PERFORMANCE PIPE
A DIVISION OF CHEVRON PHILLIPS CHEMICAL COMPANY LP

High Temperature Polyethylene (PE-RT)

Thermal Distribution Application

2016 IDEA Conference
Austin, TX

Overview

Design

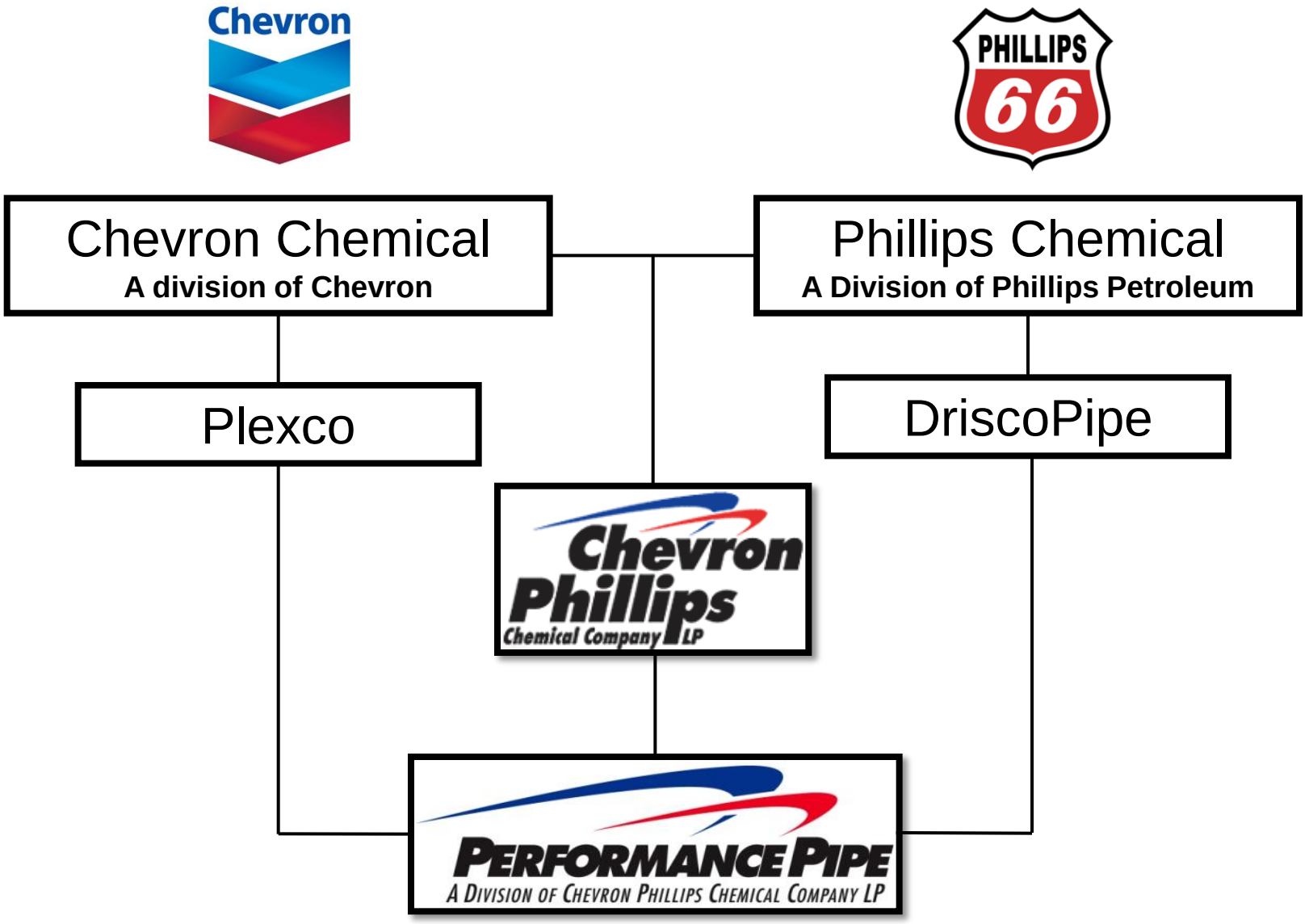
Installation

Overview

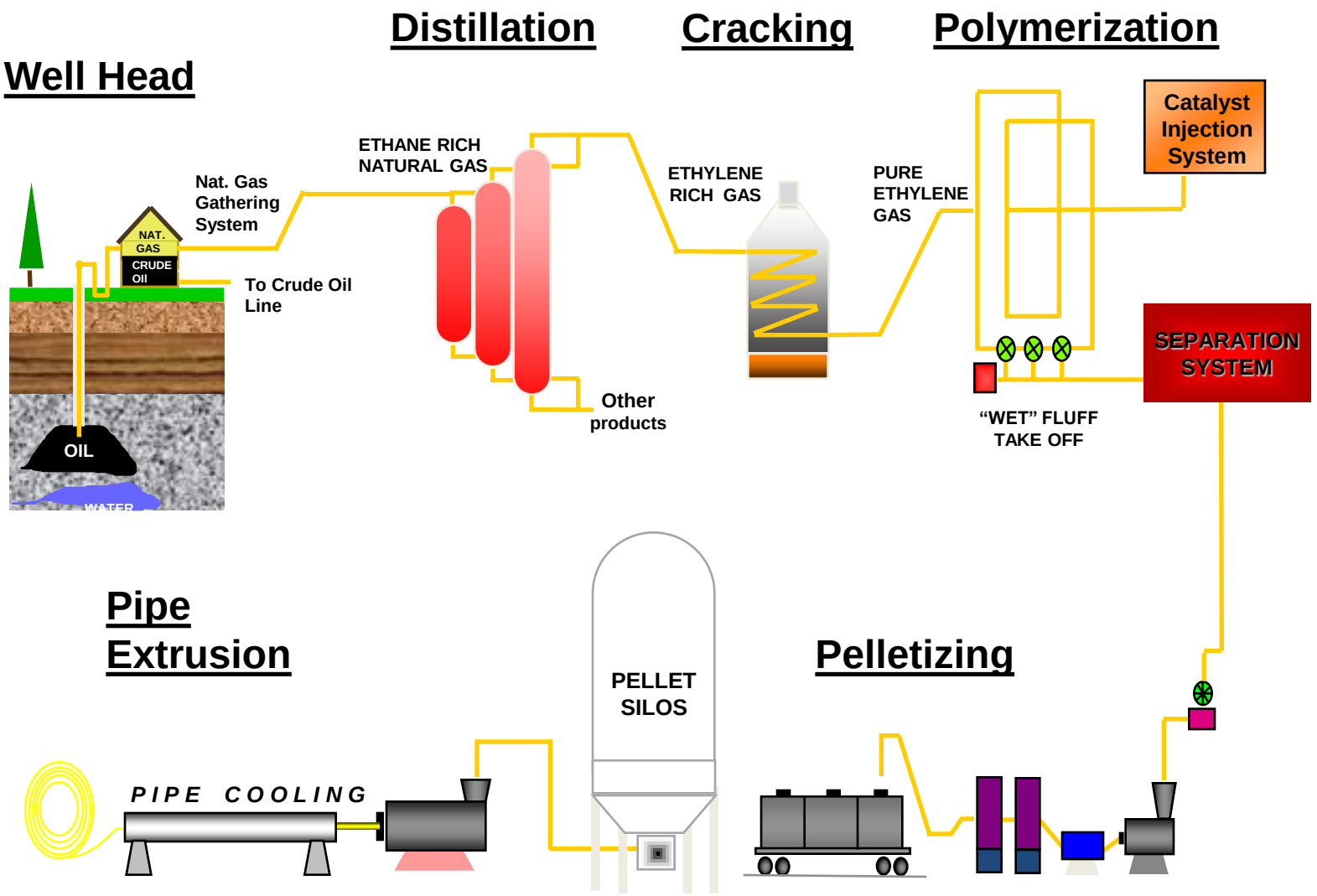
Design

Installation

Company Formation



From Cradle to Pipe



PE-RT Pipe Sizes & Pressure Rating

Solid Wall Conventional Extrusion OD Controlled Process

- Iron Pipe Size (IPS): 2” - 54”

Standard Dimension Ratios (SDR’s)

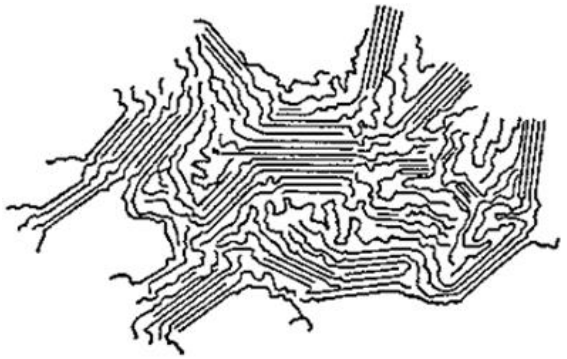
- DR 7.3 to DR 32.5
- Pressure Rated up to 180°F

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

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 effects Density
  - Tensile Strength, Stiffness, Abrasion, Hardness, Chemical Resistance

