How a Cost Effective Solution to Corrosion Became the Largest Domestic Order of HDPE Pipe

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Summary

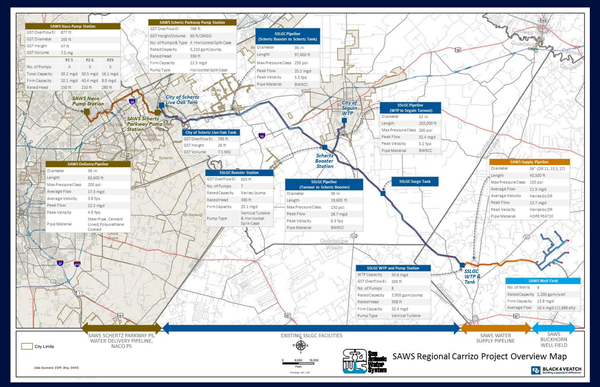
This poster describes how the implementation of a new resin of High Density Polyethylene (HDPE) pipe in a major water resources application eliminated a risk of corrosion and maintenance issues at no additional cost for the San Antonio Water System (SAWS).

Installation of HDPE pipe for the Regional Carrizo Project

Regional Carrizo Project

The Regional Carrizo Project (RCP) is a water resources program implemented by SAWS in order to provide an additional and diverse water source to their customers. The RCP system has the capacity to convey 22 mgd of water through four counties. The Program was designed by five firms and was built with seven different construction contracts. The SAWS Buckhorn Wellfield pumps water from the Carrizo Aquifer and sends it via an 8 mile supply pipeline to a Water Treatment Plant owned and operated by a neighboring water utility, the Schertz Seguin Local Government Corporation (SSLGC). SSLGC is then responsible for treating SAWS water to potable water standards and conveying it through 45 miles of existing SSLGC infrastructure to SAWS' Schertz Parkway Pump Station. The Carrizo Aquifer water is then transmitted through an 11 mile pipeline to the Nacogdoches Pump Station located within SAWS service area. The water is blended with Edwards Aquifer water and integrated into SAWS' distribution system.

The mutually beneficial regional water partnership between SAWS and SSLGC helps both entities maintain low water rates and the incorporation of Carrizo Aquifer water into the SAWS network allows them to reduce their dependency on the Edwards Aquifer.



SAWS Regional Carrizo Project Overview Map

Problem

A critical aspect to the success of the Program was the determination of the optimal material for the 120,000 feet of pipe in the Buckhorn Wellfield and Water Supply Pipeline. Because the wellfield and supply pipeline are located in western Gonzales County, approximately an hour and a half outside of San Antonio, it was important to choose a material that would require as little maintenance as possible. Raw water from nearby wells and the soil present in that region were known to be corrosive and had potential to damage standard piping materials. Additionally, the water temperature was anticipated to be in excess of 100°F. Therefore, it was necessary for the selection process to include consideration of resistance to corrosion on both internal and external pipe surfaces and effect of high temperatures, in addition to the standard criteria used during pipe selection processes. Because of the large amount of piping throughout the wellfield collection system and supply pipeline, it was important to ensure that whatever material was chosen was cost effective.

Pipe Material Evaluation

The design team, consisting of the owner, program manager, and two design firms, evaluated multiple pipe materials. Four technical memoranda were written, which each presented its own scoping and ranking methodologies for the pipe materials, and multiple meetings were held to determine the most efficient, yet cost effective material for this application.. Various coatings and linings were also assessed to be used in conjunction with the pipe materials that are not inherently corrosion resistant. Options such as specifying different types of pipe for the smaller and larger piping and allowing competitive bids for multiple pipe materials were also considered, but eventually decided against.

