Sandwich Construction PVC-U Non-Pressure Pipe

Sandwich construction PVC-U (SC PVC-U) pipe has been successfully used in Australia for more than two decades in non-pressure drain, waste, vent (DWV), stormwater and electrical conduit applications. This document provides users with information regarding the forms in which they are produced, the manufacturing process, performance, environmental, social and economic benefits and the integration of SC PVC-U pipe into Australian Standards.

WHAT IS SANDWICH CONSTRUCTION PVC PIPE?

SC PVC-U pipes contain multiple layers (typically three) of PVC with differing properties. Most commonly in Australia, the inner and outer surface layers are virgin PVC-U compounds of a colour that identifies the pipe's specific application. For example, heavy duty electrical conduit will be manufactured with an orange inner and outer surface whereas a DWV pipe will be supplied with a pearl grey inner and outer surface.

The intermediate(central) layer between the inner and outer layers will be a colour that reflects the PVC material's origin. In some instances, the intermediate layer will be PVC-U material that has been diverted from the waste stream or it may be rework generated from the pipe manufacturer's own pipe production.

Note: Australian Standards do not consider pipe manufacturer's reworked material to be recycled PVC.

FIGURE 1 – SC PVC-U HD ELECTRICAL CONDUIT

FORMS OF SANDWICH CONSTRUCTION PVC-U PIPE

There are two forms of SC PVC-U pipe depending on the composition of the intermediate layer:

1. Foamed PVC intermediate layer, and
2. Solid PVC intermediate layer.

Foamed PVC is produced by adding a very small percentage of a blowing agent into the PVC compound as it enters the throat of the pipe's intermediate layer extrusion machine. (This PVC compound may be either virgin material, manufacturer's reworked material, or PVC that has been diverted from landfill through a recycling program.) As the compound is heated within the extruder barrel, the blowing agent is activated releasing tiny "bubbles" of gas into the melt. The extreme pressure within the extruder barrel and head reduces to atmospheric once the pipe leaves the pipe die and this allows the gas to expand and foam the material, thus reducing the density of the intermediate PVC layer. The density of the foam is typically 50% that of solid PVC.

Solid PVC intermediate layer does not contain any blowing agent. Where the solid core material is the manufacturer's rework, the source may be either PVC-U, PVC-M or PVC-O pressure pipe, electrical conduit or DWV pipe. The strength, ductility and impact resistance of these formulations has the potential to improve the properties of the pipe, when compared with 100% virgin solid walled (monolayer) pipe.

Since DWV pipe is categorized by its stiffness, the overall wall thickness, or distance between the inner and outer layers has a very significant impact. It may be helpful to think of the pipe wall as a cylindrical beam where the inner and outer surfaces are the beam flanges and the intermediate layer is the web of the beam surrounding its neutral axis. As in a beam, the vast majority of the bending resistance of the pipe is provided by the extreme inner and outer surfaces that are separated by the intermediate web layer.

In the case of DWV pipe, the inner layer also provides the waterway and therefore a minimum thickness of this layer in specified in AS/NZS 1260. It is worth noting that in Australian Standard DWV pipe, the minimum thickness of this inner layer is approximately 50% greater than that nominated in ISO 21138-2.

MANUFACTURING PROCESS

PVC-U pipe is typically produced on an extrusion line that consists of an extrusion machine, pipe head and forming die, vacuum calibration and cooling tanks, haul-off, saw and belling machine. In the case of SC PVC-U pipe, two (or more) extrusion machines are used to convert the differing inner, outer and intermediate layer PVC compounds into melt streams that are simultaneously "pumped" into the pipe head and subsequently, the forming die.

Figure 2 below depicts a typical SC PVC-U pipe head and die which is connected via bolted flange connections to two individual extrusion machines. This process is commonly referred to as co-extrusion since the two extruders are independently and simultaneously, pumping PVC melt into a common receiving head.

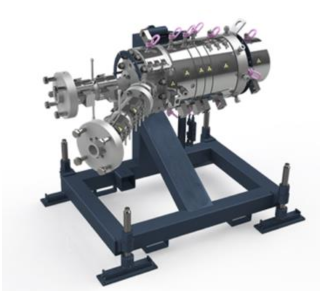

FIGURE 2 – SC PVC PIPE HEAD AND DIE

Once the individual melt streams enter the pipe head they are combined through a series of compression zones into one common melt flow. This is achieved at a temperature of between 190 °C and 210°C and between 250 and 350 bar pressure. In Figure 3 below, the inner and outer layers are depicted in pink whilst the intermediate layer is yellow. It must be understood that the separate layers are combined at extreme heat and pressure to become one inseparable melt flow; coextrusion is not a process of "coating", "lining" or "laminating" separate layers.