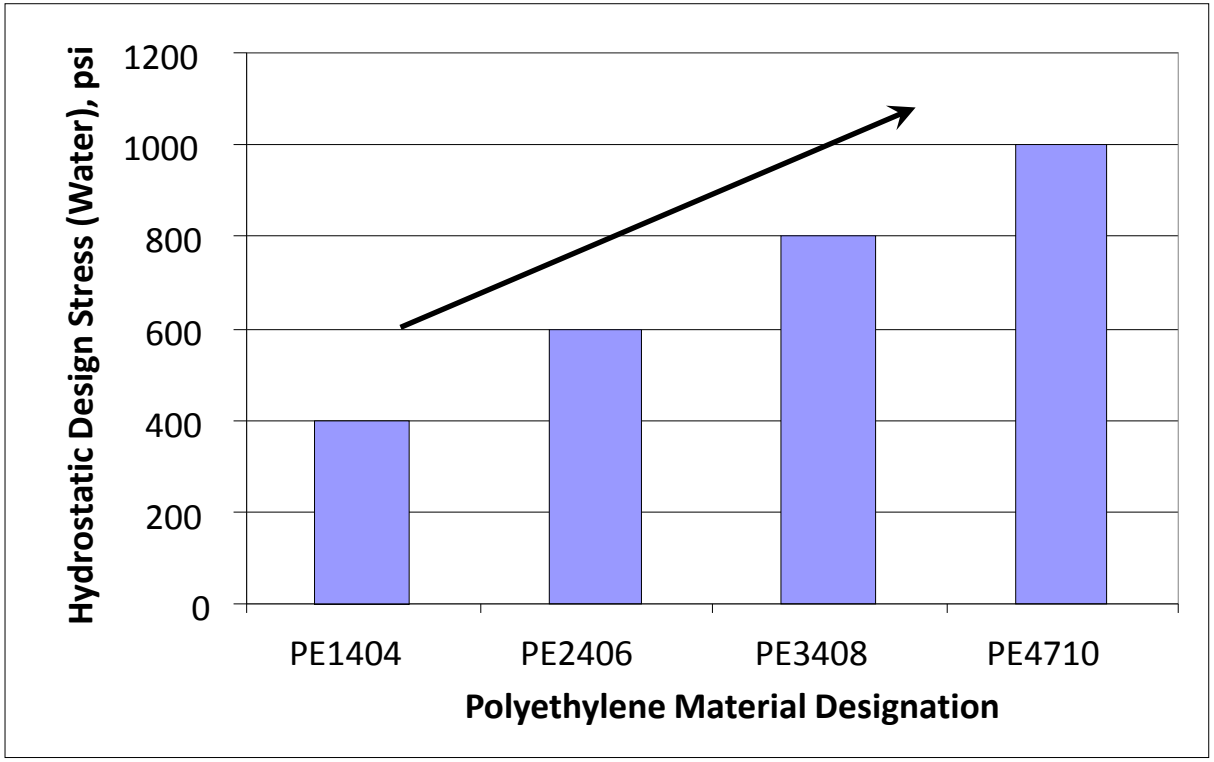
PERFORMANCE PIPE
A Division of Chevron Phillips Chemical Company LP

Benefits of PE-RT HDPE Pipe

- Higher Operating Temperature
- >20 times Stress Crack Resistant
- Use of Native Backfill for Installation
- Higher Chlorine Resistance
- Lightweight and Flexible
- Outstanding Chemical / Corrosion Resistance
- Abrasion Resistance
- Excellent Flow Characteristics
- Full Range of Pipe Sizes, Molded Fittings and Pressure Capabilities

