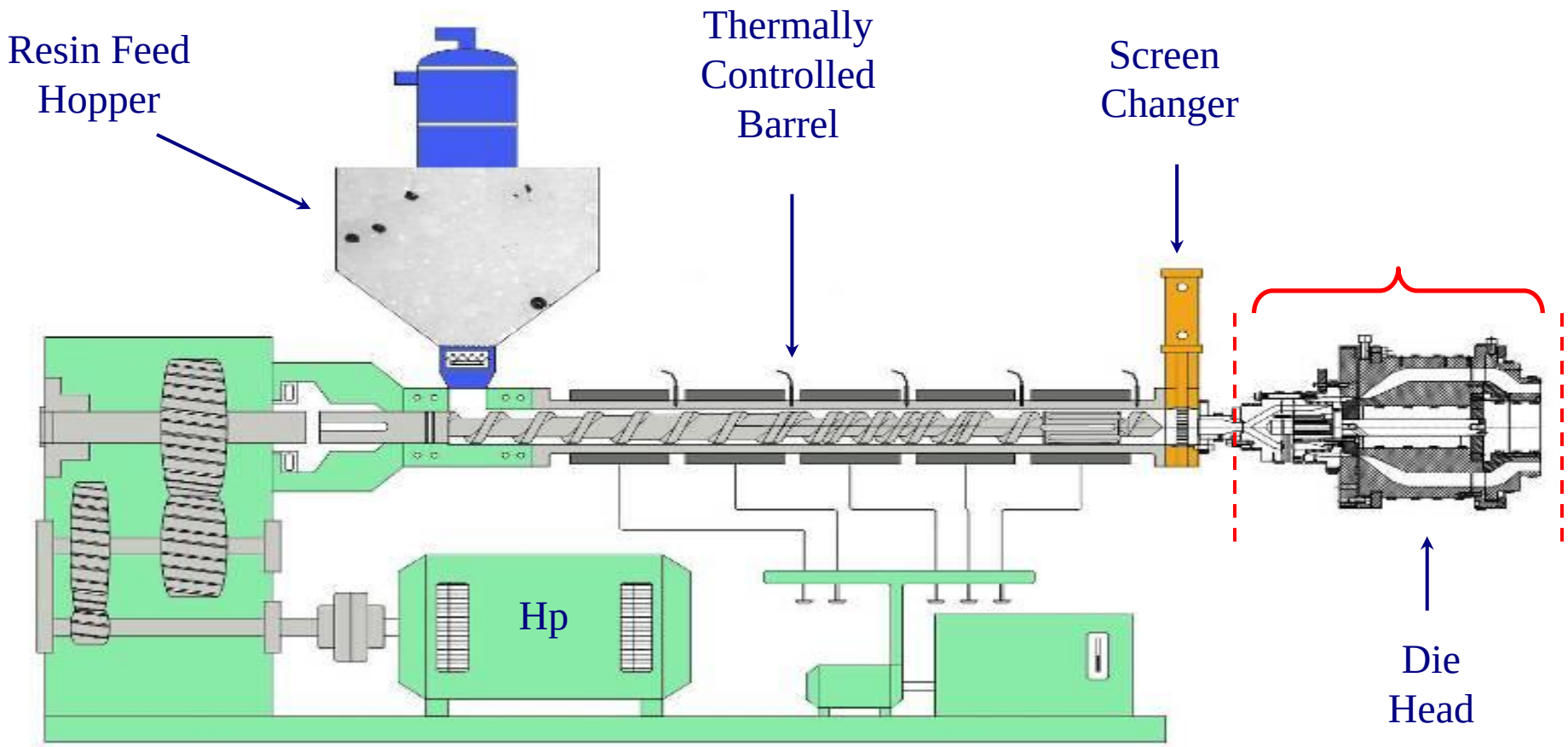
- **Thermoplastic**
  - Plastic that can be repeatedly softened by heating and hardened by cooling
  - Process is reversible and repeatable
  - Retains all physical properties
- **Semi-Crystalline Polymer**
  - Molecules pack in tight formations
  - Up to 90% crystalline region
  - Side branching reduces crystallinity and lowers density
  - Tensile strength and stiffness increase with density



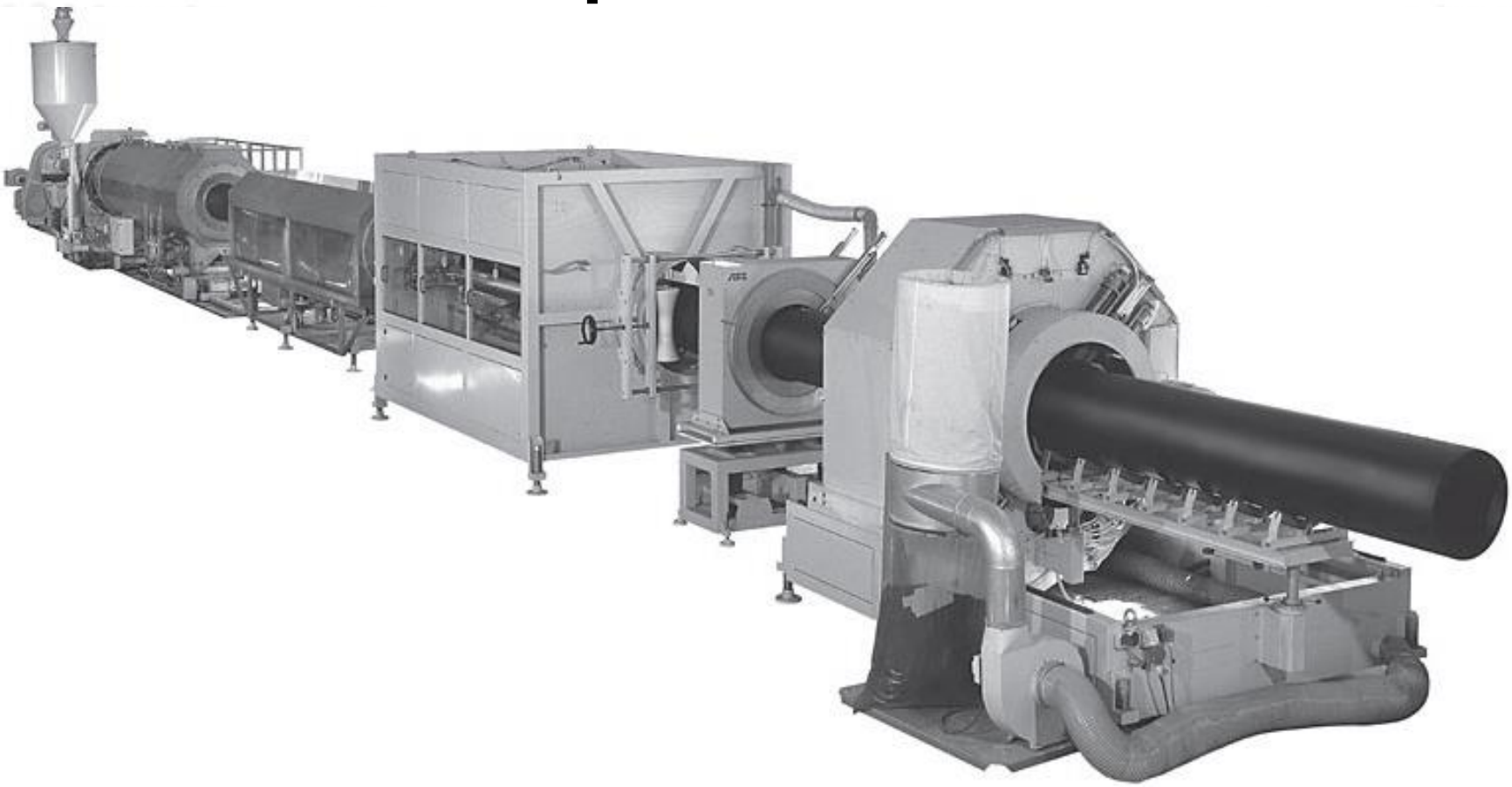
From Cradle to Pipe



Conventional Extrusion



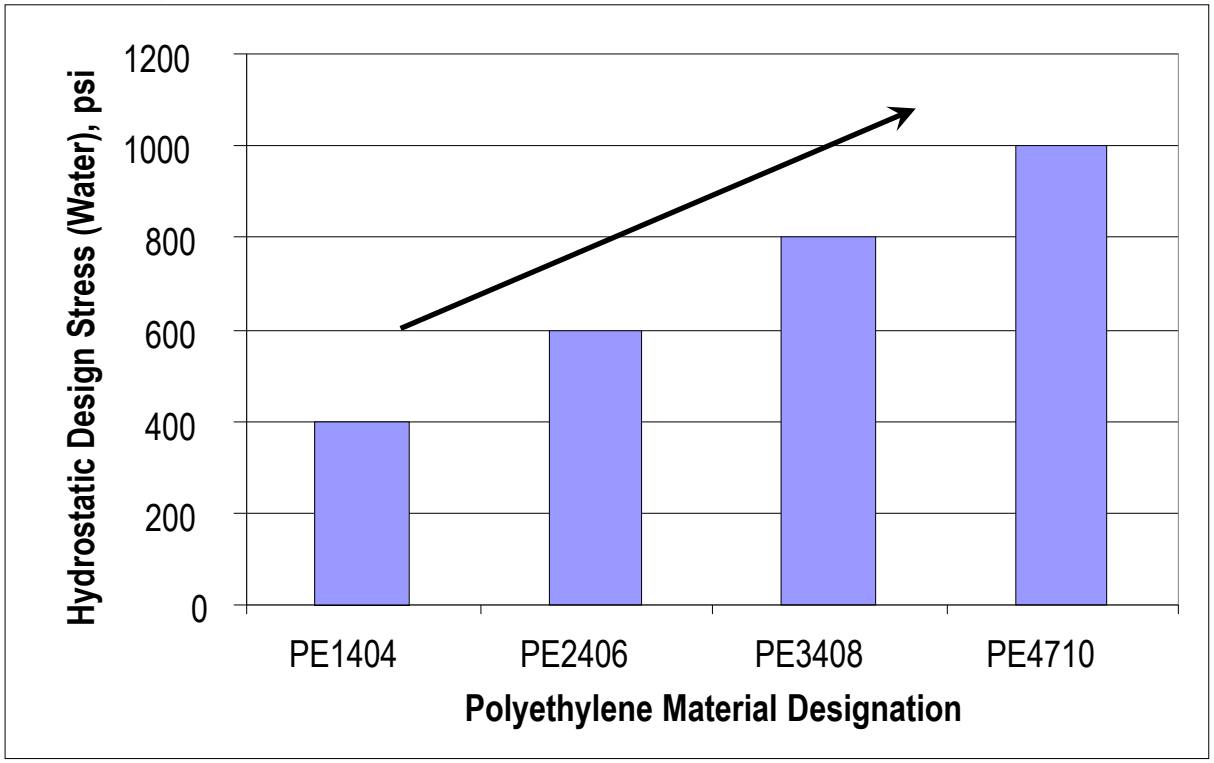
PE Pipe Extrusion Line



PE4710 Resin

- **PE3408 (Introduced in the early 1980's)**
  - 3 indicates High Density PE (>0.940 to 0.947)
  - 4 indicates PENT test of >10 hours
  - 08 indicates Hydrostatic Design Stress of 800 psi
- **PE4710 (Introduced to the market in 2005)**
  - 4 indicates High Density PE (>0.947 to 0.955)
  - 7 indicates PENT test of >500 hours
  - 10 indicates a Hydrostatic Design Stress of 1000 psi
- **PE4710 PE-RT (Introduced to the market in 2016)**

