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Technology to manufacture oriented PVC (PVC-O) pipes

Purdue ECT Team
Construction Engineering & Management, Purdue University, ectinfo@purdue.edu

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EMERGING CONSTRUCTION TECHNOLOGIES

Civil – Composite Materials & Technologies

TECHNOLOGY TO MANUFACTURE ORIENTED PVC (PVC-O) PIPES

THE NEED

The development of Molecor´s technology, which is based on the application of a Molecular Orientation process, has delivered a significant turning point in the pipelines sector. With this technological development, the company has begun to manufacture TOM® PVC-O pipes, the most ecofriendly pipes on the market. The Molecor technology enabled eradicating many of the existing disadvantages of thermoplastic pipes.

This technology delivers a clear objective; to provide the water industry with a solution for pipes carrying pressurized water in an environmentally friendly, yet cost efficient manner. This also extends a service life compared to pipeline materials currently in use. Moreover, the company has developed this technology with the aim of offering pipes with diameters and nominal pressures that traditional pipelines are unable to accommodate.

With this technology, the company has been able to manufacture pipes to DN800 mm diameter and is looking forward, through R&D, to developing and manufacturing the first DN1200 mm Oriented PVC pipes closer and closer.

THE TECHNOLOGY

The Molecular Orientation process on which Molecor´s technology is based is an Air Based System, which is completely dry. The orientation is achieved by applying a deformation to a piece of amorphous plastic (in our case preform pipe) under certain conditions of temperature and speed, so that its molecules can rotate on the weakened molecular bonds but without displacement among them. This rotation of the molecules results in a preferential direction in the orientation of the molecules, with a very pronounced change in their mechanical properties. Generally, a higher molecular orientation is obtained at higher deformation. The result is a pipe with a laminar wall structure that improves the PVC's physical and mechanical properties without altering the chemical ones.

The phases of the production process are:

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- **Extrusion**: heating the raw material (in this case PVC) and pressurizing it by means of a worm screw to obtain a plastic material. Then, it is subsequently passed through a determined gauge that configures its final shape, i.e., a concentric geometry (pipelines).
- **Cutting**: The product exits from the extruder continuously, so it is subsequently cut according to product specifications. The obtained pipes are conventional PVC and have a standard length of approximately 6 meters. These pipes are called base pipe or Preform Pipe.
- **Molecular Orientation**: The molecular orientation technique is applied to the preform pipe, which result in an Oriented PVC pipe with significant improvements in the pipes mechanical properties (tensile strength, impact behavior, circumferential resistance, strain fatigue, cracks propagation, etc.). In addition, there is a lower use of raw material in the pipe manufacture giving a lower weight, which results in easier handling and installation.

Once the cutting phase is completed, the preform pipes are automatically moved forward to Molecor's molecular orientation system, which consists of the following phases:

- **Heating**: homogenize the temperature of the preform pipes to Vicat Temperature in all their points. This phase is performed in an oven specifically designed for this purpose.
- **Expansion and cooling**: sequentially, preform pipes exit from the oven and are introduced into a mold where they are expanded to obtain the final PVC-O pipe. The PVC-O pipe is cooled prior to its removal from the mold.
- **Extraction**: the PVC-O pipes are withdrawn sequentially and packed for subsequent storage and shipping to customers.

