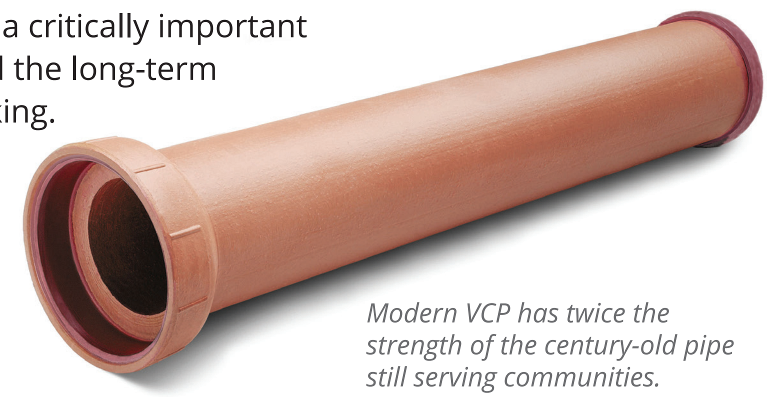
NATIONAL CLAY PIPE INSTITUTE
The VCP Authority Since 1917

Vitrified Clay Pipe vs. PVC
in Gravity Sanitary Sewers

Specifying a pipe material for any project is a critically important decision for both the life of the pipeline and the long-term environmental impact of your decision-making. Evaluating more than just the initial cost of the material is the only responsible approach for both financial and environmental implications.



Modern VCP has twice the strength of the century-old pipe still serving communities.

Vitrified Clay Pipe (VCP) has been used in storm and wastewater collection systems in the United States since the early 1800s. The first VCP sewer was installed in Washington DC in 1815, and today, most of the sanitary sewer systems in the U.S. have 100-year-old VCP still in service.

Material Comparison

Vitrified Clay Pipe (VCP) is an all-natural product made from a blend of clay, shale and water. The raw materials are pulverized, mixed, vacuum extruded, and kiln fired to temperatures approaching 2,000° F to achieve vitrification. This results in a pipe body that is ceramic. It is chemically inert, has an average compressive strength of 18,000 psi, and is extremely abrasion resistant. As a ceramic, vitrified clay does not change or degrade with time or temperature. It has everlasting physical and chemical properties.

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VCP consistently out-performs any other gravity sewer material on the market today. In more than two centuries of daily use, it is unmatched. The ceramic pipe body stands up to the heat encountered in fire-prone regions. The inherent bearing strength of the pipe and the seismic cushioning of the flexible compression joint system provides resistance to soil movement.

Prior to the 1960s, VCP joints were manufactured in the field with cement, tar or mortar. At that time, factory-applied compression joints were introduced. Today those joints must be leak-free.[1]

[1]ASTM C425 *Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings.*

VCP manufactured in the U.S. is guaranteed against chemical attack and material degradation for 100 years.

Polyvinyl Chloride (PVC) is a petroleum product. The exact content of any PVC pipe is obscure as there is a list of possible ingredients that "may" be in any given pipe. But the content of each manufacturer's pipe is treated as a trade secret.

100% of PVC was manufactured using **mercury, asbestos and/or PFAS.**[2]

In addition to its chlorine content, PVC often contains other ingredients of concern such as cadmium, lead and phthalates. A 2019 study found 100% of PVC was manufactured using mercury, asbestos and/or per-and polyfluoroalkyl substances (PFAS).[2]

"PVC is considered the most environmentally damaging plastic and one of the most toxic substances for inhabitants of our planet. From cradle to grave, the PVC lifecycle (production, use, and disposal) results in the release of toxic, chlorine-based chemicals, and it is one of the world's largest dioxin sources," according to the National Science Centre (Poland).[3]

The US EPA is investigating vinyl chloride under the Toxic Substances Control Act because of the known dangers associated with its manufacture and use. Of the five materials currently under scrutiny, only vinyl chloride fails all ten of the evaluation criteria, including tests for: hazardous substance, hazardous waste, carcinogens and persistent and bioaccumulative chemicals.[4]

"Plastics are non-linear, visco-elastic materials with temperature and time-dependent properties. Plastics physically and chemically age and are susceptible to chemical attack, environmental stress cracking and weathering."[5] Damage from UV rays as PVC sits on a jobsite is one common form of weathering.

"The main feature of plastics and polymer composites is that their physical, mechanical, thermal, and chemical properties are strongly time and temperature dependent."[6] In other words, the structural properties of PVC degrade over time.

