

## PVC-O Pipes – Superior Performance

In September 2012, I had the privilege of attending the international Plastic Pipes XVI Conference.

The conference included 465 delegates representing 47 countries the overwhelming majority coming from across Europe. The aim of the conference and exhibition is to present technical and marketing issues relating to the design and development, testing, installation and operation of plastic pipes systems.

One of key subjects for discussion at the conference was PVC-O pipes with six key presentations on PVC-O and their advancement as a material of choice due to their superior performance.

What these presentation again reconfirmed is that it is abundantly clear that PVC-O pipe, when properly produced and installed, is unmatched by any alternative pressure pipe type in performance, environmental impact and, importantly, installed cost.

I have put together a summary of the presentation of PVC-O from the conference and included local Australian information on the use of PVC-O pipes.

Regards,

Nigel Jones  
Business Development Manager  
Think Pipe Think PVC

### HISTORY OF PVC-O Pipe

The technology used to produce PVC-O pipe has come a long way since the first process was developed for commercial production by Yorkshire Imperial Plastics in the 1970's. Australia was an early adopter of this process, with Vinidex commencing manufacture of PVC-O pipes back in 1984.

This process involved orientating the pipes off-line in a separate orientation chamber, inflating the pipes using pressurised hot water. The process was slow and cumbersome and production was very limited.

Come the 1990's, a number of companies including Vinidex began to develop processes that would significantly increase the output of PVC-O pipe. Out of this work came the in-line orientation process, where a feedstock pipe from the extruder is stretched over a mandrel or plug under tightly controlled conditions to produce a bioriented PVC pipe. This concept subsequently became the standard process for production of PVC-O pipes around the world. In Australia, Iplex installed Wavin Apollo PVC-O lines, whilst Vinidex installed their patented Cornet process, both in NSW.

In 2006, Molecor was formed in Spain by former employees of the Spanish pipe producer Uralita. The company was formed to develop and market a new PVC-O manufacturing method utilising an off-line orientation technique, based on pressurised hot air to inflate feedstock pipes. This method on the surface appears to a variant of the Yorkshire process using air instead of water. However, by utilising a preheating oven to bring the feedstock pipes up to the required temperature for orientation, the Molecor process matches the output rates of the in-line processes.

The most recent PVC-O manufacturing technology comes from Rollepaal, with their RBlue process. Rollepaal have been in the PVC-O business for some time behind the scenes, supplying Wavin with the equipment for their Apollo process – Wavin are a pipe as opposed to an equipment manufacturer. However Rollepaal and Wavin have now gone their separate ways, leaving Rollepaal to directly market their equipment.

The RBlue process has effectively combined the in-line with the Molecor process and come up with a process that stretches the pipe using hot air but not in a separate orientation chamber. The air is said to act as the lubricant for the orientation mandrel. This technique overcomes the size limitations of earlier in-line orientation processes due to the large forces required to stretch pipe over a mandrel. This problem had limited the size of PVC-O pipe to around 400mm maximum diameter. The RBlue and Molecor processes have allowed sizes up to 600mm to be produced. Molecor has most recently developed the technology to produce 800mm PVC-O pipe, with 1200mm diameter PVC-O pipe now under investigation.

### ADVANTAGES OF PVC-O PIPE

PVC has a number of inherent advantages as a material for water pipe over alternatives products. In particular, resistance to corrosion and chemical attack including water disinfectants, effect on water quality, smooth bore, excellent balance between strength, stiffness and flexibility, ease of installation, cost effectiveness and recyclability.

The advent of PVC-O pipe enhanced these advantages, but also importantly enhanced the environmental benefits of PVC pipe. The following diagrams illustrate the advantages of PVC-O pipe over conventional PVC-U and alternative products. It is important to note that PVC-O and PVC-U typically have very similar compositions – the difference in properties is due to the orientation process.

