Sustainability and Vitrified Clay Pipe

A White Paper of the National Clay Pipe Institute

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Many products that are used in today's market are considered "Green" because of the Resource Conservation and Recovery Act of 1992. In essence, if a material has the ability to be recycled it was designated as a "green material". Many thermoplastic materials were designated in this way due to the fact that some post consumer plastics are recycled and reused. Today's "green" engineers measure environmental performance using a more comprehensive set of criteria. The real measure of a product's environmental benefit is not limited to the ability of that material to be recycled. When a complete Sustainability Analysis is performed, VCP will stand far ahead of every other material available for gravity sewer pipe.

This white paper briefly looks at four different parts of the product lifecycle

- Acquisition of raw materials
- Manufacture of the pipe product
- Life cycle and durability of the pipe
- End of life issues

When you are done reading you'll see, *it's not easy being green*!

Acquisition of Raw Materials

Vitrified Clay Pipe is made from various shale's and clays which are the natural decomposition products of stone. It is an abundant, naturally occurring group of materials found all over the country. While not renewable in the purest sense, they are so readily abundant that there will never be a shortage of raw material.

Thermoplastic resins are the result of significant chemical processing using non-renewable resources, such as petroleum. Both PVC and HDPE start with Ethylene which is a direct product of the processing of crude oil. In a recent article from Spirit Magazine, it was stated that in the United States we consume roughly 2 million barrels of oil every day to make the plastics used in our country. This is roughly equal to 10% of our nation's daily oil consumption.[1] Over 40% of the plastics produced are for the construction industry, with a majority of that used for pipe. The production of these resins is a chemically intensive process. The raw polymer is blended with several additives which include plasticizers, UV inhibitors, colorants, flame retardants, and anti-oxidizers. These materials are each hazardous in their own right. During the process of polymerization and blending, many by-products are generated. The most widely recognized by-product of PVC production is a persistent toxin called Dioxin. A quick search of the Internet on manufacture of thermoplastic materials reveals several resources of valuable information about the production of the resins used in thermoplastic pipe.[2]

Manufacture of the Pipe Product

Vitrified Clay Pipe is manufactured using a simple process. The shale's and clays are ground into a powder and roughly 12%-15% water is added. This mixture is then vacuum degassed and extruded into the shape of the pipe. The pipe is dried to a low moisture content using waste heat from other processes in the plant. The pipe are then fired to 2000 ºF and cooled. Jointing materials are applied, final quality checks are performed and the pipe are prepared for shipment. Any off-grade pipe are reground and used in the process. This regrind material not only improves the processing but it enhances the quality of the final product. There is essentially no waste generated by this process. Total energy consumption has been shown to be half of that needed to produce the same amount of thermoplastic pipe. Energy studies from both the United States and Europe are available for review upon request.[3]

Thermoplastic Pipe is also processed using heat. The resin blend beads are melted so that they can flow and be extruded into the shape of a pipe. During this process the chemicals present in the resin beads are exposed to temperatures as high as 450 ºF. These temperatures often generate gases that can be hazardous to the employees. Once the pipe is extruded, temperature must be controlled carefully to keep the pipe in the proper shape. Off gassing continues to occur for many hours after the extrusion of the pipe. Scrap materials are often reground and re-used. With thermoplastic materials, the more times they are heated, the more the physical properties change. This is because subsequent heat cycles can break the chemical bonds within the polymer chains, changing the physical properties of the end product. This is the primary reason ADS limits the application of its “green” pipe (40% recycled materials) to only 8 ft of cover! For any other application it recommends products with 100% virgin resin (no recycled materials). This information comes directly from the ADS website.[4]

Life cycle and Durability

Vitrified Clay Pipe has a proven track record of long-term performance. It is one of the few materials used for thousands of years for the same purpose. Clay Drainage pipe has been found dating back roughly 2500 years in Ephesus, Turkey (see photo right). Today, seven of the ten largest municipalities in the United States have been using VCP for well over 100 years. In Europe clay is still the standard in countries like Germany, Sweden and England. The Army Corp of Engineers stated that “*A 100 year service life can be assumed for most clay pipe installations”.*[5] The Canadian NRC-ICR has rated Clay Pipe for a service life of 132 years. At the ASCE Pipelines Conference in 2008, Terry Martin, Seattle Public Utilities, stated that he expected the clay pipe in his system to last up to 500 years. These comments were made in response to questions from the audience after his presentation. His actual written report projected anywhere from 300 to 400 years.[6] Properly installed VCP will outlast anything else because it’s physical properties will not change over time.

Thermoplastic Pipe is a material that is subject to the ravages of time. Professor Mehdi Farshad, in his book titled, ***Plastic Pipe Systems-Failure Investigation and Diagnosis*** stated it this way, "*the main feature of plastics and polymer composites is that their physical, mechanical, thermal, and chemical properties are strongly time and temperature dependent*".[7] These materials can change based on the conditions to which they are exposed. This is why life-cycle predictions vary significantly depending on who you ask! PVC manufacturers will tell you 100 years but the EPA rates PVC pipe for 50 years. The Vinyl Institute has said "***up to*** 50 years".[8] There are municipalities across the country returning to VCP due to quality and performance issues with thermoplastic pipe materials after only 30 years. The HDPE people tout a recent University study that says that HDPE will last 2870 years! This, of course, requires that the stress in the wall be kept very low. As one reviews this study further it becomes apparent that this is a mere mathematical exercise and is essentially impossible in real world construction practices. Large deflections and high stresses are a common cause of accelerated deterioration and failures in thermoplastic pipe. The Florida DOT recently commissioned a study at Florida Atlantic University on HDPE Pipe showing that top quality, virgin resin pipe *may* last up to 80 years un-damaged, but if notched or damaged, only 30 years.[9] Without a proven history, what can an engineer truly expect as a life cycle for these materials?

End of Life Issues

Vitrified Clay Pipe is as close to permanent as any material can be for gravity sewer applications. Due to its long lifecycle and environmentally friendly body composition, there are no long-term disposal or environmental concerns.

Thermoplastic Pipe have all of the disposal issues currently associated with plastics world-wide. While we would like to believe that 40% to 50% of plastics are recycled, the actual number is closer to 6%. Much of that is consumer grade plastics and not construction materials. Incineration generates too many toxic by-products and filling our landfills with plastic materials is not a sustainable option. In a recent report presented to the USGBC from the Healthy Building Network the following statement was made;

> "At the end of its life, PVC waste creates intractable disposal problems because it is expensive and unsafe to burn, it releases hazardous chemicals into groundwater and air when buried, and is not cheaply or easily recycled."[10]

In the end, it's not easy being Green. The "greenest" pipe product available has been used in gravity sewers for several thousand years. VCP comes from abundant natural materials, uses less energy to manufacture, and has the longest life of any material in the market-place for this application.

We would like the opportunity to make the case for Vitrified Clay Pipe to you in person. If you have any questions about the material presented here, please contact Michael VanDine, PE, via email at mjvandine@ncpi.org or 262-248-3439.

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