Resin Evolution

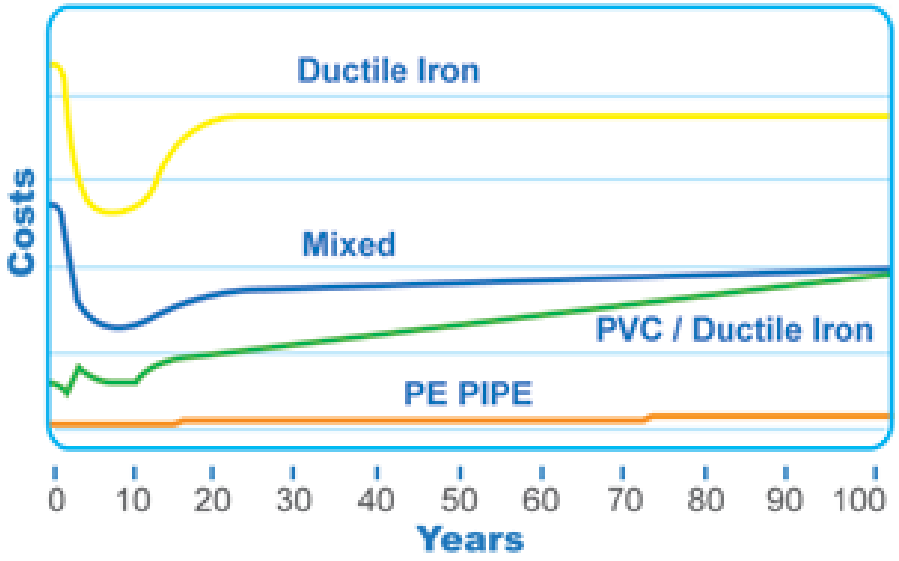


PE 3408 DR 11= 160 psi
vs.
PE 4710 DR 11 = 200 psi

Why PE Pipe?

Lowest life cycle cost of all piping solutions

- Very low failure rate
- Properly fused joints – leak free
- Flexible – ability to bend reduces need for fittings
- Seismically qualified - excellent for use in shifting soils
- No corrosion – non-stick inner surface smoother than FRP, steel, and concrete
- Abrasion/wear resistant – five times greater than steel pipe
- Produced in straight lengths & coils
- Lightweight – material 1/8 density of steel
- UV protected for outside storage and operation
- Long design life



Physical Characteristics

- Water can freeze in HDPE without damage
- HDPE can be Squeezed off to slow or stop flow (up to 12”)
- Reduced water hammer transient surge pressure
  (thrust blocks are not required)
- UV (ultraviolet) protected for unlimited outdoor storage or above ground use (>2% Carbon Black)
- Toughness – loss of up to 10% of the wall will not impact the integrity of the pipe

Thermal Expansion and Contraction

- **Rule of Thumb**: **The pipe will expand or contract 1.4 inches for every 100 feet of pipe for every 10°F temperature change.**

$$\Delta L = \frac{1.4in.}{100\,ft{*}10^{\circ}\,F} \times PipeLength \times \Delta T$$

Corrosion / Chemical Resistance

- Does not rust, rot, corrode, tuberculate, or support biological growth
  (Tuberculation is the development of small mounds of corrosion products on the inside of iron pipes.)
  - Material of choice in the packaging industry

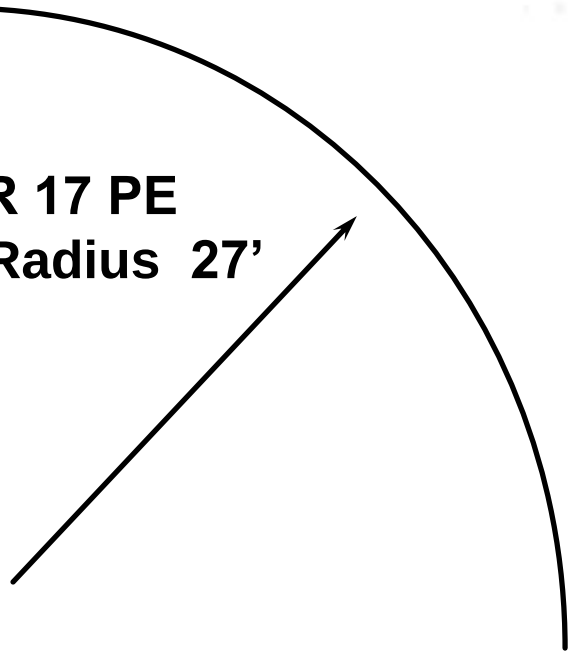
Cold Bending Radius

(20 to 40 Times the Pipe O.D Pending DR)

Example:

12” DR 17 allows a bending radius of 27 X the pipe OD (27 Feet)

12” steel pipe has a minimum bending radius of 200 X the pipe OD (200 Feet)



Molded Fittings Capabilities

- Elbows (90's & 45's and Tees) available from ½" to 8"
- Flange adapters and back up rings available from 2" to 18"
- Branch saddles
- Reducers
- Fabricated Fittings and Transitions are provided by others

Heat Fusion Joining Options

Butt Fusion

Saddle Fusion

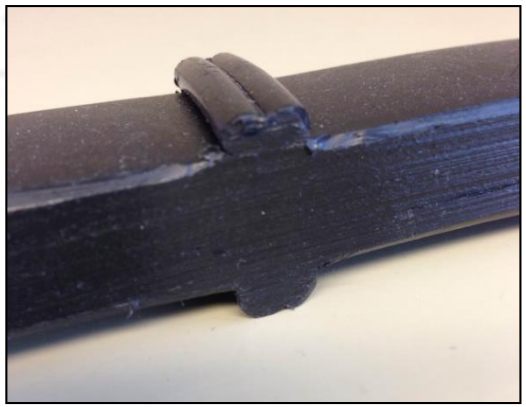
Electrofusion

Heat Fusion Welding

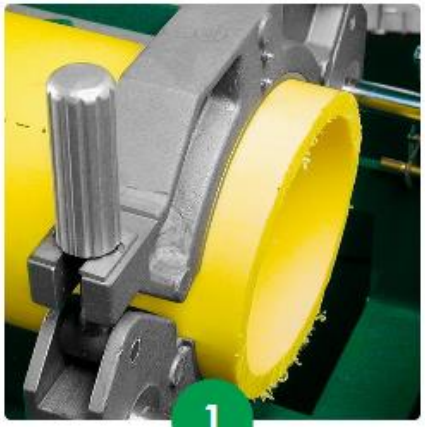
- Secure Pipe
- Face
- Align
- Melt
- Join

Fusion

- Fusion Training CD
- Fusion Literature
  - English and Spanish

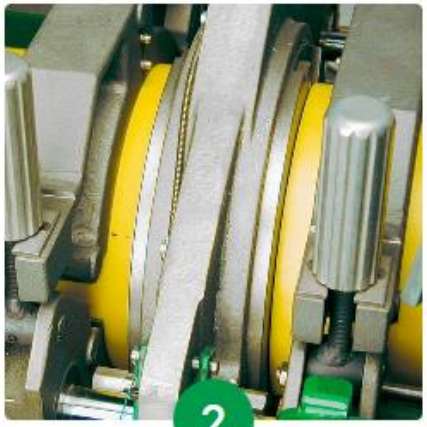


THE THEORY OF HEAT FUSION



CLAMPING THE PIPE

The pipe pieces are held axially to allow all subsequent operations to take place.



FACING THE PIPE

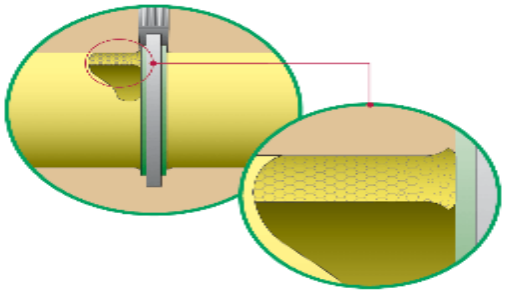
The pipe ends are faced to establish clean, parallel mating surfaces, perpendicular to the centerline of each

HEATING THE PIPE

The melt pattern, that penetrates into the pipe, must be formed around both pipe ends.

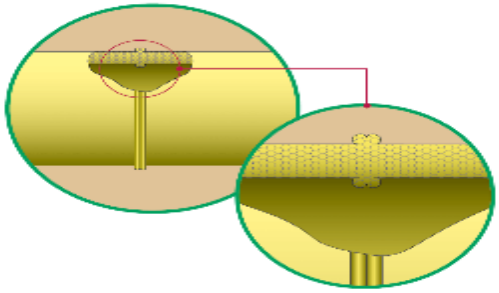
FUSING THE PIPE

The melt patterns must be joined with a specified force. The force on the joint must be held until the joint cools.