PERFORMANCE PIPE
A Division of Chevron Phillips Chemical Company LP

Resin Evolution

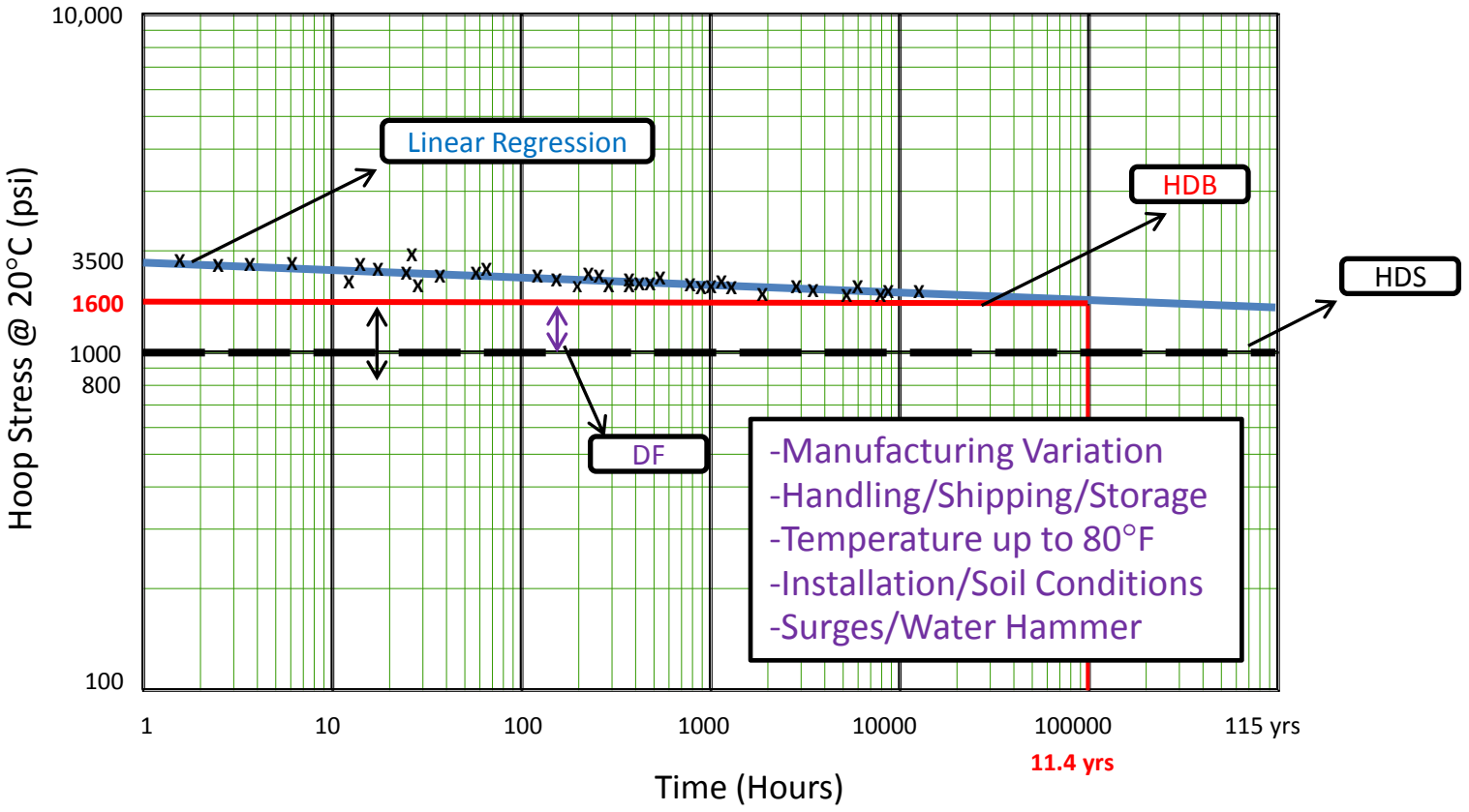


PE 3408 DR 11= 160 psi
vs.
PE 4710 DR 11 = 200 psi

PERFORMANCE PIPE
A Division of Chevron Phillips Chemical Company LP

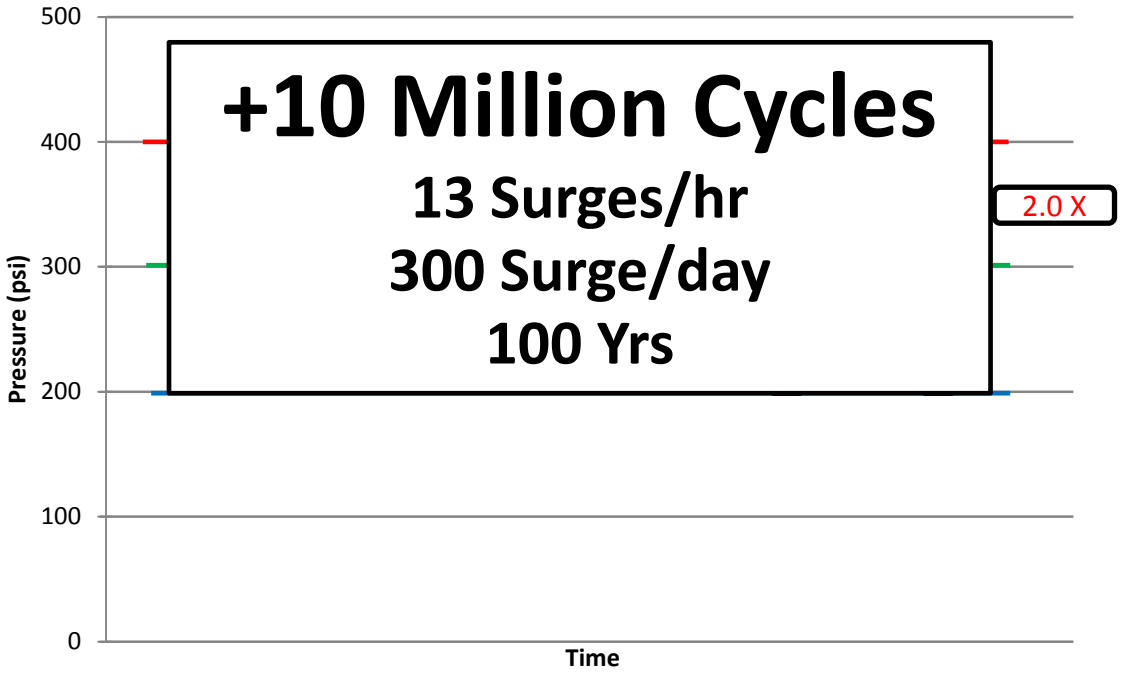
Long-Term Hydrostatic Strength

1. ASTM D2837 – Testing Standard to obtain Hydrostatic Design Basis (HDB)
2. Data Analysis must yield Straight Line through at least 100,000 hours → 50 yrs
3. Long Term Hydrostatic Strength (LTHS) is determined at 100,000 hours
4. HDS = HDB x DF → 1000 psi = 1600 psi x 0.63