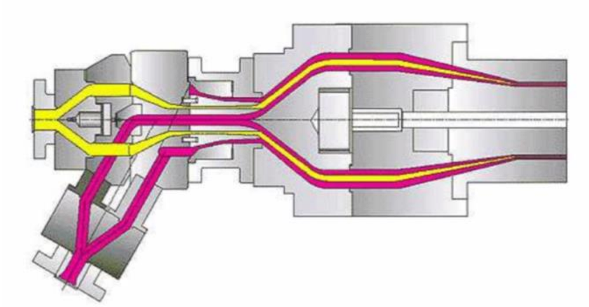

FIGURE 3 – SC PVC PIPE HEAD AND DIE SECTIONAL VIEW

PERFORMANCE BENEFITS

The primary performance benefits of SC PVC-U compared to solid walled (monolayer) pipes are:

- Reduced weight, where foamed material is used in pipe,
- Pipe properties are often enhanced by the use of manufacturers' rework material, providing improved strength, ductility or impact resistance. The extent of the improved properties is dependent on the source of the rework material used in the intermediate layer.

In all non-pressure applications, the anticipated service life of SC PVC-U pipe will at least be equal to that of 100% virgin solid walled (monolayer) pipe.

ENVIRONMENTAL AND SOCIAL BENEFITS

The use of manufacturers' rework and post-consumer PVC waste in SC PVC-U pipe is directly responsible for the annual diversion of thousands of tonnes of plastic from landfill in Australia. The responsible use of recycled materials to replace virgin materials is in Australia's best interests and this can be achieved with SC PVC pipes without compromising pipe performance.

Australian PVC manufacturers' commitment to product stewardship actions including SC PVC-U pipe, assisted PIPA and the Vinyl Council of Australia to achieve recognition by the Green Building Council of Australia (GBCA) and the Infrastructure Sustainability Council of Australia (ISCA) of the environmental benefits of PVC. This ultimately resulted in the normalisation of Best Environmental Practice PVC (BEP PVC).

The use of third-party certified BEP PVC in GBCA and ISCA assessed green developments and buildings, earns positive Green Star and ISCA assessment scheme credit points in recognition of the sustainability benefits of these PVC products. Many of Australia's leading engineering, building, construction companies and water utilities are signatories to GBCA and ISCA programs and benefit significantly from these schemes.

Foamed intermediate layer pipe SC PVC-U pipe reduces the embodied energy in a pipe system and its lower mass, reduces the possibility of strain injury to pipe installers.

Environmental Product Declarations (EPDs) based on the Life Cycle Assessment of SC PVC-U pipe have been published by a number of PIPA members. These EPDs are independently verified and registered documents that communicate transparent, comparable data and other relevant environmental information in accordance with ISO 14025 and EN 15804, about the life-cycle environmental impact of SC PVC-U pipe.

The acceptance and use of SC PVC-U pipe is socially and environmentally responsible and a smart application of plastics.

More information is available of the PIPA website's Sustainability page.

ECONOMIC BENEFITS

SC PVC-U pipe reduces economic cost by:

- Avoiding waste disposal levies of otherwise unusable rework material and post-consumer waste,
- Avoiding the storage and holding costs of rework PVC material by pipe manufacturers,
- Reducing material content costs in foamed SC PVC-U pipe,
- Reducing freight, handling and installation costs of lower weight, foamed SC PVC-U pipe.

AUSTRALIAN STANDARD INTEGRATION

BEP PVC has been recognised in Australian and New Zealand non-pressure pipe Standards AS/NZS 61386.21, AS/NZS 1254 and AS/NZS 1260.

DISADVANTAGES OF SC PVC

There are no disadvantages specifically attributable to SC PVC-U pipe, however it is acknowledged that in rubber ring jointed systems, reasonable care needs to be exercised by installers when chamfering the spigot of foamed intermediate layer pipe.

INSTALLATION CONSIDERATIONS

SC PVC-U pipes and conduits, either foamed PVC intermediate layer or solid PVC intermediate layer are installed, tested and commissioned in the same manner as solid wall mono-layer pipe. i.e. In accordance with AS/NZS 2032.

For water supply and sewerage network infrastructure involving design and installation of SC PVC-U DWV pipelines, reference should also be made to the Water Services Associations of Australia (WSAA) Codes.

SUMMARY

- SC PVC-U pipe has been successfully used in Australian non-pressure pipe applications for more than two decades.
- SC PVC-U pipe is produced with either a solid or foamed intermediate layer.

- The inner, outer and intermediate layers are combined within a pipe head at extreme temperature and pressure. SC PVC-U is not manufactured in a lamination or coating process – it is a totally integrated multilayer extrusion.
- SC PVC-U pipe provides significant social, environmental, economic and performance benefits to Australia, when compared with equivalent 100% virgin solid walled (monolayer) pipe.
- Australian Standards for non-pressure PVC pipe and conduit have integrated SC PVC-U pipe.
- Installation of SC PVC-U pipe and conduit needs to conform to the same Standards and codes as equivalent mono-layer pipe.

More information about performance and availability of SC PVC-U pipes can be obtained from PIPA members.

PIPA wishes to acknowledge and thank all our Technical Committee members and Industry Consultants for their contribution, expertise, and assistance in the development of this technical document.