THE PRINCIPLE OF HEAT FUSION

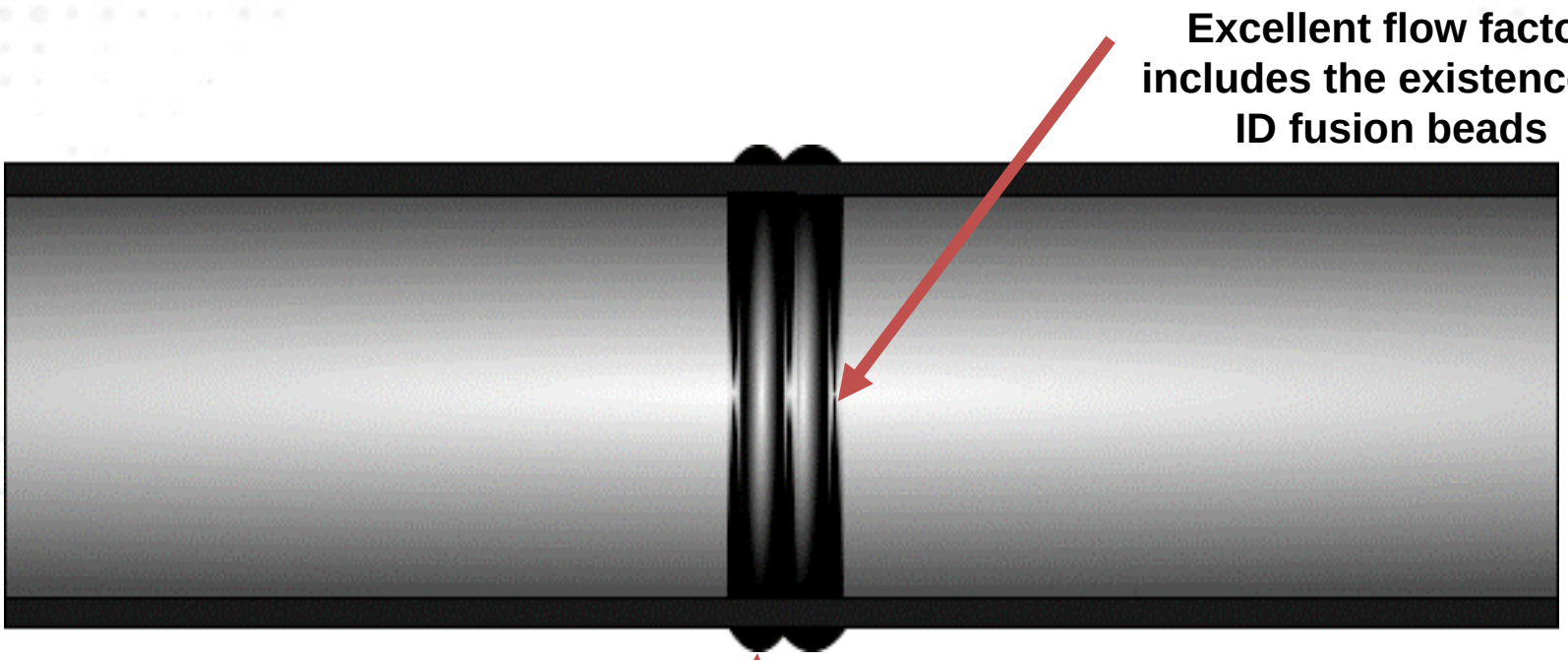
Heating two surfaces to a designated temperature, and then fuse them together by application of force. This process develops pressure, causing flow of the melted materials, which causes mixing and fusion. When the thermoplastic pipe is heated, the molecular structure is transformed from a crystalline state into an amorphous condition. When fusion pressure is applied, the molecules from each pipe end mix.



THE RESULT OF HEAT FUSION

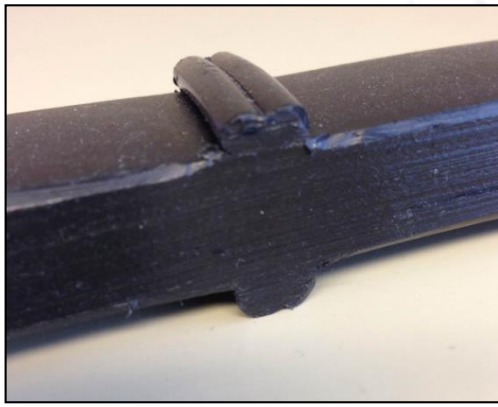
As the joint cools, the molecules return to their original form, the original interfaces are gone, and the two pipes have become one monolithic pipe.

BUTT FUSION


Excellent flow factor includes the existence of ID fusion beads
Double Roll Back Bead

HDPE Butt Fused Joint

Homogeneous, monolithic thermal fusion joint

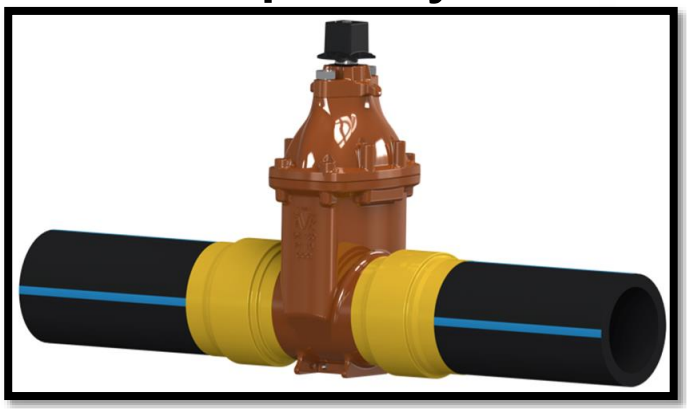


- Joint as strong as the pipe itself
- ASTM F2620 - Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings
- For HDPE butt fusion joints, two common fusion joint tests are available
  - Bend back test – ASTM F2620 (Appendix X4) for wall thicknesses less than 1”
  - Guided side bend test – ASTM F3183 for wall thicknesses of 1” and larger
  - Recommend fusion joint verification and documentation by data logger

