Sandwich Construction PVC-U Non-Pressure Pipe

Sandwich construction (also referred to as multi-layer) 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, electrical and telecommunications conduit applications. This technical note provides information regarding, the manufacturing process, different types of SC PVC-U, performance, sustainability benefits including social and economic and the integration into Australian Standards.

Note: 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.

1. WHAT IS SANDWICH CONSTRUCTION PVC-U PIPE?

SC PVC-U pipes contain multiple layers (typically three) of PVC. Most commonly , the inner and outer surface layers are virgin PVC-U compounds of a colour that identifies the pipe's specific application. For example, 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(core) layer between the inner and outer layers will be a colour that reflects the PVC material's origin. This PVC-U material can be pre-consumer or post-consumer recycled material diverted from the waste stream or re-work 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

2. MANUFACTURING PROCESS

Typically, a PVC-U pipe is 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 inner, outer and core layer PVC compounds into melt streams that are simultaneously sandwiched and fused together in the pipe head and subsequently, the forming die.

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

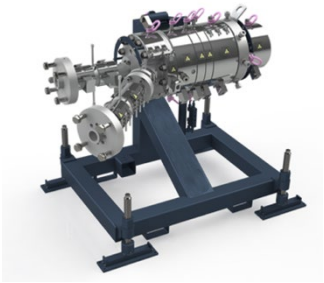

FIGURE 2 – SC PVC-U PIPE HEAD AND DIE

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. Figure 3 shows the inner and outer layers depicted in pink whilst the core or "inner layer" is yellow. The separate layers are combined and fused together with extreme heat and pressure to become one inseparable melt flow. Co-extrusion is not a process of "coating", "lining" or "laminating" separate layers.

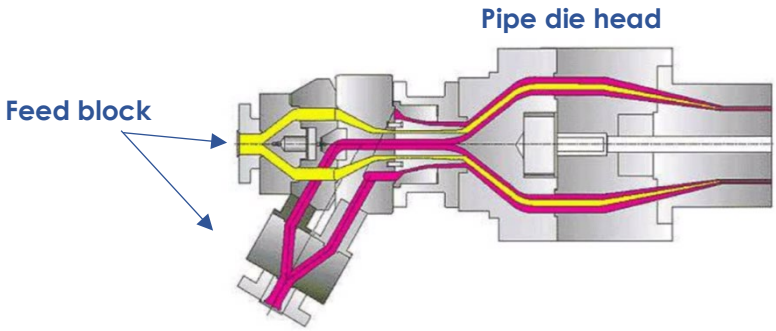

FIGURE 3 – SHOWS THE INNER "YELLOW" AND OUTER "PINK"LAYERS GOING THROUGH THE FEED BLOCK AND PIPE DIE HEAD

3. TYPES OF SANDWICH CONSTRUCTION PVC-U PIPE

There are two types of SC PVC-U pipe:

1. Foamed PVC multi-layer, and
2. Solid PVC multi-layer.

Foamed PVC multi-layer pipe is produced by adding a very small percentage of a blowing agent into the PVC compound that forms the core layer. This PVC compound can comprise of virgin material, manufacturer's rework or post-consumer and pre-consumer material. As the compound is heated within the extruder barrel, the blowing agent is activated releasing tiny "bubbles" of gas into the compound 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/ This reduces the density of the core PVC layer, foam is typically 50% that of solid PVC.

Solid PVC multi-layer core does not contain any blowing agent. The solid core material can comprise of manufacturer's rework (including PVC-U, PVC-M or PVC-O pressure pipe, electrical and telecommunications conduit or DWV pipe), post-consumer or pre-consumer material. The strength, ductility and impact resistance of these materials give the same performance as 100% virgin solid walled (monolayer) pipe.

4. IDENTIFICATION /MARKINGS

Due to the different origins of materials used in the core of sandwich construction pipes, the colour can differ. However, it is easy to identify the types of sandwich construction by the print message on the pipe.

To conform to AS/NZS 1260 *PVC-U pipes and fittings for drain, waste and vent applications* and AS/NZS 1254 *PVC pipe and fittings for stormwater and surface water applications* the markings for sandwich construction pipes must include the letters **SC**.

Sandwich construction solid core PVC electrical conduits print message will contain the marking **SOLID CORE**.

5. PERFORMANCE BENEFITS

The primary performance benefit of SC PVC-U compared to solid walled (monolayer) pipes is reduced weight, where foamed material is used in pipe.

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.