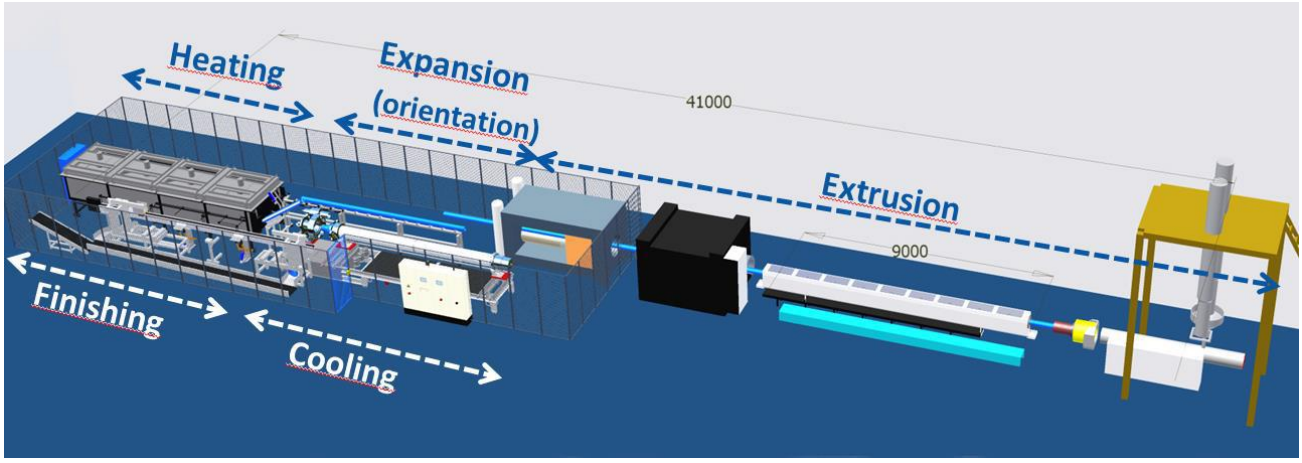

FIGURE 1 PHASES OF THE MOLECOR PIPE MANUFACTURING SYSTEM

Further, to introduce and enrich the market with new diameters, the company has developed different systems since its foundation in 2006. There are multiple manufacturing systems that manufacture PVC-O

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pipes with varying the size in diameter depending on customers' needs. Specifically, the M-OR-P 1640 System manufactured the first DN500 mm PVC-O pipes, and the M-OR-P 3163 System manufactures DN630 mm PVC-O pipes. The M-OR-P 3180 System widened its range of product up to DN800 mm, and finally, the M-OR-P 5012 System will enable Molecor to manufacture the first DN1200 mm PVC-O pipes.

The company has also achieved another important breakthrough, "the Integrated Seal System (ISS+)," that enables automatically inserting a rubber gasket inside the pipe. The Integrated Socket System that allows production of the socket, the most important part of the pipe, in the same process for the rest of the pipe, enables achieving optimal conditions of Molecular Orientation.

FIGURE 2 MOLECOR M-OR-P 3180 SYSTEM

THE BENEFITS

The advantages of the manufacturing systems developed by Molecor include:

- **Security and reliability:** Instead of boiling water, the use of air prevents possible leakages and the consequent burns that the operators could suffer from. It is also a stable system since a fully automatic control center that allows disconnecting the machine in stages, preventing the collapse of the line in case of punctual failures. The learning curve is low and its remote assistance system favors the preventive maintenance thereof.
- **Flexibility and compatibility:** A standard PVC extrusion system allows working in line and adjusting the manufactured pipes to the specific needs of each customer.
- **Efficiency and productivity:** It only uses the necessary amount of energy for distributing the air through the pipe only, and with an electricity consumption similar than conventional extrusion lines.
- **Profitability:** Molecor´s exclusive technology enables manufacturing of PVC-O pipes with the greatest degree of orientation (Class 500) achieving the maximum savings in raw material, of around 50% (according to specific local criteria). Specifically, the improved quality of the product extends its service

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life. All these facts together with the lower quantity of raw materials required to manufacture lead to significant savings in raw materials and costs.

Molecor´s developments, with the advantages mentioned above, have enabled the company to offer highly competitive PVC-O pipes to the market. The Molecular Orientation process, which is the transversal axis of Molecor´s technology, improves the mechanical properties of the TOM® pipes making them the most efficient and ecological solution for the supplying and distribution of water under pressure.