Fitting Options

Molded

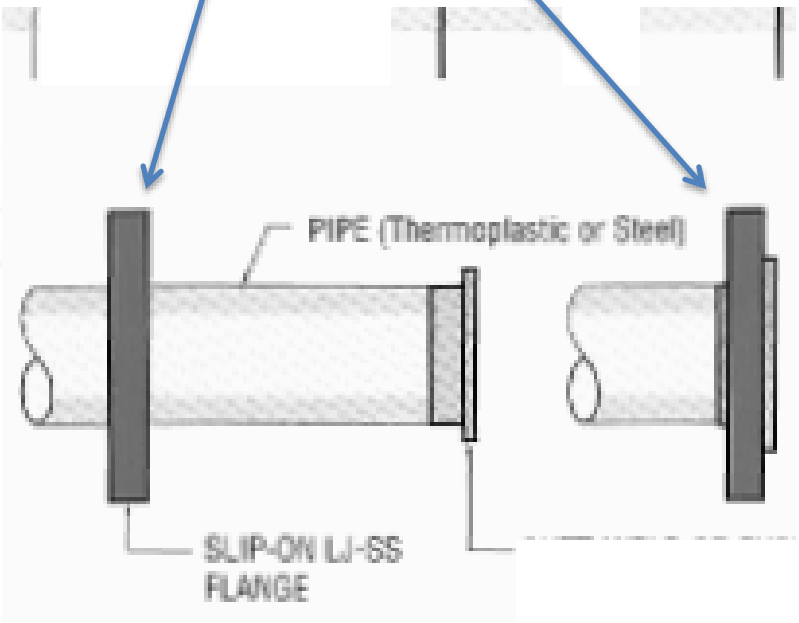
Specialty

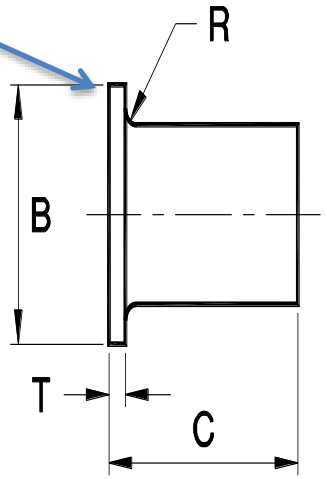


Fabricated

Flange Connections

Back up Rings - Flange Adapters



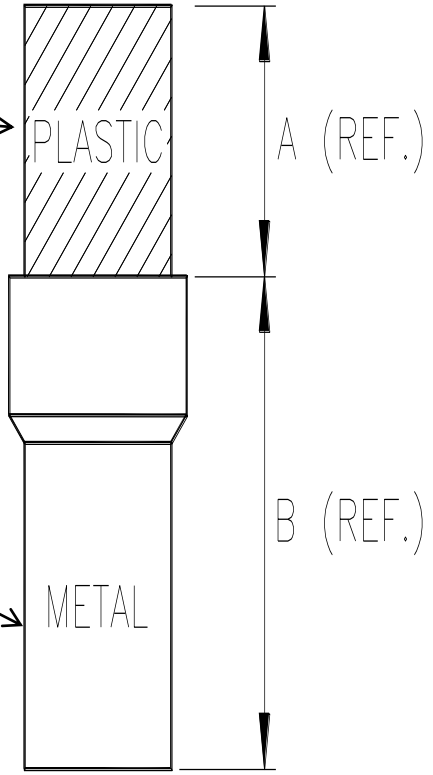


Transitions Fittings

HDPE

Steel

- Beveled Weld End
- Threaded End
- Flanged End



ELECTROFUSION

Victaulic Style Couplings

Style 905
Coupling

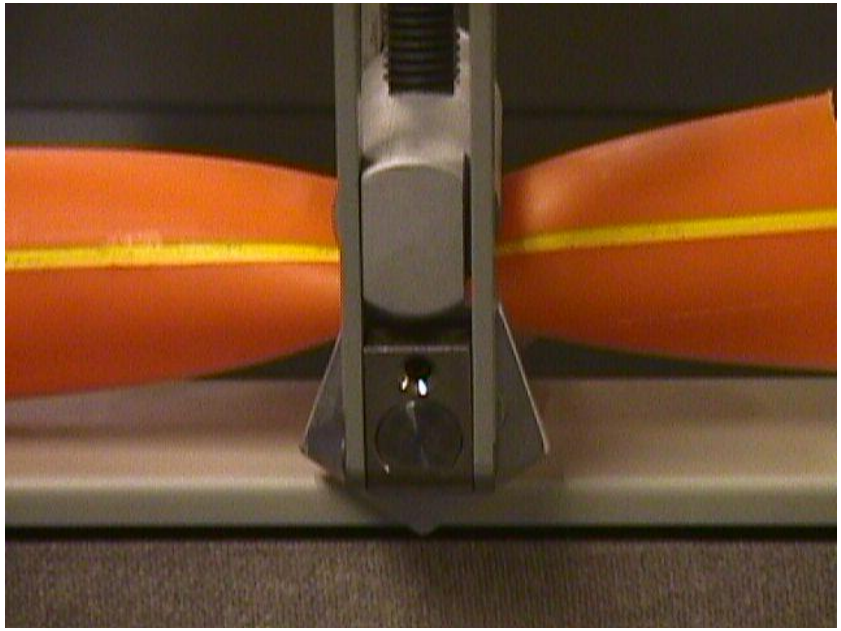
Style 926
Outlet

Style 994
Flange
Adapter

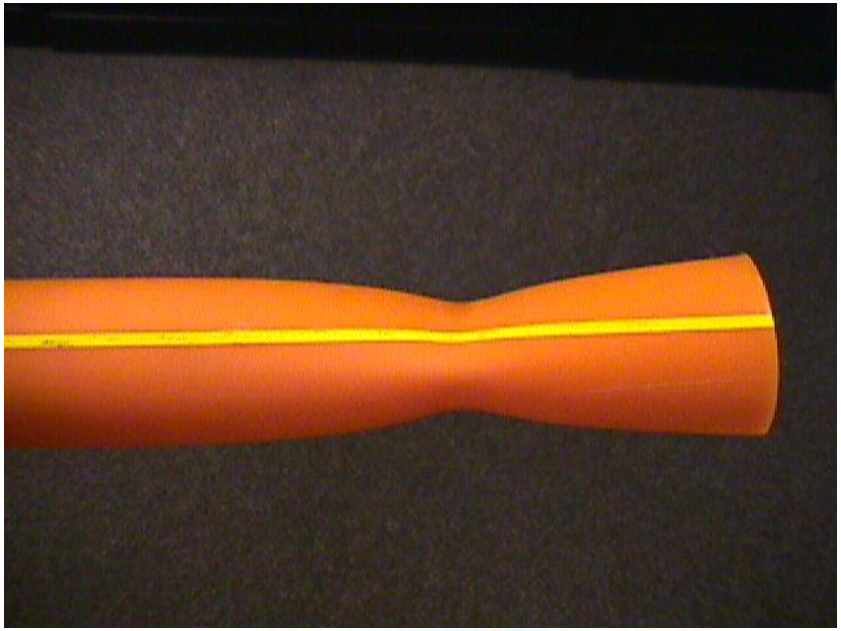
Style 907
Transition
To Steel

Squeeze Off

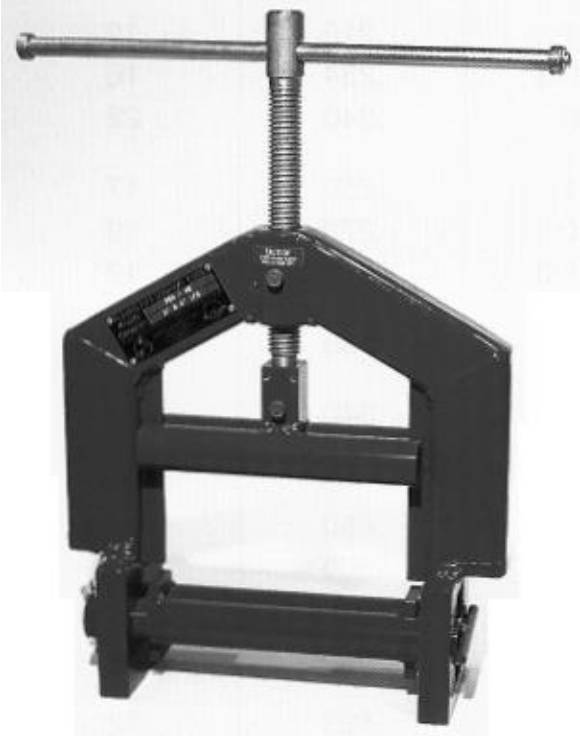
AS SQUEEZED



AFTER SQUEEZE



Squeeze Off Tool



Installation Methods

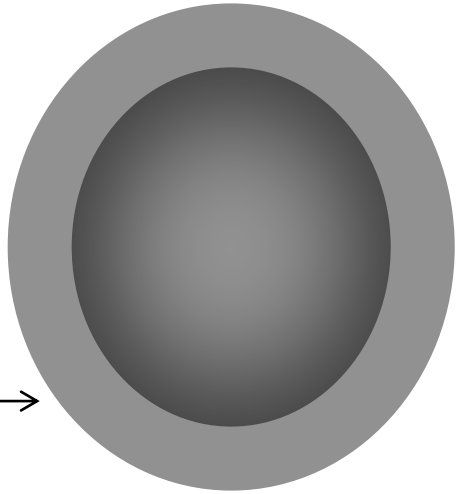
- Above Grade
  - UV protected with 2% Carbon Black.
- Ditch
  - Open Cut, Direct Buried ASTM D2774 for embedded material size.
- Trenchless
  - Tightliner, Loose fit.
  - Horizontal Directional Drill
- Marine
  - Submerged Crossings, Floating

HDPE Tight Fit Lining

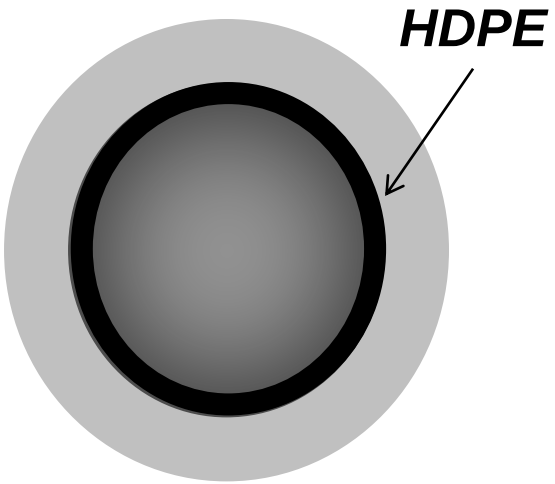
New API Liner Standard

Improved Hydraulic Efficiency

Steel Host Pipe



Hazen-Williams factor 125 *



Hazen-Williams factor 150 *

Testing PE With Air

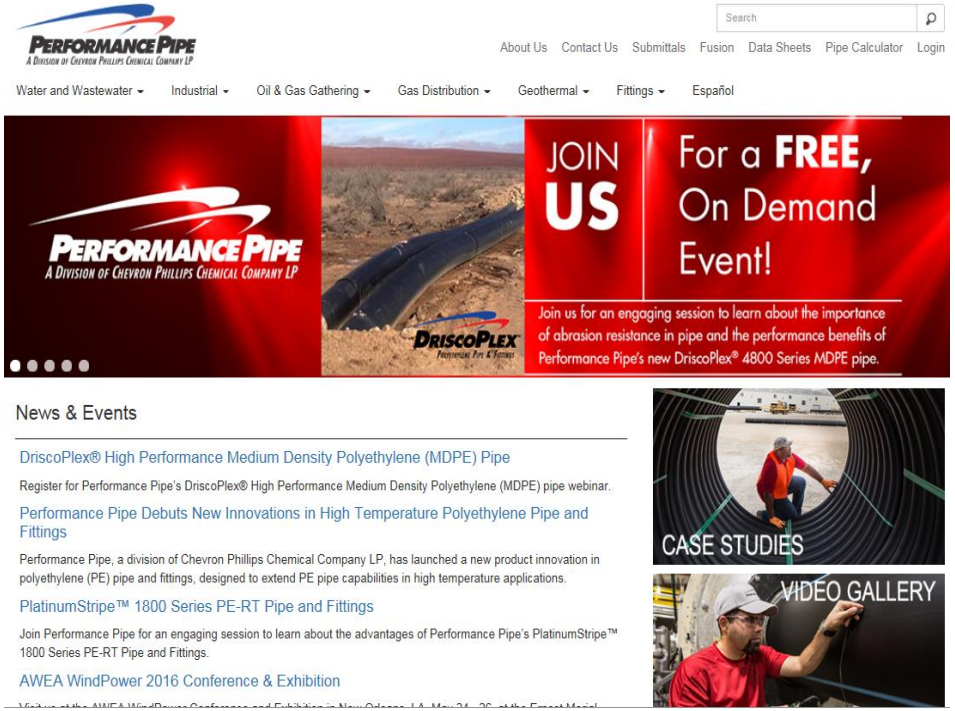
- **Performance Pipe does not have a standard pneumatic test detailed in our literature. A pressure test with air has no adverse effects on the pipe, but there are safety considerations associated with an air test that are beyond our control.**
- However, there are two ASTM Standards they could acquire that cover air testing:
- ASTM F1417 is a low pressure (3 to 4 psi) test
- ASTM F2786 is a high pressure test ("Field Leak Testing of PE Pressure Piping Systems Using Gaseous Media Under Pressure (Pneumatic Leak Testing)"
- Both can be acquired at www.astm.org.

Field Leakage Testing

- Maximum Test Pressure
  - 150% of Design Operating Pressure.
- Initial Expansion Phase
  - Pressurize to test pressure (temperature)
  - Maintain for 3 hours (add water as needed)
- Test Phase
  - Reduce pressure by 10 psi
  - If pressure remains within 5% of target value for 1 hour, no leakage is indicated.

www.performancepipe.com

- ***Contacts***
- ***Engineering Catalog***
- ***Technical Notes & Information***
- ***Literature , Handbooks***
- ***Plexcalc***
- ***Shipping Information***
- ***Packaging***
- ***Presentations***
- ***Engineering Support***



- ***Plexcalc Application*** – Pipe Calculator - Go to Apple store or Android store and search for PLEXCALC or Performance Pipe. Download application. It is free.

Overview

Pipe Design With New PE-RT Resin

Case Studies

What is PE-RT?

- A PE-RT material (polyethylene of raised temperature resistance) designation applies to PE materials that have an established HDB at 180F (82.2C) in PPI TR-4
- Dow's PE-RT resin is the only PE resin listed above 60 °C (140 °F) in TR-4

PPI Listing for INTREPID 2499 PE-RT

Dow Chemical Company | PE 4710 | INTREPID 2499 BK

Temp (ºF)	MRS (MPa)	CRS (T,t)	HDB (psi)	HDS (psi)	SDB (psi)	PDB (psig)	HDP (psi)	Grade
73F			1600	1000				S*
180F			800					S

1 Displaying items 1 - 2 of 2

Dow Chemical Company | PE 4710 | INTREPID 2499 NT

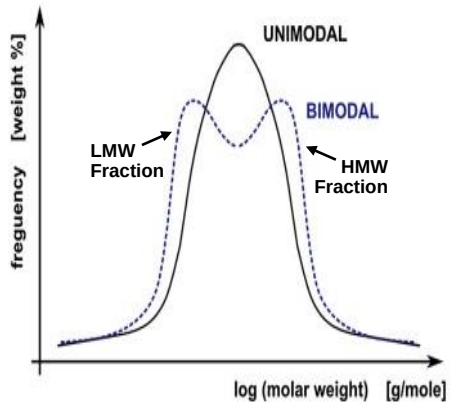
Temp (ºF)	MRS (MPa)	CRS (T,t)	HDB (psi)	HDS (psi)	SDB (psi)	PDB (psig)	HDP (psi)	Grade
73F			1600	1000				S*
180F			800					S

1 Displaying items 1 - 2 of 2

PE-RT Pipe | The Bimodal Benefit

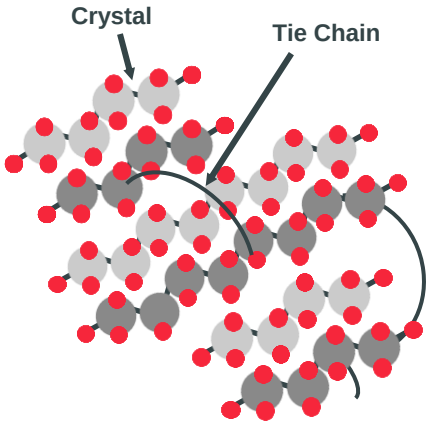
The bimodal approach utilizes a dual polyethylene reactor system to produce pipe resins that achieve excellent raised temperature performance – without the need for cross-linking. INTREPID 2499 contains a greater number of high molecular weight chains than ordinary PE4710. Bimodal technology delivers the tie chains that make it tough and temperature resistant. Patented additive technology gives it the oxidative resistance required for demanding applications.

Bimodal vs. Unimodal Property Distribution



Dual reactors (versus one) are utilized to create PE resin with bimodal (two) molecular weight peaks – providing the extruded pipe with the properties required to perform in raised temperature and oxidative environments.