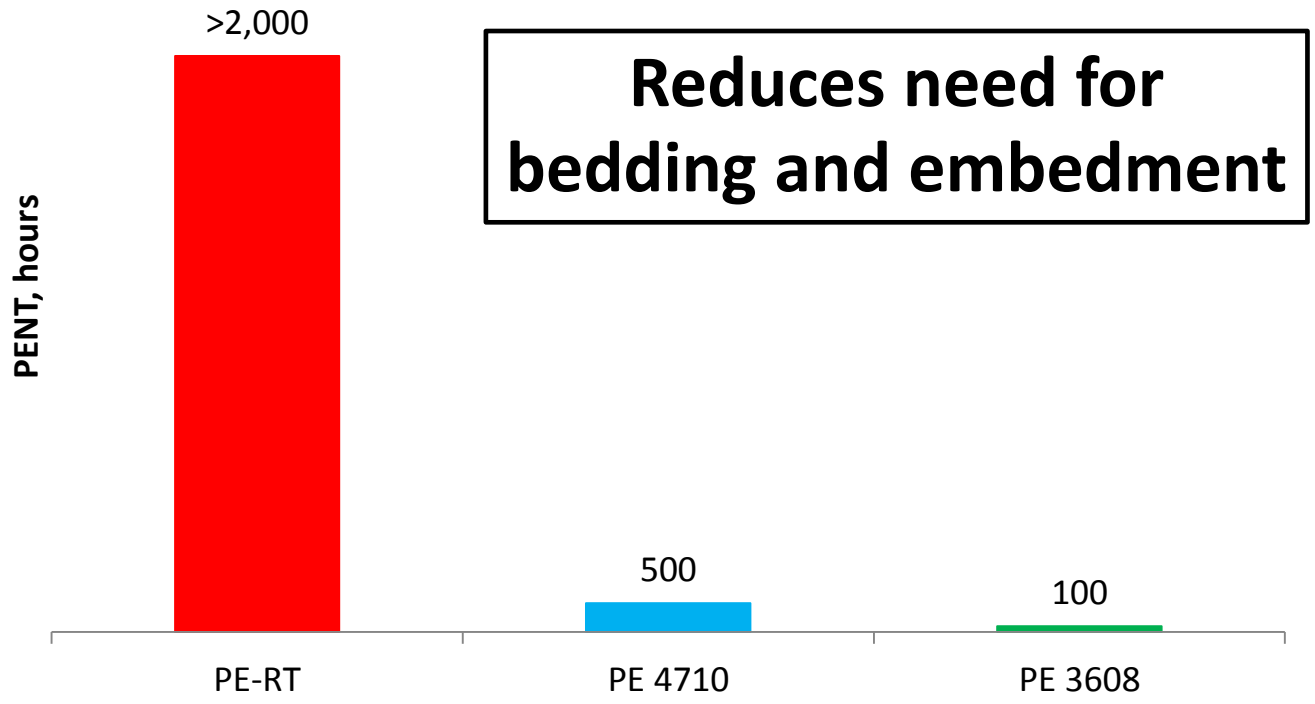


Long-Term Toughness

1. Total Pressure = Working Pressure (Steady) + Surge Allowance (Anticipated)
2. Reoccurring Surge Allowance = 150% x Pressure Rating
3. Occasional Surge Allowance = 200% x Pressure Rating



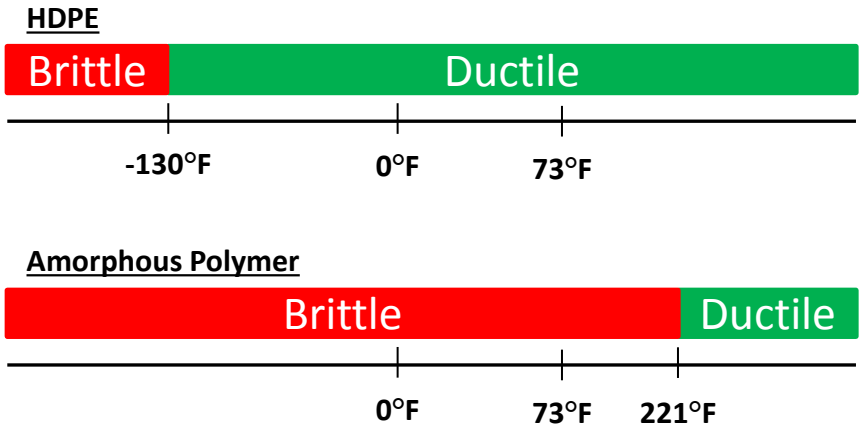
Resistance to Slow Crack Growth



PERFORMANCE PIPE
A Division of Chevron Phillips Chemical Company LP

Embrittlement Range

1. Water Can Freeze in HDPE pipe without Damage
2. Glass Transition Temperature for PE is -130F



Increased Toughness
Larger Deformation
High Impact
High RCP Resistance

PERFORMANCE PIPE
A Division of Chevron Phillips Chemical Company LP

DriscoPlex® 1000 PE-RT Series
High Temperature PE Pipe

- **IPS Size**
- **2” – 36”**
- **PE 4710**
- **Standards**
  - ASTM D3350
  - ASTM F714/D3035
- **Industrial**
  - Mining
  - Power plants
  - Landfill
  - Pulp and Paper Mill
- **Municipal**
  - Water/Wastewater
  - Dual Containment

PERFORMANCE PIPE
A Division of Chevron Phillips Chemical Company LP

Overview

Design

Installation

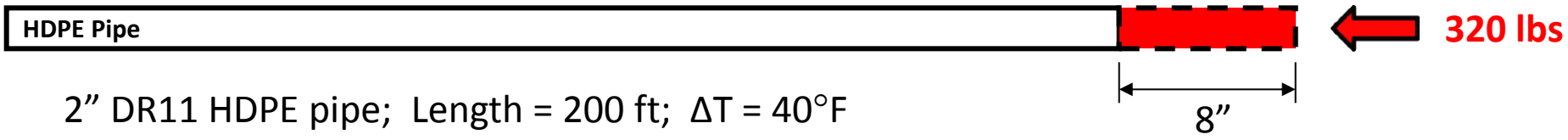
Thermal Expansion

1. PE has Higher Coefficient of Thermal Expansion (α) than other Piping Materials
2. PE Has Lower Modulus of Elasticity than other Piping Materials
3. PE Thermal Expansion ≈ 1 in/10°F/100 ft

