PVC Pressure Pipe: Past, Present and Future

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Abstract

Today plastics are among the most promising and potentially useful structural materials available to the engineering profession, more so than they were in previous decades; yet to some degree, they remain unfamiliar to the civil engineering community. Some of the reservations many civil engineers have in using plastics are connected with the fact that they have not had access to a proper education concerning the use of viscoelastic materials. As a result, the very group that could benefit the most from structural plastic technology is often reluctant to specify plastic materials. Polyvinyl chloride, commonly referred to as PVC, is a thermoplastic material commonly used for a variety of pressure pipe applications including potable water distribution piping, irrigation systems and sewage force-mains. PVC offers a unique combination of structural characteristics, which enable it to overcome the problems associated with older, more traditional pipe materials.�

Introduction

PVC is made from Vinyl chloride monomer, first synthesized by a German scientist in 1835. In 1839, a paper was published detailing the observation of a white powder, which formed in a sealed bottle of vinyl chloride exposed to sunlight, marking the initial finding of what we know today as PVC.� In 1912, several decades after its accidental discovery, Fritz Klatte, another German, laid the groundwork for the technical production of PVC. The oldest known PVC pipe was manufactured and installed in the 1930�s in pre- and post-World War II Germany.� The technology was brought to North America following WW II, and started to take off after the National Sewer Foundation (NSF) began certifying pipe products for potability in the 1950�s, when PVC was also certified. The rest, as the clich� goes, is history �

Statistical Facts

According to 1991 data, plastic pipes accounted for 69.3 % of the overall buried pipe used in water distribution. Other pipe material in this data included iron, steel, concrete and asbestos-cement. Of the 4.5 billion pounds of plastic resin used for pipe manufacture during this period, 3.6 billion pounds of it was PVC resin. In a 1999 study of buried pipe, 66% of the total 310 linear feet of pipe laid in potable water systems (all diameters) was PVC. It is estimated that for sizes 4 inches and less, PVC has approximately 95% of market share.

Engineering Properties and Physical Characteristics

To understand the reasons for the rapid growth of the PVC pipe industry, one need only consider the numerous advantages that the material offers over existing alternative piping materials. The quality of a pipeline system may be expressed in terms of the degree to which the functional requirements are expected to be fulfilled during the total lifetime of the system. The requirements concern particularly the long-term strength of the pipe material, the resistance to degradation by the conveyed fluid (corrosion) and biological attack, the tightness with regard to leakage and the flow capacity; all are discussed briefly below:

- � Corrosion Resistance: PVC is an inert material that is non-reactive to pH�s ranging from 1 through 13. Corrosion is a nuisance plaguing water systems throughout North America and is the single greatest contributor to the decay of existing buried pipe infrastructure. PVC provides an excellent deterrent for both internal and external corrosion associated with water systems.

- � Improved Hydraulics: Numerous experimental and real-life data provide testimony of PVC�s smooth internal characteristics in its long-term performance. For PVC pressure systems, a conservative Hazen-Williams �C� factor of 150 is widely accepted and used. This equates to much lower lifetime pumping and maintenance costs.
- � Tight Joints: Gasketed-jointed PVC pressure pipes provide ideal protection against leakage as well as ability for the piping system to accommodate expansion and contraction as a result of temperature differentials. Stringent standards by organizations such as ASTM ensure that the highest levels of protection against leakage are adhered to.� Numerous QA/QC requirements are in place, which also ensure the manufacture of a PVC product that will provide a water system with excellent performance in the long run.

Current ASTM and AWWA Standards

The 1960�s saw the first ASTM standard written for PVC pressure pipe. Used to this day, *ASTM D 2241, Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series),*
was primarily used in rural applications for force mains and turf irrigation in the early days. To ensure its longevity, keeping in mind the vicsoelastic properties of a thermoplastic material such as PVC, ASTM D 2241 allowed for a Factor of Safety of 2.

In 1975, AWWA published *C900, Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings 4 inches through 12 inches for Water Distribution*. After a development period of eight years, C900 pipe finally offered the engineer an ideal product that was easily an equivalent, if not a better alternative, to many of the older, traditional piping materials already widely in use. To account for its use in distribution systems, C900 employed a Factor of Safety of 2.5 and also included in its calculation of pressure class, a surge allowance.

With the successful performance of AWWA C900 pipe, a natural demand arose for larger diameters of this pressure pipe standard; the result was the publishing of AWWA C905 in 1988, *Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings 14 inches through 48 inches for Water Transmission.*

Efforts are now in place to eventually combine the C900 and C905 standards. One of the reasons is that the Factor of Safety of 2.5 in the current C900 Standard is overly conservative and quite unnecessary in ensuring the long-term performance and the useful life span of the PVC pressure pipe.

Conclusion

The successful performance of PVC pressure pipe will continue to manifest itself as utilities across North America continue to specify it in their water systems. In light of the focus being given to piping materials in preserving and prolonging the life-span of our existing buried pipe infrastructure, PVC will continue to provide an ideal alternative for engineers.

If you have any questions, please contact **Dr. C.Vipulanandan**