Molecular Structure of PE-RT Pipe



Tie chains in the high molecular weight fraction connect the crystalline structure in the polymer, which toughens the material and gives it superior strength at high temperatures.

PE-RT History

- PE-RT was first introduced in 1981. The same product that was introduced in 1981 is still sold today for radiant heating applications.
- Although there are several suppliers of PE-RT resins around the world, they are predominantly MDPE resins and do not meet the ASTM requirements in North America.
- PE-RT resins have only been used in limited industrial applications until now due to pipe size limitations. Most PE-RT resins cannot be used to produce pipe larger than 6 inches in diameter due to low melt strength. They have lower hydrostatic strength requiring thicker walls to achieve desired pressure ratings due to their low density.
- PlatinumStripe™ 1800 Series PE-RT changes the game. It is produced from the first PE-RT resin to achieve an 800 psi HDB at 180˚F and to be listed as such in PPI TR-4. It also has the highest ratings for oxidative stability in the industry as well as the high melt strength required to produce the very large diameter pipe needed in industrial applications.

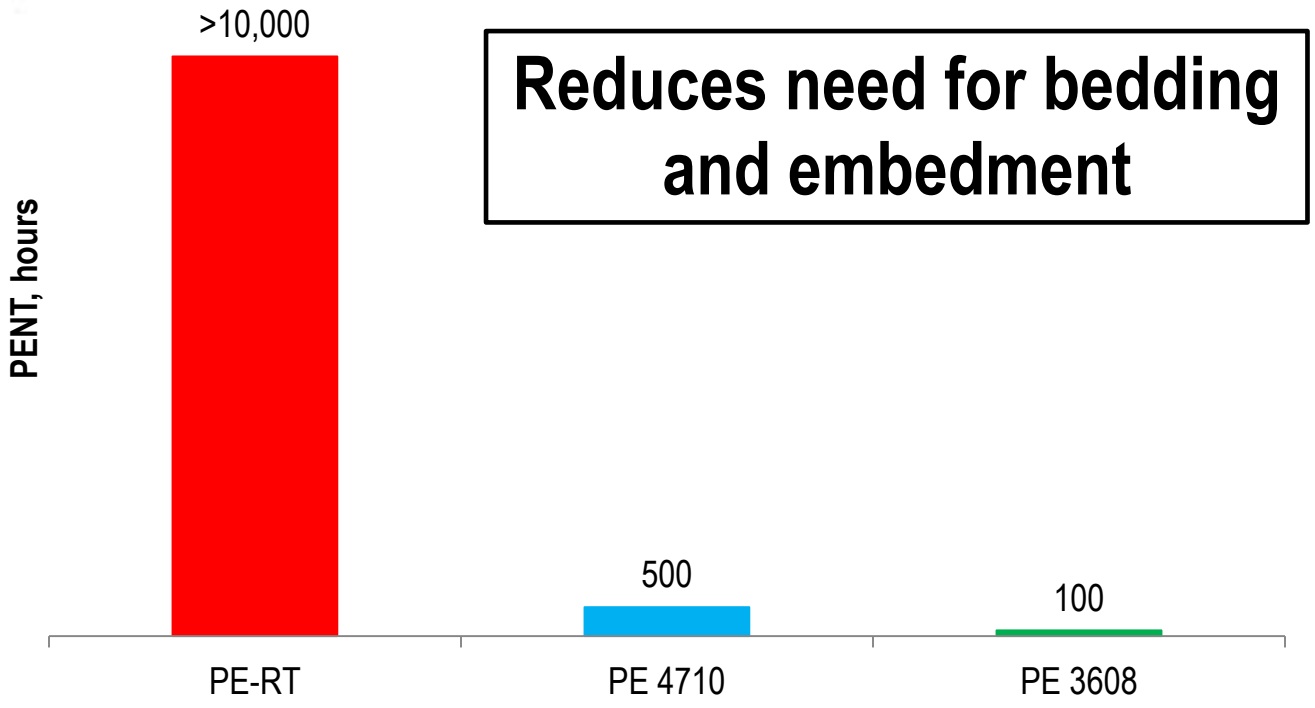
PlatinumStripe™ 1800 Series PE-RT High Temperature PE Pipe & Fittings

- **Standards**
  - PE 4710
  - ASTM D3350
  - ASTM F714/F2619/API 15LE
- **Industrial & Energy Applications**
  - Mining
  - Pulp and paper mills
  - Oil & Gas Gathering
  - Produced Water
  - District Energy
  - Chemical processes
  - Power plants

PE-RT Performance Attributes

- Higher operating temperature compared to standard PE4710 products
  - Allows continuous operating range from -49°F (-45°C) to 180°F (82°C) with intermittent temperatures up to 203°F (95°C)
- >20 times PE4710 requirements for stress crack resistance
- Use of native backfill from trench (sandless installation) for shallow, non-traffic applications
- Patented stabilizer system for high temperature oxidative environments with D3350 CC3 rating
- Same fusion parameters as standard PE4710 pipes
- Full Range of Pipe Sizes, Pressure Capabilities, Molded & Fabricated Fittings

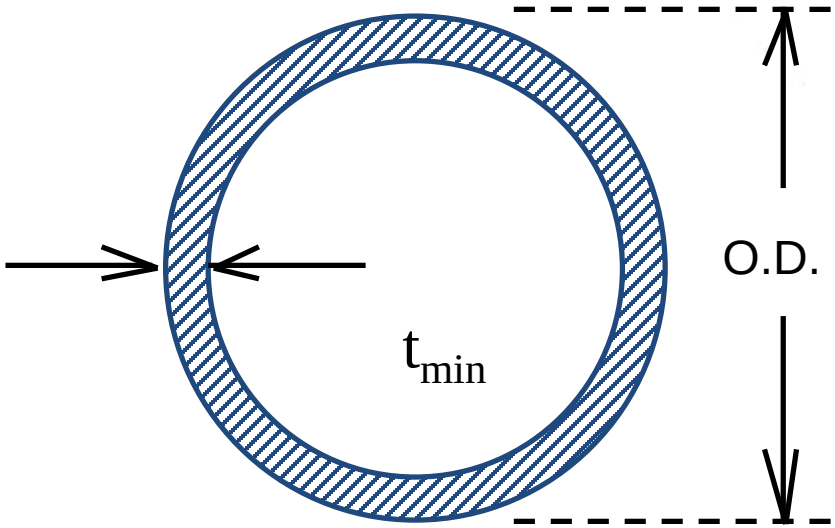
Resistance to Slow Crack Growth



Reduces need for bedding and embedment

Dimension Ratio, DR

$$DR = \frac{OD}{t_{MIN}}$$



Standard Dimension Ratio (SDR) 41, 32.5, 26, 21, **17**, 13.5, **11**, 9, 7.3

Standard in the industry = **11** is rated for 200 psi working pressure
17 is rated for 125 psi working pressure

Working Pressure Rating

HDS = 1000psi at 73°F
AF = 1.0 (FOR WATER)
F_t = 1 @ 73°F
DR = Dimension Ratio

$$P = \frac{2 \cdot HDS \cdot AF \cdot F_T}{(DR - 1)}$$

PE-RT Pipe Sizes & Pressure Ratings

- Solid Wall Conventional Extrusion
- OD Controlled Process
  - Iron Pipe Size (IPS)
  - 1/2” (16mm) to 54” (1400mm)
- Standard Dimension Ratios (SDR’s)
  - DR 7 to DR 32.5
  - Pressure Rated up to 180ºF

SDR	PR @ 73°F	PR @ 180°F
7	333	167
9	250	125
11	200	100
13.5	160	80
17	125	63
21	100	50
26	80	40
32.5	63	32

PERFORMANCE PIPE
A Division of Chevron Phillips Chemical Company LP

Pressure Ratings of PlatinumStripe™ 1800/6300 PE-RT PIPE(1,2)

Temperature		MRS/LCL(3)		SDR									
				32.5	26	21	19	17	15.5	13.5	11	9	7
°C	°F	MPa	psi	Pressure Rating, psig									
10	50	7.95	1153	73	92	115	128	144	159	184	231	288	384
16	60	7.45	1081	69	86	108	120	135	149	173	216	270	360
23	73	6.90	1000	63	80	100	111	125	138	160	200	250	333
27	80	6.62	959	61	77	96	107	120	132	153	192	240	320
32	90	6.22	902	57	72	90	100	113	124	144	180	225	301
38	100	5.79	839	53	67	84	93	105	116	134	168	210	280
43	110	5.44	789	50	63	79	88	99	109	126	158	197	263
49	120	5.04	731	46	58	73	81	91	101	117	146	183	244
54	130	4.72	684	43	55	68	76	86	94	109	137	171	228
60	140	4.34	630	40	50	63	70	79	87	101	126	158	210
66	150	4.11	596	38	48	60	66	74	82	95	119	149	199
71	160	3.88	562	36	45	56	62	70	78	90	112	141	187
77	170	3.66	530	34	42	53	59	66	73	85	106	133	177
82	180	3.45	500	32	40	50	56	63	69	80	100	125	167

(1) Data per tests conducted by Dow. Additional information available upon request.
(2) Based on 0.63 design factor for PE4710 and PPP TR-4 HDB listing of 1600 psi/23°C (73°F), 1000 psi/60°C (140°F), and 800 psi/82°C (180°F)
(3) LTH (long term hydrostatic strength)

DRISCOPLEX
Polyethylene Pipe & Fittings

PE-RT Spec Sheets

PERFORMANCE PIPE
A Division of Chevron Phillips Chemical Company LP

PlatinumStripe™ 1800 Series PE-RT Pipe

PlatinumStripe™ 1800 Series PE-RT
High-Temperature, High Density Polyethylene (HDPE) Pipe

PlatinumStripe™ 1800 PE-RT significantly expands the operation window for polyethylene (PE) pipes with pressure ratings up to 180°F. PlatinumStripe™ 1800 PE-RT is intended for high-temperature mining, chemical processing, water/wastewater, power plants, pulp and paper mills and other industrial applications.

Complies with:

- ASTM D3350 Cell Class PE445574C
- ASTM D2837 HDB = 800 psi at 180°F
- ASTM F714
- ASTM D3035

Key Benefits of PlatinumStripe™ 1800 PE-RT:

- Higher permissible operating temperatures compared to standard PE4710 products
  - ✓ Allows continuous operating range from -49°F (-45°C) to 180°F (82°C) with intermittent temperatures up to 203°F (95°C)
- >20 times PE4710 requirements for stress crack resistance
- Allows use of native backfill material from trench (sandless installation) for shallow, non-traffic applications
- Follows same fusion parameters as standard PE4710 pipes
- Patented stabilizer system for high temperature oxidative environments with ASTM F2263 CC3 rating
- Full range of pipe sizes, pressure capabilities, molded and fabricated fittings

PlatinumStripe™ 1800 PE-RT is identified with four platinum color stripes.