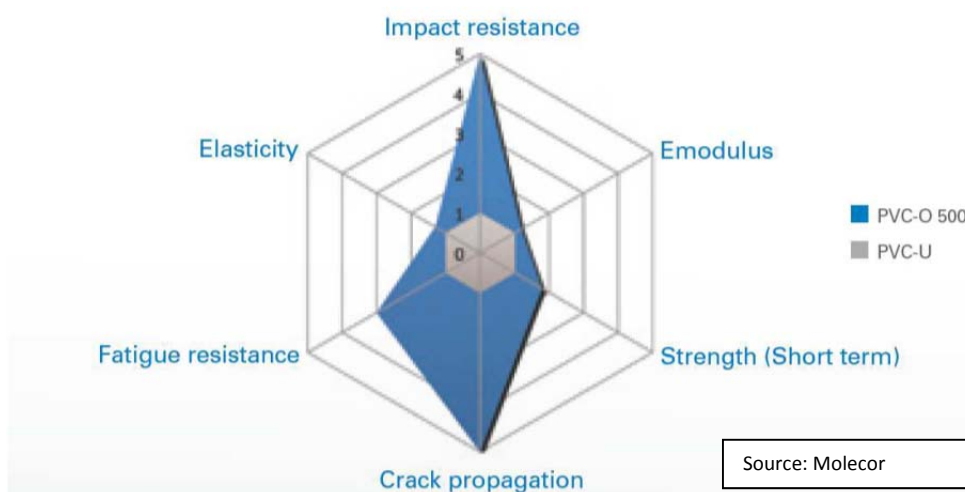
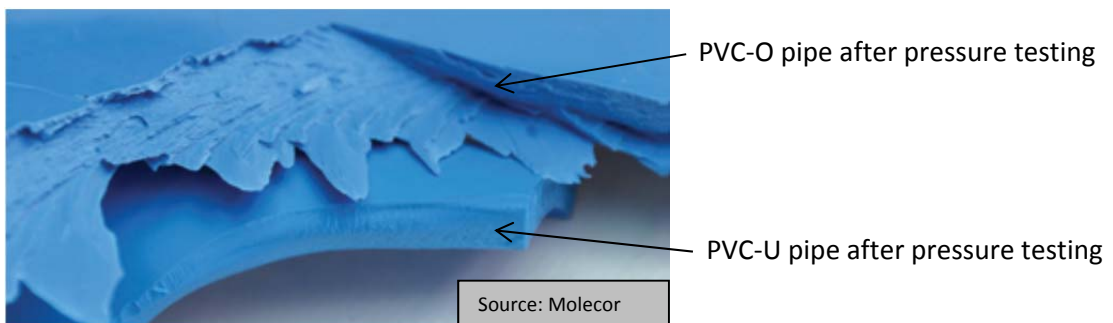


Figure 1. Spider diagram of key features of PVC-O vs PVC-U

The above diagram shows the key property advantages of PVC-O over PVC-U pipe. The orientation process significantly improves the impact and crack propagation resistance of the pipe. This is due to the laminate structure imparted on the pipe through the orientation process, which disperses the energy from an impact or crack circumferentially around the pipe rather than directly through the wall.

This laminate structure makes PVC-O pipe virtually notch insensitive. PVC-O pipe is therefore less sensitive to scratching or other surface damage that may happen during installation.

The image below compares PVC-O and PVC-U pipes after pressure testing up to the point of failure. The laminate structure of PVC-O can clearly be seen.



The orientation process changes and significantly increases the tensile strength of the material. The following stress-strain curve shows the different behaviour of PVC-O compared to PVC-U and PE.