Pipe Materials Considered

- Ductile iron
- PVC
- Bar-wrapped concrete cylinder
- Fiberglass reinforced pipe
- Steel
- HDPE

Evaluation Criteria

- Strength
- Corrosion resistance
- Durability
- Constructability
- Effect of water temperature
- Cost

Pipe Material Cost (2011)

Diameter (in)	Pipe Material	Pipe Lining	Unit Cost ($/lf)
18	HDPE	n/a	$54.27
	DIP	Cement Mortar	$57.78
	DIP	Ceramic Epoxy	$81.12
24	HDPE	n/a	$77.36
	DIP	Cement Mortar	$78.17
	Steel	Cement Mortar	$87.00
	Steel	Polyurethane	$94.00
	DIP	Ceramic Epoxy	$109.70
36	Steel	Cement Mortar	$130.00
	DIP	Cement Mortar	$144.53
	Steel	Polyurethane	$140.00
	HDPE	n/a	$183.90
	DIP	Ceramic Epoxy	$188.08

HDPE Pipe Resins

During the selection process, two types of HDPE resin were evaluated: PE3408 and PE4710. The PE3408 resin for HDPE pipe was originally considered because it had been previously used for similar applications by SAWS and was approved by the AWWA standards. However the pressure rating of that resin is decreased by a factor of 0.78 for the anticipated design temperature, which required thicker pipe walls and thus greater costs. Although HDPE resin PE4710 is less common and was, at the time, not approved by AWWA, it is recognized in ASTM standards and is NSF approved. The PE4710 de-rating factor is 0.84 at the required temperature and the material is much stronger, which allowed the use of standard sized pipe and made it more cost effective. HDPE resin PE4710 was chosen over PE3408 because it can be installed with thinner walls and standard sized fittings, which makes it a much more cost effective material.

HDPE Pipe Properties (PE3408 vs. PE4710)

Property	PE3608	PE4710
De-rating @ 100°F	0.78	0.84
Density, g/cm3 (Base Resin)	0.940-0.947	0.947-0.955
Melt Index, dg/min	<0.15	<0.15
Flexural Modulus, psi	110,000-160,000	110,000-160,000
Tensile Strength, psi	3000-3500	3500-4000
Slow Crack Growth, Pent Test, hrs	>100	>500
Hydrostatic Design Basis, @ 23°C, psi	1600	1600
Color & U.V. Stabilizer Code	"Black" (min 2% carbon black)	"Black" (min 2% carbon black)
Hydrostatic Design Basis @ 60°C PPI TR-4, MPa (psi)	800	1,000
NSF Approved	Yes	Yes

Recommendation

The main factors that ultimately resulted in the final decision to use HDPE for both the wellfield collection piping and the water supply pipeline are:

- HDPE is corrosion resistant without exterior coating or interior lining
- HDPE is approved by the SAWS Standards Committee and has been used by SAWS on other projects
- HDPE allows the same material to be used for all diameters in both the wellfield and the supply pipeline
- The cost of HDPE is about the same as other pipe materials, and competitive pricing can be achieved because of the multiple HDPE pipe manufacturers in the area

A package describing the resin and the decision process for its use was submitted to the Texas Commission on Environmental Quality (TCEQ).

Design and Construction

Installation of HDPE pipe involves fusing the joints together into long sections prior to placement and burial.

Due to the relative newness of the material and corrosive conditions, certain considerations were taken into account during the design, including use of stainless steel pipe connections to the HDPE (for which a new design detail was created), UV protection, testing of the joints, and the decision to allow multiple manufacturers to produce the pipe under a single supplier.

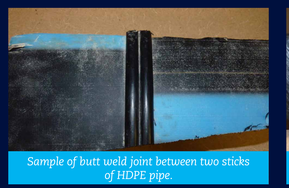
Some issues relating to the pipe material that arose during construction were only allowing personnel with required training to fuse the joints, possible damage to joints from dragging long runs of fused pipe, and special consideration for local livestock.

HDPE pipe in fusion machine

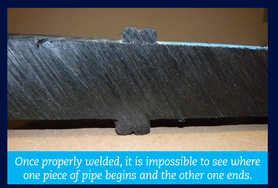
Fused pipe placed into trench

Bending of HDPE pipe

Connections of HDPE to stainless steel



Sample of butt weld joint between two sticks of HDPE pipe.



Once properly welded, it is impossible to see where one piece of pipe begins and the other one ends.

Conclusion

In the end, the pipeline was installed and tested successfully with only minor issues typical of any pipeline construction project. All of the HDPE pipe is currently in operation and the program is being commissioned.

The Regional Carrizo Project won the Plastic Pipe Institute, Inc's (PPI) 2013 Project of the Year Award for the Municipal and Industrial Division. PPI is the major trade association representing all segments of the plastic pipe industry.