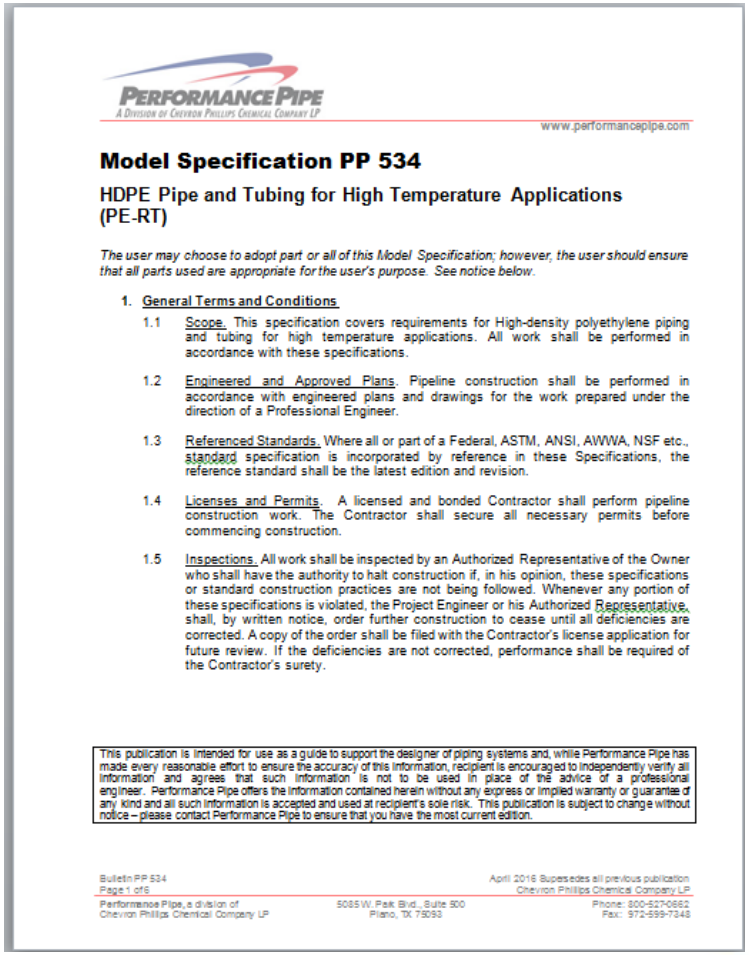
PlatinumStripe™ 1800 PE-RT Pipe Material Physical Properties

Property	Standard	Typical Value†
Material Designation	ASTM F714	PE 4710
Cell Classification	ASTM D3350	445574C (black)
Density [4]	ASTM D792	0.930 g/cc (natural)
Melt Index [4]	ASTM D1238	0.1 g/10 min
Flexural Modulus [5]	ASTM D790B	150,000 psi
Tensile Strength [5]	ASTM D638	>3500 psi
SCG (PENT) [7]	ASTM F1473	10,000 hours
HDB at 73°F (23°C) [4] HDB at 180°F (82.2°C)	ASTM D2837	1600 psi 800 psi
Color [C]	ASTM D3350	Black

This is not a product specification and does not guarantee or establish specific minimum or maximum values or manufacturing tolerance for material or piping products to be supplied. Values obtained from tests of specimens taken from piping product may vary from these typical values.

Performance Pipe, a division of Chevron Phillips Chemical Company LP | 9085 W. Park Blvd | Suite 500 | Plano, TX 75093 | Phone: 800-527-0662 | Fax: 972-599-7329

PE-RT Model Specification



PERFORMANCE PIPE
A Division of Chevron Phillips Chemical Company LP

www.performancepipe.com

Model Specification PP 534

HDPE Pipe and Tubing for High Temperature Applications (PE-RT)

The user may choose to adopt part or all of this Model Specification; however, the user should ensure that all parts used are appropriate for the user's purpose. See notice below.

1. General Terms and Conditions

1.1 Scope. This specification covers requirements for High-density polyethylene piping and tubing for high temperature applications. All work shall be performed in accordance with these specifications.

1.2 Engineered and Approved Plans. Pipeline construction shall be performed in accordance with engineered plans and drawings for the work prepared under the direction of a Professional Engineer.

1.3 Referenced Standards. Where all or part of a Federal, ASTM, ANSI, AWWA, NSF etc., standard specification is incorporated by reference in these Specifications, the reference standard shall be the latest edition and revision.

1.4 Licenses and Permits. A licensed and bonded Contractor shall perform pipeline construction work. The Contractor shall secure all necessary permits before commencing construction.

1.5 Inspections. All work shall be inspected by an Authorized Representative of the Owner who shall have the authority to halt construction if, in his opinion, these specifications or standard construction practices are not being followed. Whenever any portion of these specifications is violated, the Project Engineer or his Authorized Representative, shall, by written notice, order further construction to cease until all deficiencies are corrected. A copy of the order shall be filed with the Contractor's license application for future review. If the deficiencies are not corrected, performance shall be required of the Contractor's surety.

Performance Pipe, a division of
Chevron Phillips Chemical Company LP
5085 W. Park Blvd., Suite 500
Plano, TX 75093
Phone: 800-527-0662
Fax: 972-599-7348

12” DR 11 PlatinumStripe™ 1800 Series PE-RT

24” DR 11 PE-RT

30” DR 21 PE-RT

Quick Burst Testing – 8” DR 11 PE-RT (750 psi)

Overview
Pipe Design With New PE-RT Resin
Case Studies

6” and 8” 1800 Series PlatinumStripe™ PE-RT
University of MN Athletic Additions

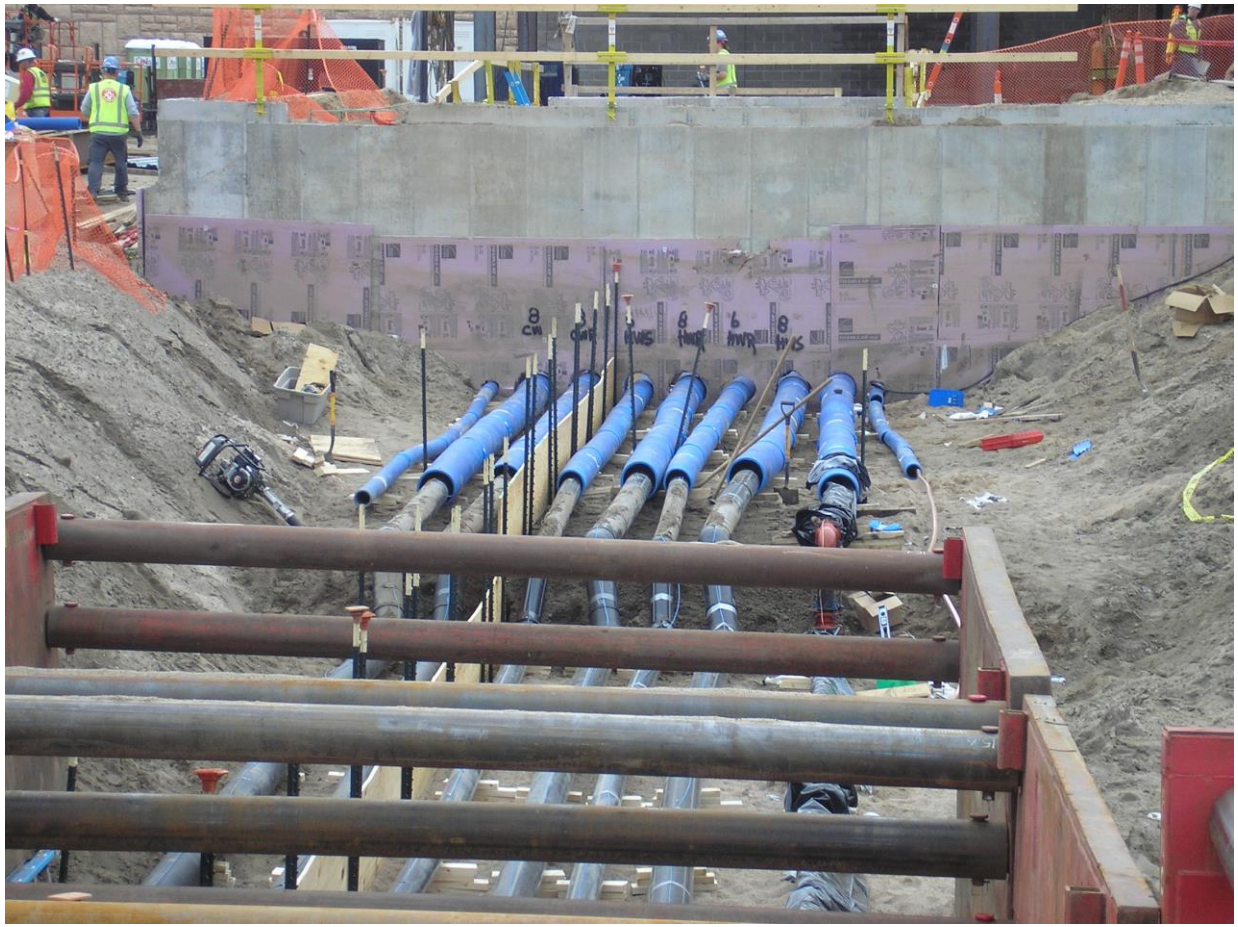
Scope of the project

- 600’ of 6” IPS 11 1800 series PE-RT
- 640’ of 8” IPS 11 1800 series PE-RT
- Molded 90’s, 45’s, Caps, Flange Adapters
  - University of MN at Minneapolis Twin City campus (Gopher athletic village addition)
  - General Contractor = Mortenson Construction
  - Subcontractor = Horwitz Inc.
  - Engineer = MEP Associates
  - Pipe was sold by Ferguson Waterworks
  - Pipe project is the HVAC system for the new additions to the athletic department:

    -Academic Center
    -Training Table
    -Indoor Football Complex
    -Women's Gymnastics Facility
    -Olympic Sport Indoor Practice Facility
    -Outdoor Olympic Sport Track
    -Men's/Women's Basketball Practice Facility
    -Wrestling Training Facility

- This $190MM project estimated to be completed by November 2017

Hot and cold water HVAC lines leaving mechanical building (2 lines on the left are chilled water, 4 on the right are hot water)




United Rentals
KOBELCO

Caped lines ready to be pressure tested

This new building will house men and women's basketball courts as well as training tables for the athletes