Among the multiple advantages of the TOM® pipes we can highlight the following:

- **Greater lightness and easy handle:** The manufacturing system of the TOM® pipes delivers both health & safety and economic savings during the pipe installation process.
- **Excellent flexibility:** The high flexibility of the pipes enables withstanding large deformations without suffering structural damages.
- **Greater hydraulic capacity:** Between 15% - 40% higher than pipes made of other materials with the same outer diameter.
- **Higher chemical resistance:** PVC-O is immune to corrosion so it does not require any coating or special protection what would result in cost savings.
- **Higher hydrostatic resistance:** The TOM® pipes can endure internal pressures up to twice the nominal pressure conventional pipes can withstand.
- **Higher resistance against water hammers:** The lower celerity figure of the TOM® pipes virtually eliminates the possibility of breakages that can occur during the process of opening/closing valves or when starting pumping operations. This will also protect all the elements of the network against potential damages produced by water hammers.

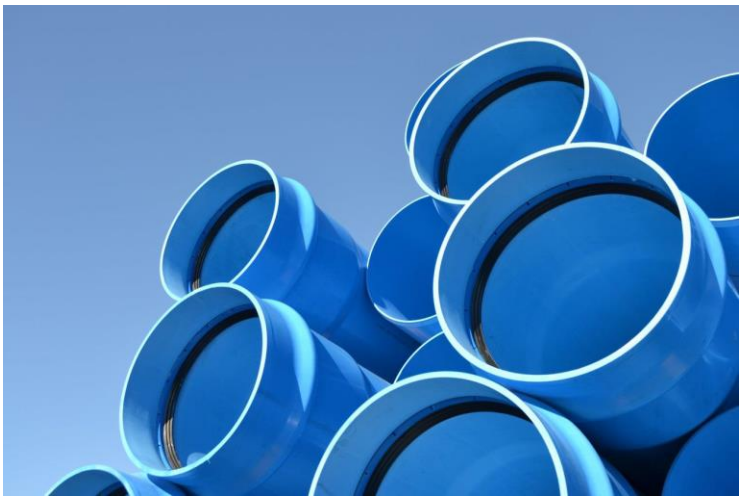

FIGURE 3 PVC-O PIPES MANUFACTURED WITH THE TECHNOLOGY OF MOLECOR

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STATUS

The Molecor´s technology has faced numerous barriers due to the high level of competitiveness in the market and the relatively short period since its development. Notwithstanding, the technology is now highly recognized by the market and has spread continuously and gradually over the world to the five continents. We have served many international markets: North America (i.e., Canada), South America (i.e., Colombia and Ecuador), European countries (i.e., Italy and Spain), African countries (i.e., South Africa) and East countries (i.e., India, Kazakhstan, Malaysia and Australia).

In addition to the manufacturing system centered on Loeches (Madrid – Spain), we also have the facilities located in two countries, South Africa and Malaysia, where the company can manufacture PVC-O pipes.

The demonstrated good results of Molecor´s technology and the continuous improvements that the company has introduced in its developments, thanks to the continuous efforts in R&D, and the ambitious international projects, in which it is immersed, justify a great optimism and future prospects for the expansion of these systems.

BARRIERS

Both the high degree of maturity and the conservative nature of the pressurized water pipes market make it difficult for Molecor´s technology to enter the market. Materials such as HDPE, steel, ductile iron, PVC-U, PRFV, etc., have been in use for a much longer period than Oriented PVC (PVC-O). Therefore, the traditional pipe materials are strongly embedded in the sector, which often hampers the entry of the PVC-O. Moreover, the unfamiliar technology of PVC-O, the lack of knowledge about its operating properties, manner of use and its profitability, together with its relatively high implementation investment are other barriers.

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Points of Contact

Almudena Blázquez, Marketing, Molecor Tecnología, S.L.
Phone: +34 (629) 143-513, Fax: +34 (902) 566-578, E-mail: almudena.blazquez@molecor.com
Cristina Onieva, Marketing, Molecor Tecnología, S.L.
Phone: +34 (911) 337-090, Fax: +34 (902) 566-578, E-mail: cristina.onieva@molecor.com

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Reviewers

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