In fires, PVC will melt, releasing dioxins into the environment. In seismic events, plastic pipe can deflect leading to eventual (if not immediate) failure.

PVC manufacturers warranty their product for 12 months from the date of invoice.

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[2]https://informed.habitablefuture.org/index.php/resources/news/134-newly-completed-inventory-of-chlorine-pvc-production-sheds-new-light-on-supply-chain-challenges#:~:text=Our%20research%20confirms%20that%20100,PFAS)%20in%20its%20supply%20chain. Published March 19, 2019, Viewed June 27, 2024

[3]Kudzin MH, Piwowarska D, Festinger N, Chruściel JJ. *Risks Associated with the Presence of Polyvinyl Chloride in the Environment and Methods for Its Disposal and Utilization. Materials (Basel).* 2023 Dec 28;17(1):173. doi: 10.3390/ma17010173. PMID: 38204025; PMCID: PMC10779931.

[4]U.S. EPA Presentation, February 20, 2024

[5]O'Conner, Chris, Long-Term Testing Critical for Material Selection; *Modern Plastics Worldwide*; October 2007 pp 22 – 25

[6]Farshad, Mehdi, *Plastic Pipe Systems Failure Investigation and Diagnosis; 2006;* pp 2 - 3

Operations and Maintenance

VCP can be cleaned using hydro jetting systems, and when blockages demand, it can also be cleaned using power rodders, chain flails, grinders, hydraulic root saws and can cutters (among others).

The only option for cleaning PVC is a hydro-jet with very limited power. When using hydro-jets to clean pipe, VCP may be cleaned at 5,000 psi[7], compared to the 1,740 psi permitted by PVC[8]. Jetting angles, maximum nozzle weights, minimum stand-off distances and permitted stationary positions all heavily favor the use of VCP.

Both PVC and VCP can be cleaned using hydro jets. Only VCP permits the use of mechanical cleaning methods in addition to hydro jetting.

The abrasion resistance of VCP is unmatched by any other pipe material. In municipalities where water usage is a concern, mechanical cleaning methods can significantly decrease the amount of water needed for cleaning pipelines.

Lifecycle Cost vs. Upfront Cost

When evaluating the options for pipe materials in sanitary sewer pipelines, municipalities have focused on initial cost because that is what their budgets demanded. Looking at only the initial installation cost is no longer good enough. The shorter lifecycle of PVC demands that it be replaced at least once during the expected service life of a VCP line.

Because mechanical cleaning is not an option in a PVC line, a dig and replace repair to eliminate a blockage may be the only option, adding significantly to the lifetime cost of the line.

While the initial cost can be lower when using PVC, when the total cost of ownership is considered, the obvious choice is VCP.

[7]ASTM C1920 *Standard Practice for Cleaning Vitrified Clay Sanitary Sewer Pipelines*, 2021

[8]ASTM F3618 *Standard Practice for Cleaning Thermoplastic Solid Wall Sanitary Sewer Pipelines*, 2022

Environment & Sustainability

Flaring oil refineries in Port Arthur, TX
Photo by Hilton Kelley

The raw materials used in the production of VCP are natural, abundant and sourced from the earth (generally within 25 miles of the manufacturing plant). Once vitrified, the material is inert. It does not degrade in any fashion over time.

Toxicity is inherent throughout the PVC lifecycle. It is one of the most environmentally problematic materials in use today.

The embodied carbon of PVC is roughly ten times that of VCP.[9] Vinyl Chloride is a known carcinogen, it is a bioaccumulative, persistent chemical. As a thermoplastic, PVC degrades over time.

Conclusion

The fiscal and environmental health of cities and our future generations are at risk based on the choice of pipe materials.

Material Comparison – A VCP line does not change over time. The service life of a properly installed VCP line is indefinite. PVC degrades over time.

Operations & Maintenance – VCP makes mechanical cleaning methods and greater jetting pressures allowable. This can save water, time and money over the life of a pipeline.

Cost – A fiscally responsible model requires evaluation of the comparative cost of ownership for the full life of the installation.

Environmental – VCP is a natural product that has been in use for centuries. PVC is toxic at every stage of its life.

The only fiscally and environmentally responsible choice is vitrified clay pipe.

[9]Hammond and Jones, *Embodied Carbon The Inventory of Carbon and Energy (ICE);* A BISRA guide, 2011