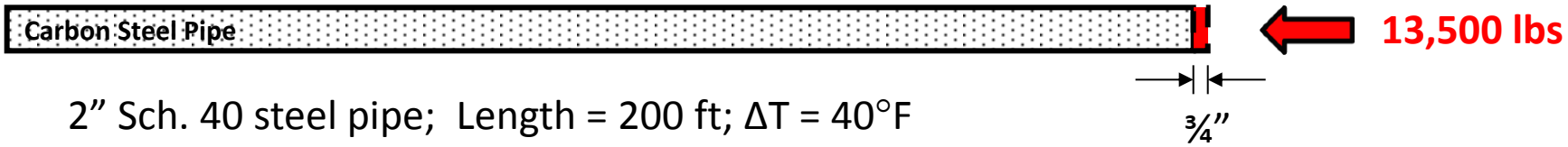
Piping Material	Coeff. Thermal Exp/Cont, (α) in/in-°F	Elastic Modulus (E) psi	Stress σ=αEΔT psi
Carbon Steel	6.1×10^{-6}	29×10^{6}	177ΔT
Stainless Steel	9.1×10^{-6}	28×10^{6}	255ΔT
Polyethylene	80×10^{-6}	0.065×10^{6}	5.2ΔT

Force to Required to Prevent Thermal Expansion?

$$F = \sigma A$$
$$\sigma = E\alpha\Delta T$$
$$\downarrow$$
$$F = E\alpha\Delta T A$$



2” DR11 HDPE pipe; Length = 200 ft; ΔT = 40°F



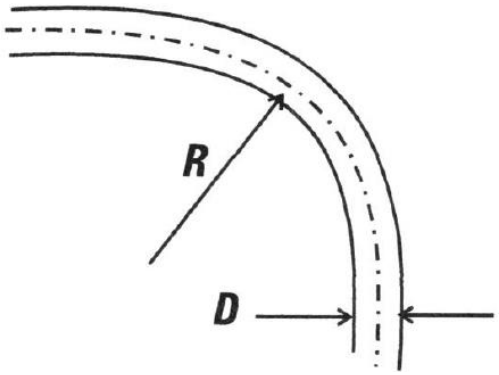
2” Sch. 40 steel pipe; Length = 200 ft; ΔT = 40°F

PERFORMANCE PIPE
A Division of Chevron Phillips Chemical Company LP

Bend Radius

1. Function of Pipe Size, DR and Bend Ratio
2. Lower DR = Tighter Bend Capability
3. Short Term vs. Long Term Bend Radius

Pipe DR	Minimum Long Term Bend Ratio, α	Minimum Short Term Bend Ratio, α
≤ 9	20 times pipe OD	10 times pipe OD
11 - 13.5	25 times pipe OD	13 times pipe OD
17 - 21	27 times pipe OD	17 times pipe OD
26	34 times pipe OD	-
32.5	42 times pipe OD	-
41	52 times pipe OD	-
Fitting or flange present in bend	100 times pipe OD	-

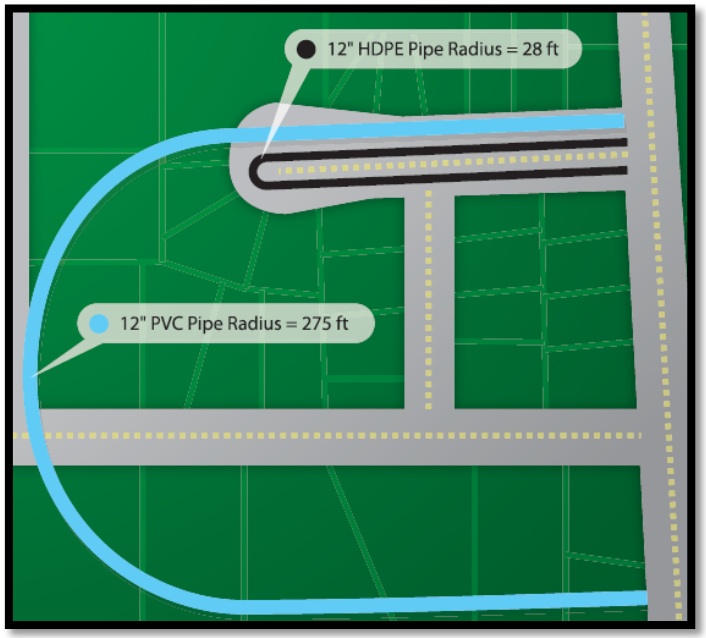


Bend Radius?

$$R = \alpha \times OD$$

Lay Length Required?

$$S = \Theta \frac{\pi}{180^\circ} R$$



Example:

$$R = 25 \times 13.2" = 28\ ft$$

$$S = 90^\circ \times \frac{\pi}{180^\circ} \times 28' = 44\ ft$$

Overview

Design

Installation

Heat Fusion Joining Options

Butt Fusion

Electrofusion

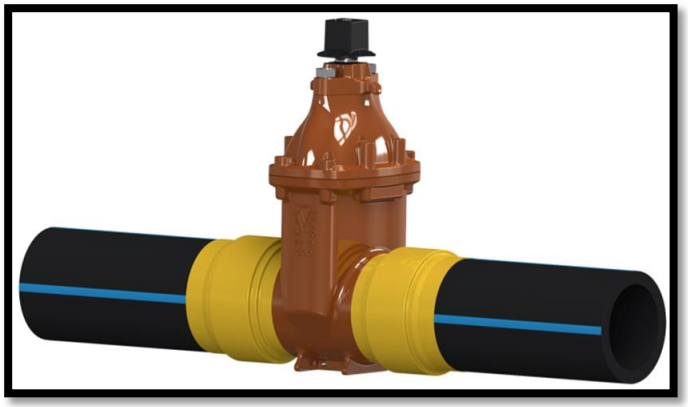
Saddle Fusion

PERFORMANCE PIPE
A Division of Chevron Phillips Chemical Company LP

Fitting Options

Molded

Specialty



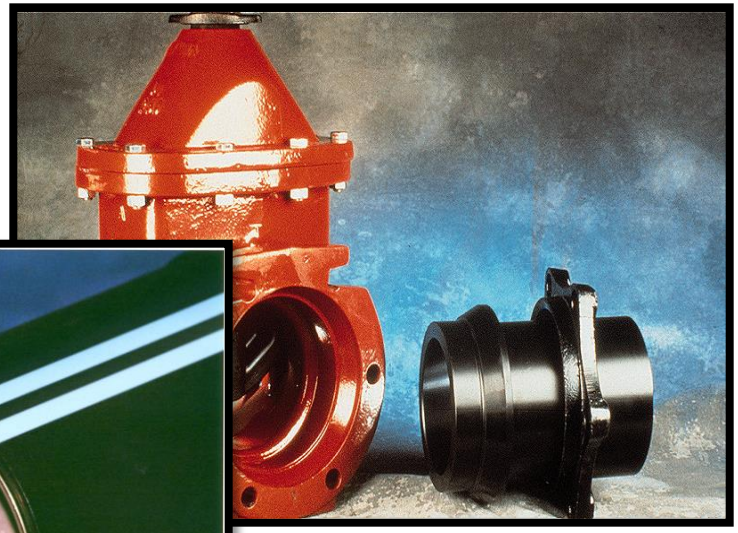
Fabricated

PERFORMANCE PIPE
A Division of Chevron Phillips Chemical Company LP

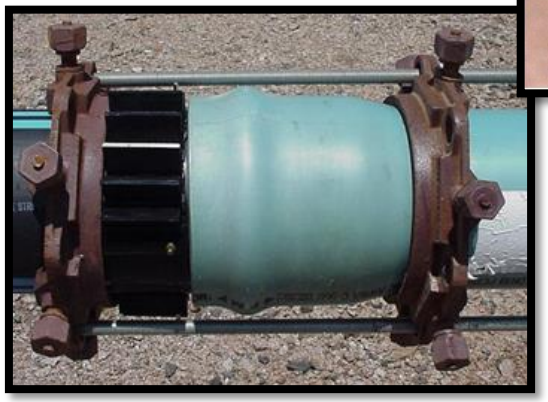
Mechanical Joining Options

Flange Adapter

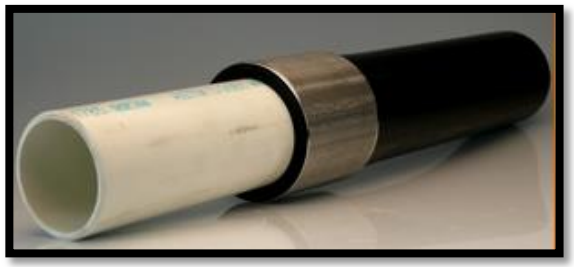
Mechanical Joint Adapter



Restraint Device



Transition Fitting

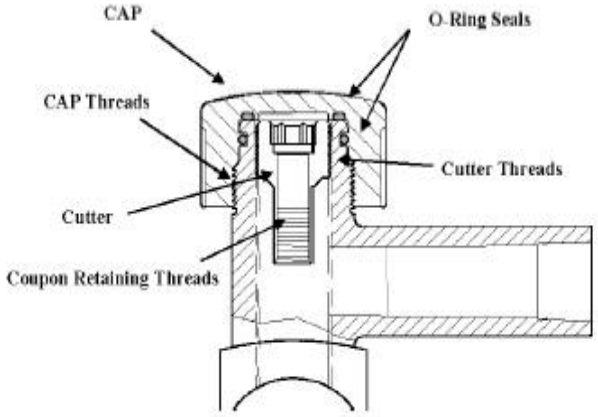


Source: Poly-Cam

Branching/Tapping Option

In-line Tapping

Saddle Tapping Tee



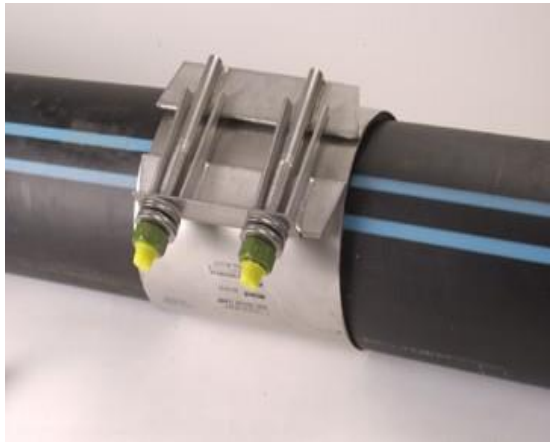
Mechanical Tapping Saddle

Electrofusion Branch Saddle

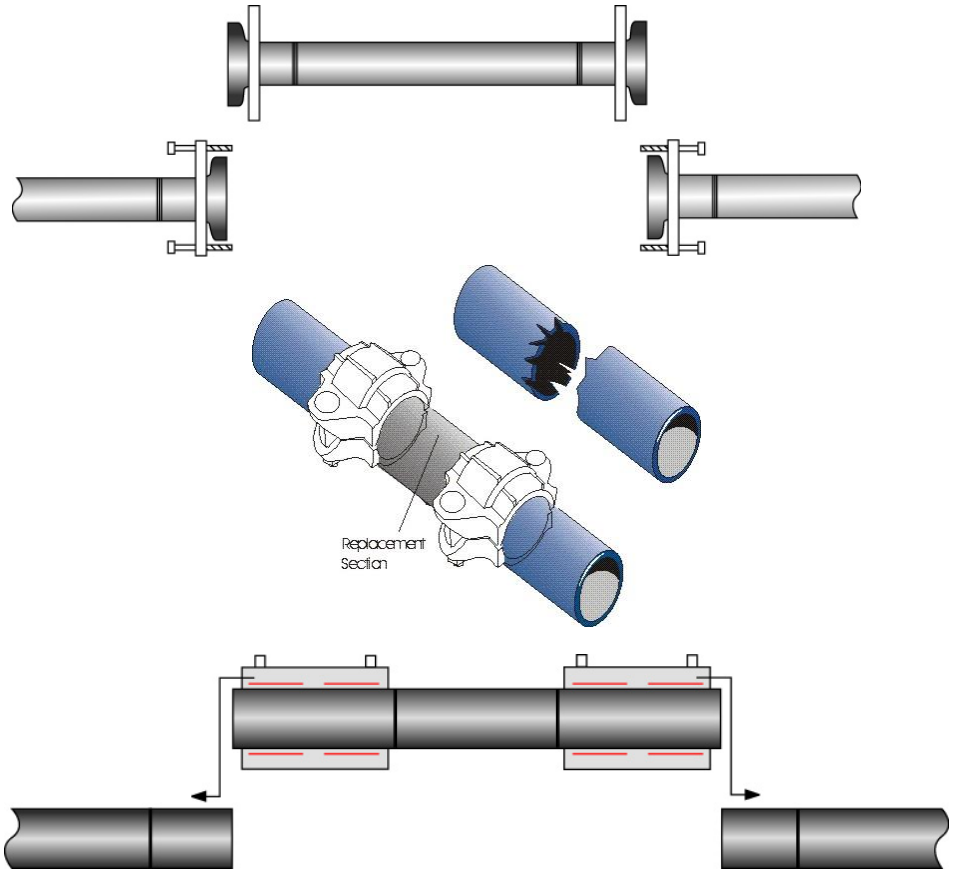
PERFORMANCE PIPE
A Division of Chevron Phillips Chemical Company LP