Testing on medium duty conduits has shown that monolayer solid wall pipes and multi-layer solid core PVC pipes containing recycled content consistently perform the same across all size ranges. Mechanical testing to AS/NZS 2053 focused on low temperature impact performance at -5°C, compression testing at 20°C and resistance to heat at 60°C covering both lower and higher service temperatures. The results showed they not only passed the medium duty but also the heavy-duty conduit testing requirements.[1]

Additional testing was carried out on heavy duty multi-layer solid core PVC conduits containing recycled content. These tests included a 2m drop height impact test at 20°C using test weights and conditions for PVC-U pressure pipes. Pipe stiffness and pipe ring flexibility demonstrates the ability of the conduit to withstand loads without cracking or permanent deformation. In all cases impact test results showed the conduits are extremely robust under impact, passing all impact tests. HD multi-layer conduits returned stiffness (SN ratings) exceeding SN25, well above the minimum requirements for deep installations and high loading conditions.[1]

Ring flexibility showed that solid core HD multi-layer conduits containing recycled materials do not permanently deform or crack when subjected to 30% deflection. This confirms that the sandwich layers are properly fused together.[1]

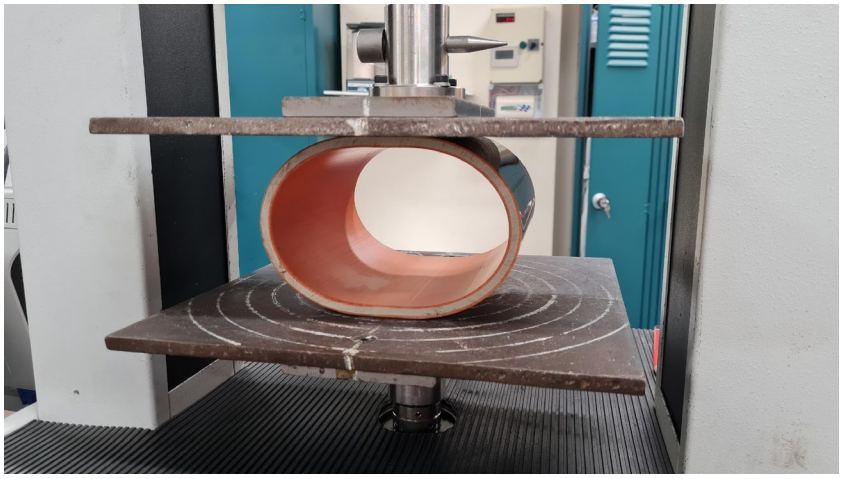

FIGURE 4 – RING FLEXIBLITY TESTING ON MULTI-LAYER SOLID CORE PVC ELECTRIAL CONDUIT

6. SUSTAINABILITY BENEFITS

The plastic pipes industry commitment to the Australian community is simple – we aim to recycle the maximum amount of available and suitable plastics material. This includes the use of manufacturers' rework, pre-consumer and post-consumer PVC waste in the manufacturer of SC PVC-U pipe. The common plastics used for pipe production like PVC are thermoplastics – in simple terms means they can be cut up, remelted, and reformed into another shape or new product, easily reprocessed – making them 100% recyclable. The industry actively collects available material from the waste steam and 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 pipe manufacturers are committed to product stewardship actions, including SC PVC pipe for its sustainability benefits. Australian PVC pipes are also made using Best Environmental Practice PVC (BEP PVC). This is recognised by the Green Building Council of Australia (GBCA) and the Infrastructure Sustainability Council (ISC) as demonstrating the environmental benefits of PVC pipes and fittings. The use of third-party certified BEP PVC in rating schemes such as the GBCA Responsible Products Framework for Green Star and ISC IS Rating Scheme enables PVC pipe and fittings be assessed in green developments and buildings earning positive credit points.

Many of Australia's leading engineering, building, construction companies and water utilities are signatories to GBCA and ISC 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 reduced mass makes for easier handling.

Environmental Product Declarations (EPDs) based on the Life Cycle Assessment (LCA) of SC PVC-U pipe have been published by several PIPA members. These EPDs are independently verified and registered documents that communicate transparent, comparable data about the life-cycle environment impact of SC PVC-U pipe in accordance with ISO 14025 *Environmental labels and declarations - Type III environmental declarations - Principles and procedures* and EN 15804 *Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products*.

The acceptance and use of SC PVC-U pipe is socially, and environmentally responsible highlighting plastic pipe systems are smart, efficient, and sustainable.

More information on the sustainable benefits of PVC and our sustainability story visit the PIPA website .

7. ECONOMIC BENEFITS

Using 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.

8. INSTALLATION CONSIDERATIONS

SC PVC-U pipes and conduits, either foam core PVC multi-layer or solid core PVC multi-layer are installed, tested, and commissioned in the same manner as solid wall mono-layer pipes. The primary reference Standard is AS/NZS 2032 *Installation of PVC pipe systems*. It is acknowledged that in rubber ring jointed systems, reasonable care needs to be exercised by installers when chamfering the spigot of foam core multi-layer pipe.

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.

9. REFERENCE

[1]Performance of PVC-U conduits incorporating recycled PVC, July 2021 – Presented to Ecologiq Innovation Challenge.

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.