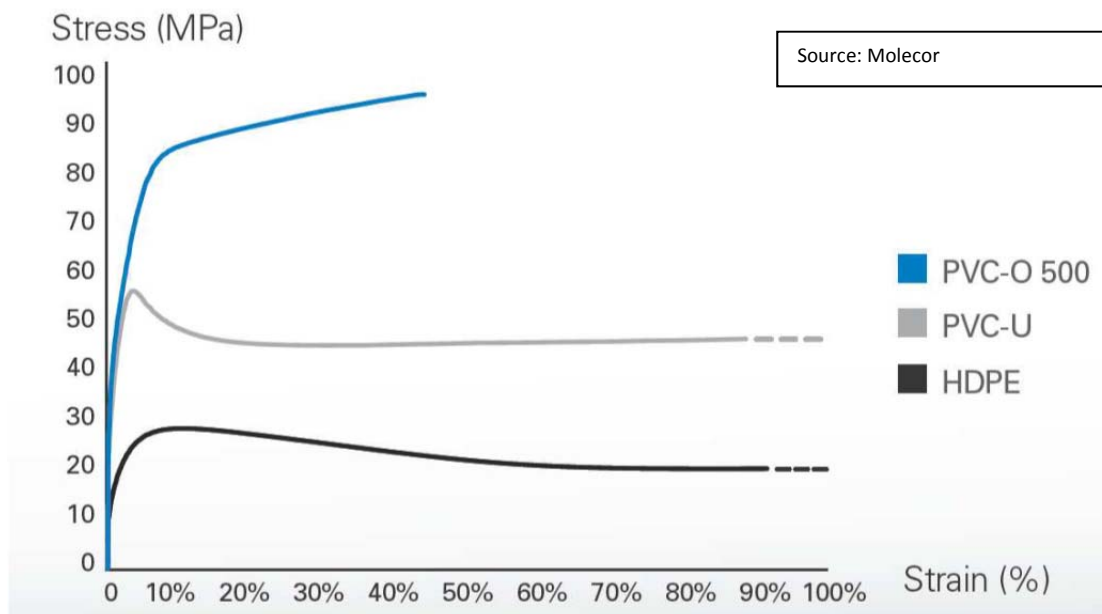


Figure 2. Stress-Strain behaviour of PVC-O

Given the higher tensile strength of PVC-O, it clearly would be expected to have a superior long-term hydrostatic resistance than conventional plastic pressure pipes. The following stress regression chart confirms that this is the case.

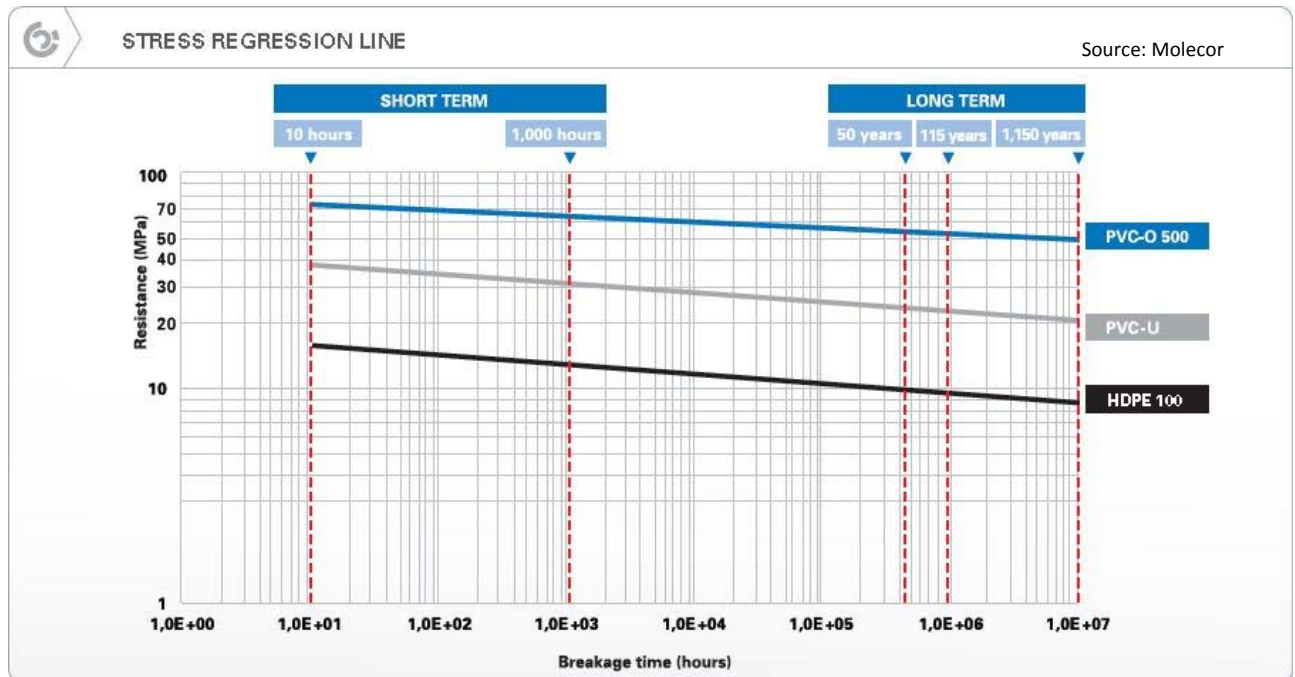
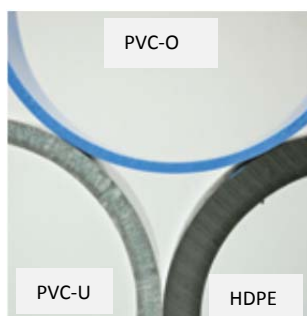


Figure 3. Long-term regression analysis of PVC-O, PVC-U and HDPE pipe

As the above radar plot shows, PVC-O has superior fatigue resistance to PVC-U. Cyclic fatigue testing conducted by the University of Queensland determined that PVC-O has up to four times the resistance to cyclic fatigue of PVC-U pipe.