Repair Options

Puncture Repair



Rupture Repair



PERFORMANCE PIPE
A Division of Chevron Phillips Chemical Company LP

Why Use?

Short-Term

	HDPE	Steel	Iron	PVC
Tensile Strength	3500 psi	Higher	Higher	Higher
Compressive Strength	1150 psi	Higher	Higher	Higher
Modulus of Elasticity	130,000 psi	Higher	Higher	Higher
Poisson's Ratio	0.45	Higher	Higher	Higher

Long-Term

	HDPE	Steel	Iron	PVC
Corrosion Resistant?	Yes	No	No	Yes
Leak Free Joints?	Yes	Yes	No	No
Seismic Resistant?	Yes	Yes	No	No
Abrasion Resistant?	Yes	Yes	No	No
Toughness?	Yes	No	No	No

Direct Cost

Design
Construction
Equipment
Installation

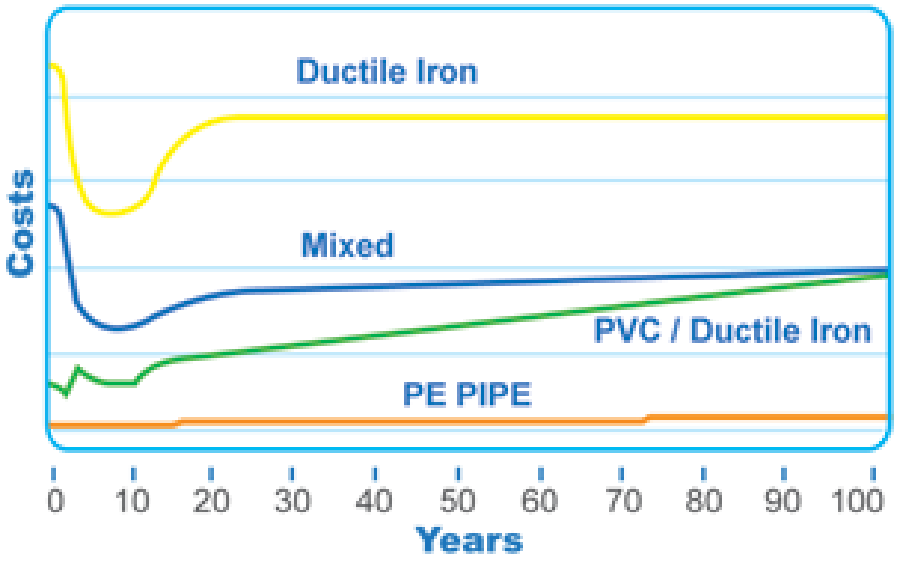
Operational Cost

Maintenance
Repair
Rehabilitation
Replacement

Indirect Cost

Water Loss
Pumping Cost
Hydraulic Efficiency
Corrosion Cost
Failure Penalties

Lowest life cycle cost of all water piping solutions



PERFORMANCE PIPE
A DIVISION OF CHEVRON PHILLIPS CHEMICAL COMPANY LP

QUESTIONS?

Chase Auansakul, EIT
auansc@cpchem.com
1-800-233-6495