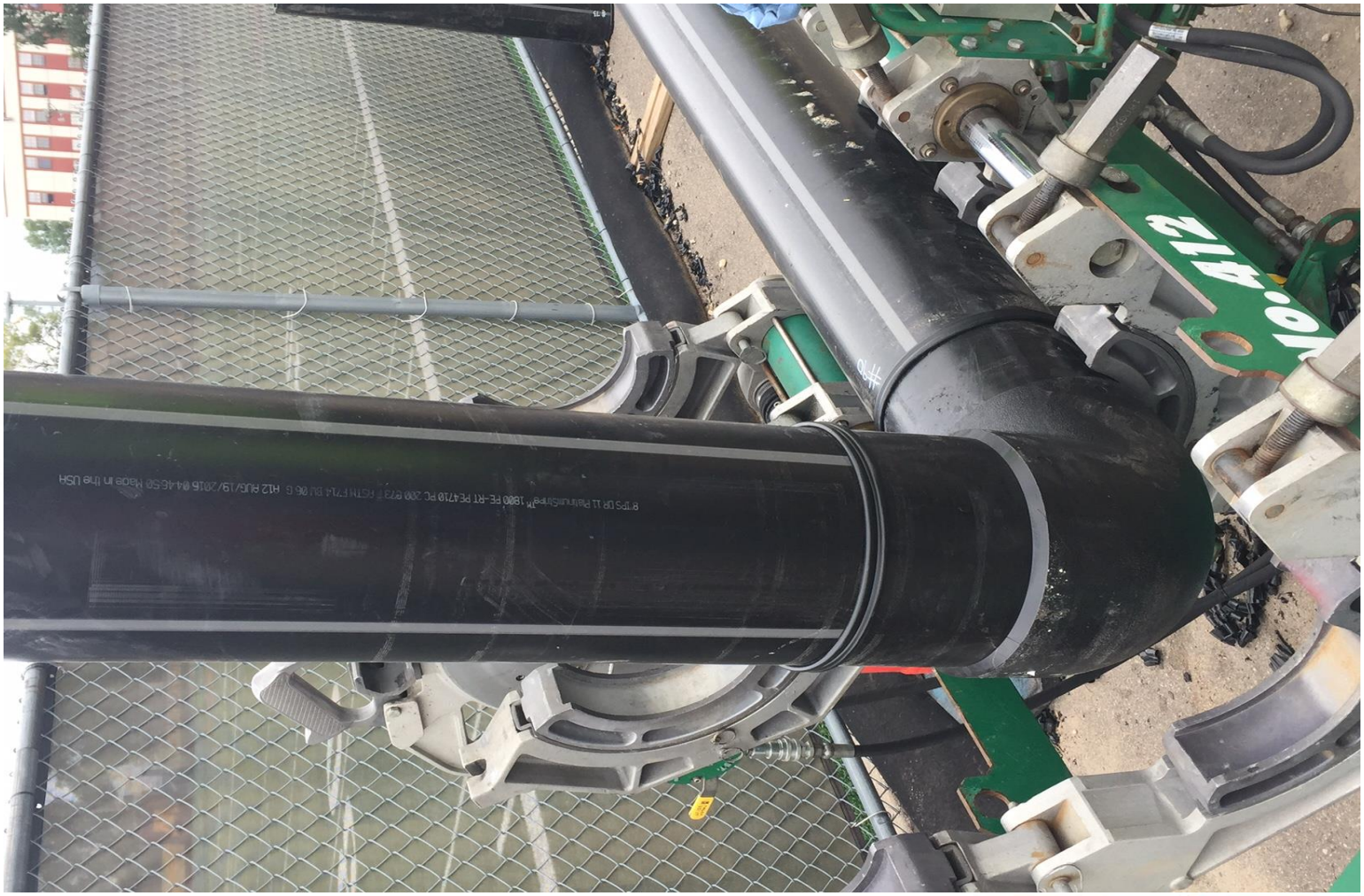

CONCEPTUAL IMAGE ONLY

New indoor football practice facility will be here


MINNESOTA GOLDEN GOPHERS
CONCEPTUAL IMAGE ONLY


CONCEPTUAL IMAGE ONLY

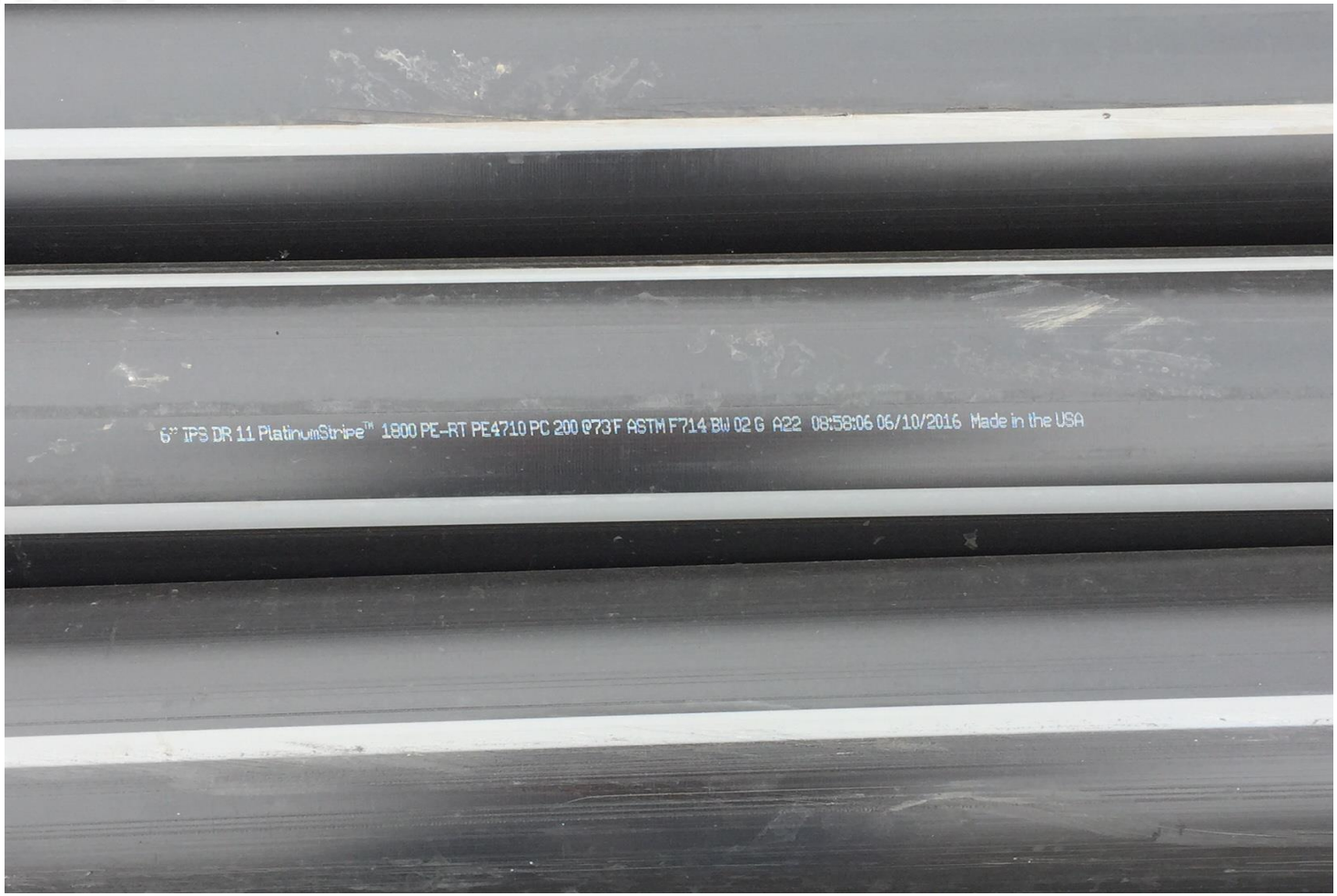
90's being fused for additional sections to be installed later



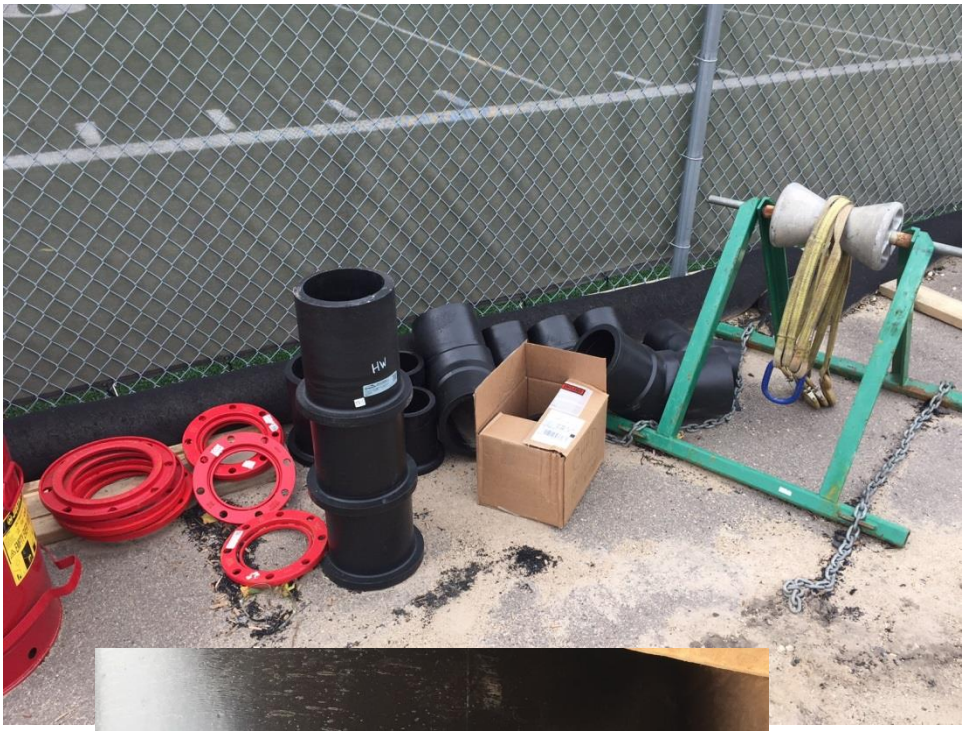
Pipe ready to be fused

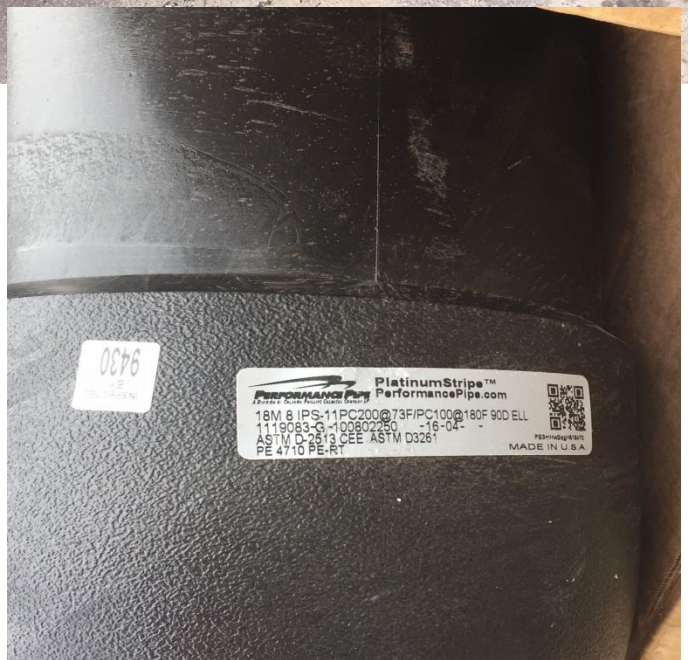

McELROY

Print Line Information



Molded Fittings





20” and 24” DR 17 PE4710 for Chilled Water and 12” DR 11 PlatinumStripe™ 1800 Series PE-RT Texas A&M Utilities & Energy Services