## ENVIRONMENTAL

Numerous studies from Australia and overseas have demonstrated the superior environmental properties and benefits of PVC-O pipe compared to all other pressure pipe options. Comparing pipe weights and diameters, it is not hard to see why.



This image shows the difference in wall thicknesses for pipes of identical pressure rating. PVC-O pipe of equivalent size and pressure rating will be less than half the weight of PE. This represents a very large saving in raw material. With less than half of the raw material in PVC-O being Carbon based, its environmental credentials are very strong.

On a life cycle assessment basis, PVC-O again rates very well. The following chart from Edge Environment compares the different pressure pipe options on the basis of ecopoint ratings, where the higher the rating, the greater the environmental impact.

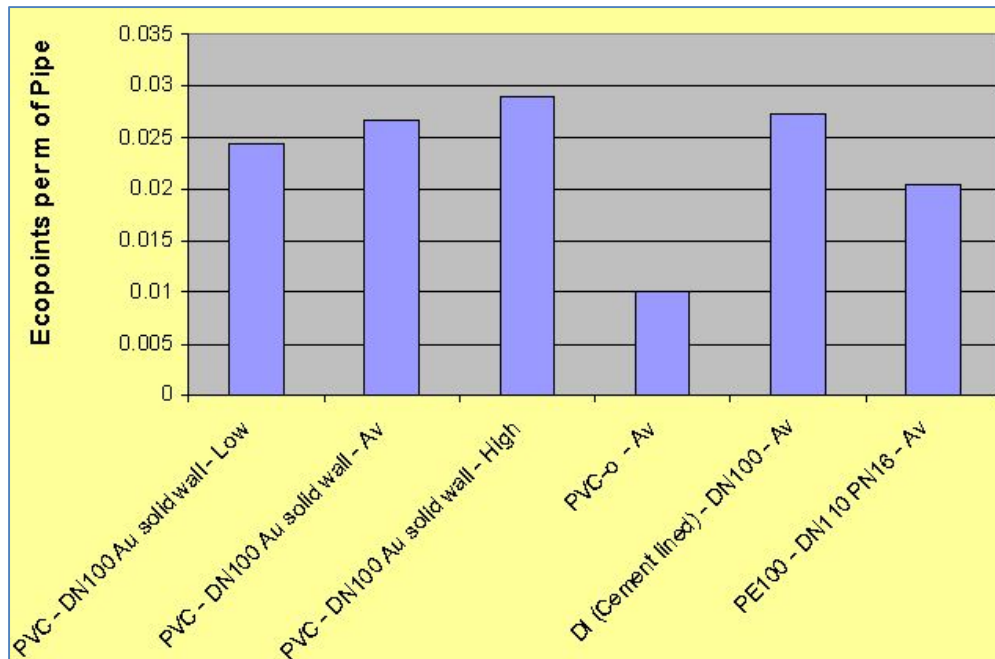


Figure 4. LCA of different pressure pipes (DI = ductile iron)

The reduction in wall thickness of PVC-O means the pipe will have a significantly larger bore for a given external diameter. This enables PVC-O pipe to have the highest flow capacity of all pressure pipes, allowing it to move more water, faster than the alternatives. This represents a potential saving in energy consumption in transporting water when using PVC-O pipe, further enhancing its environmental credentials.

## SUMMARY

PVC-O pipe has a number of technical, performance, commercial and environmental advantages over competing pressure pipes such as ductile iron and PE. From a sustainability perspective, it is a clear winner. The following table summarises the sustainability advantages of PVC-O pipe compared to the alternatives.

Social	Ecologic	Economic
<ul style="list-style-type: none"> <li>• Lowest failure rates</li> <li>• Faster installation</li> <li>• Safer to install</li> <li>• Lowest effect on water quality</li> <li>• Best ROI for consumers</li> <li>• Proven longevity</li> </ul>	<ul style="list-style-type: none"> <li>• 57% by weight from salt</li> <li>• No hazardous RM's</li> <li>• Lowest embodied energy</li> <li>• Conserves water</li> <li>• Recyclable</li> </ul>	<ul style="list-style-type: none"> <li>• Lowest cost pipe</li> <li>• Lowest installed cost</li> <li>• Lowest operating cost</li> <li>• Lowest maintenance cost</li> <li>• Allows capex to stretch further</li> </ul>

PVC-O pipes are available in Australia from the following companies:

- Iplex Pipelines
- Pentair
- Promains
- Vinidex