Pulp and Paper Mill Case Study
Canfor's Prince George Pulp and Paper

- 30" DR 21 & 26
- 3200 ft
- 175°F
- FRP vs PERT
- Material Evaluation Criteria
  - Changing Effluent Stream
  - Installation
  - Burial
  - Cost

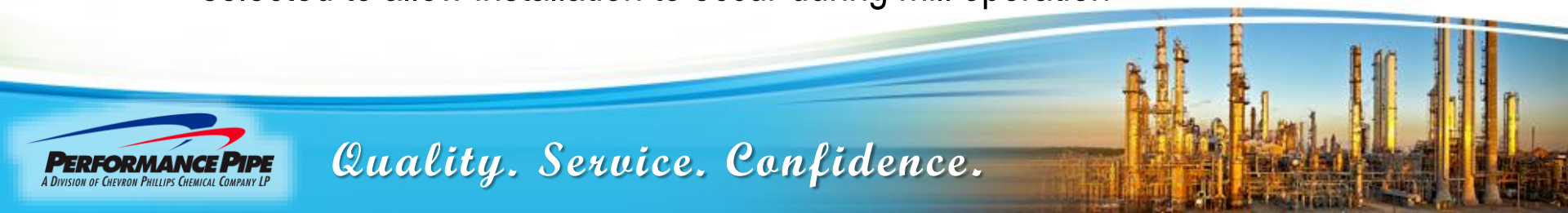
Case Study

Problem

- The FRP bleach effluent piping that conveys effluent from the PG Pulp bleach plant to the PG biobasin has reached the end of its useful life
- In 5 years there have been over 10 pipe failures
- The effluent streams are bleach plant acid filtrate, caustic filtrate, boiler feedwater acid and caustic effluents and chemical containment basin effluent
- Existing FRP piping showed evidence of spider cracking or complete inner delamination from the outer pipe wall

Solution

- New PE-RT Piping used to replace 3,200’ of FRP piping
  - Significant cost savings replacing FRP with PE-RT
  - PE-RT liner considered, but too many bends make this impracticable
  - Underground installation of PE-RT piping adjacent to existing FRP piping was selected to allow installation to occur during mill operation



Replace Aging FRP with New PE-RT Piping System


N
Canfor, PG Pulp
& Paper mill
Approx. buried route of new
30"ø HDPE pipe (~3100 ft)


45kVA
Shindaiwa


#13
#13

Cost Comparison

- **Material supply and field installation of PE-RT reduce project cost by 1/3**
  - PE-RT material costs less than equivalent FRP material cost
  - PE-RT installation performed over 11 times faster than FRP
    - 8-50’ pipe length PE-RT fusions completed per day compared to 2-20’ pipe length butt and wrap joining of FRP

Table 1. FRP vs PE-RT Joining Times

Hours vs Diameter	2”	3”	4”	6”	8”	10”	12”	14”	16”	20”	22”	24”	26”	28”	30”
FRP	0.5	0.7	0.9	1.2	1.8	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0
PERT	0.1	0.1	0.2	0.3	0.3	0.4	0.4	0.5	0.6	0.7	0.7	0.8	0.9	0.9	1.0

Source: Pipe Design Considerations, Composites USA, Inc, and McElroy Manufacturing

Conclusions

- Cost savings of 33% achieved by replacing FRP with the new PE4710 PE-RT
- PE-RT was able to be quickly joined by heat fusion creating a leak-free continuous monolithic pipe, that could be field bent eliminating joints and minimizing flanged connections
- PE-RT was able to be joined by the same fusion procedures used for standard PE4710 pipe requiring no additional training
- Fusion joint verification and documentation by data logger eliminated the need for most hydrostatic testing
- Engineering contractor was on-site during construction enabling better communication with construction minimizing change orders

PERFORMANCE PIPE

A DIVISION OF CHEVRON PHILLIPS CHEMICAL COMPANY LP

PlatinumStripe™ 1800 Series PE-RT Pipe

PlatinumStripe™ for Extreme Conditions

PE-RT High Temperature Polyethylene Pipe

- Higher operating temperature compared to standard PE4710 products
- >20 times PE4710 requirements for stress crack resistance
- Patented stabilizer system for high temperature oxidative environments with F2263 CC3 rating
- Use of native backfill from trench (sandless installation) for shallow, non-traffic applications
- Same fusion parameters as standard PE4710 pipes
- Full range of pipe sizes, pressure capabilities, molded and fabricated fittings

www.performancepipe.com

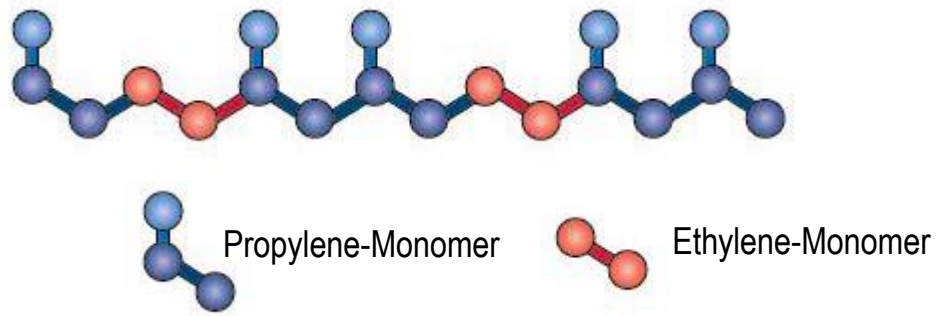
Proudly made in the USA

What is PP-RCT?

- 1951 Phillips Petroleum Scientists J. Paul Hogan and Robert L. Banks discovered Polypropylene in 1951.
- Polypropylene has been used to make pipe since the early 1970s and was first introduced in North America in February 2006
- Polypropylene Pipe is a thermoplastic pipe, which is joined using heat fusion. This involves heating the pipe ends, bringing the molten ends together under pressure, then allowing the joint to cool. This process when done properly creates a leak free joint.

What is PP-RCT?

Random-Copolymer
PP-R



- PP-R is polypropylene copolymerized (combined) with a small amount of ethylene, giving the material a balance of durability, rigidity and flexibility
- PP-R/PP-RCT pipes are primarily used indoors and can replace many other pipe systems used inside the building
- PP-R/PP-RCT is 5-6% lower density than HDPE and has a significantly higher modulus (200-300% higher) providing greater stiffness

Victaulic Style Couplings

Style 905
Coupling

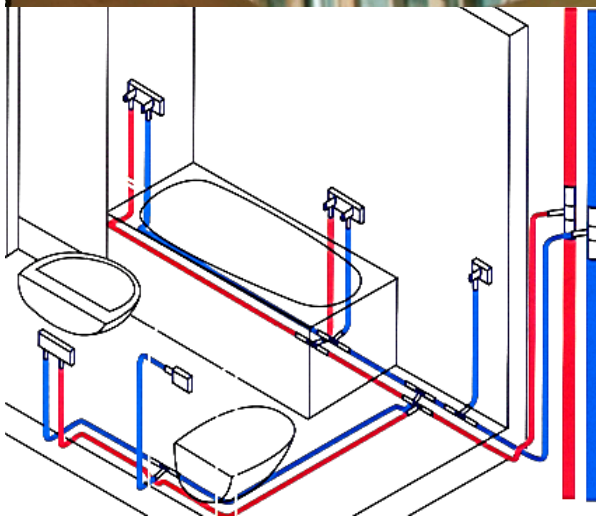
Style 926
Outlet

Style 994
Flange
Adapter

Style 907
Transition
To Steel

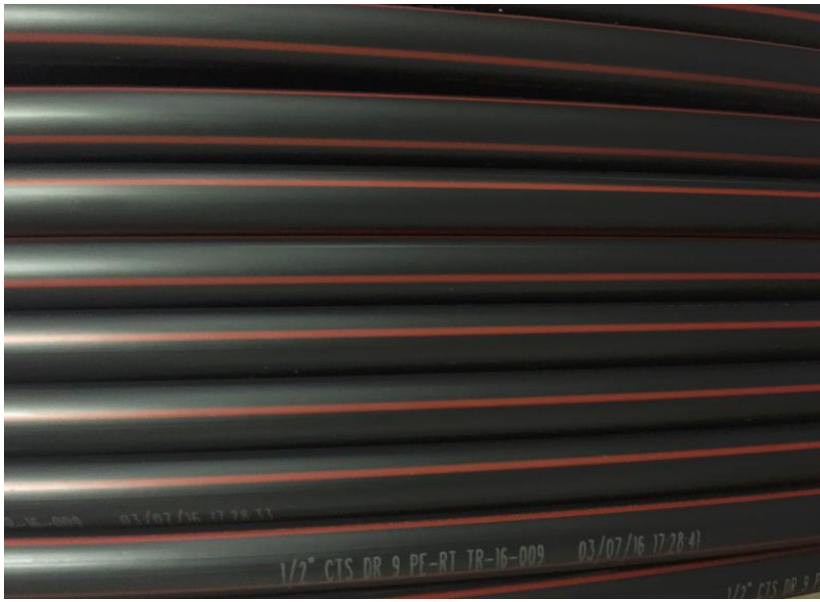
SapphireStripe™ and RubyStripe™ 5200 Series PE-RT Hot & Cold Water Tubing For Residential Plumbing & Water Service Lines

- PE-RT tubing has the same temperature and pressure capabilities as PEX
- PPCo will provide black with red and blue stripes providing UV resistance for long-term outdoor storage
- Pressure ratings for SDR 9 CTS
  - 100 PSI @ 180°F,
  - 200 PSI @ 73°F
- Can be used in potable water with ASTM F2769/F2023 level 5 chlorine resistance
- Codes
  - Code approval required to sell product in NA
  - Radiant Heating in all major codes (NSPC, IPC, UPC) as of 2009
  - Potable Water in all major model codes (NSPC, IPC, UPC) in 2012



SapphireStripe™ and RubyStripe™ 5200 Series PE-RT Hot & Cold Water Tubing For Residential Plumbing & Water Service Lines

- Produced to ASTM F2769 Standard Specification for Polyethylene of Raised Temperature (PE-RT) Plastic Hot and Cold Water Tubing and Distribution Systems
- Can be joined with traditional mechanical fittings, but can also be heat fused offering installation flexibility that is also leak free
- Socket fusion fittings are available
- Contains no byproduct, so no flushing required to eliminate order and bad taste
- 100% recyclable
- Permanent laser marking



Thank You!

CONTACT US | 800-233-6495 | WWW.PERFORMANCEPIPE.COM

PERFORMANCE PIPE
A Division of Chevron Phillips Chemical Company LP