Lifetime value for pipes

THERMOFORMING PROCESSES FOR SOCKETS INTEGRATED IN OPVC PIPES FOR PRESSURIZED WATER DISTRIBUTION

SPM SICA PLASTIC MACHINERY

Sica America Corp.

Agenda

- Brief introduction of SICA
- Mechanical Mandrel process for OPVC pipes
- Rieber process for OPVC pipes
- OPVC Belling Machine portfolio
- Q&A

SICA in brief

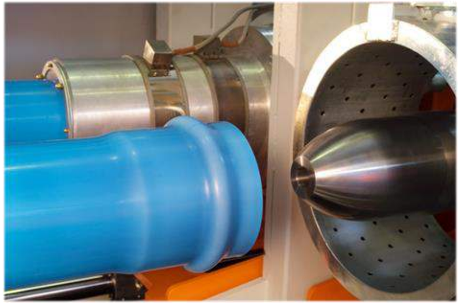
Structure	Family run, limited company
Foundation year	1962
Main site	Sica S.p.A. (Italy)
Other sites	
Norcross, GA	Customer care service
Mumbai, India	Manufacturing site
Specialization	Solutions for plastic pipes

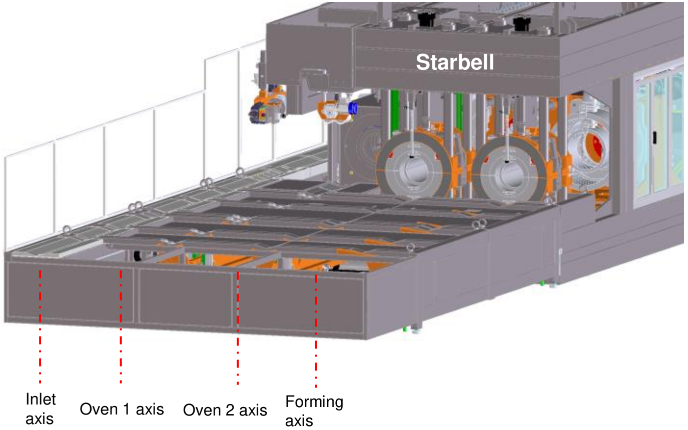
Volume	Approx. 400 machines per year
Number of active patents	Around 30
Turnover	Around 40 M€
Number of employees	161
Export	94%
Market	>100 countries
D&B financial rating	Rating n°1 - Maximum Reliability

Mechanical Mandrel process

The method for joining OPVC pipes for drinking water piping distribution systems is the socket joint integrated in the pipe. Typical methods include:

OPVC Mechanical mandrel method: a metal mandrel shapes the socket with expandable mechanical inserts (segments) next to the gasket area; inserts disappear inside the mandrel body when the mandrel is removed from the formed socket. Gasket is inserted afterwards.





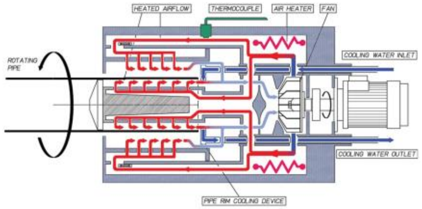
Main Technical Issue

Socketing the OPVC pipe
without loosing its **mechanical strength**

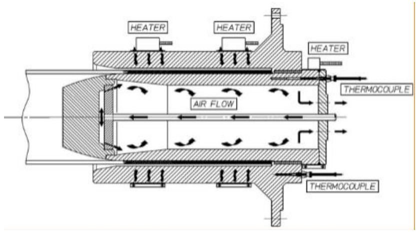
Heating process

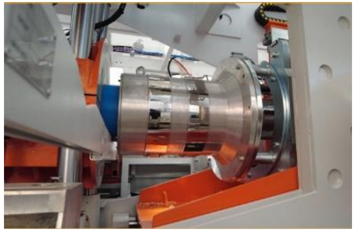
A typical belling machine configuration for OPVC pipes with a mechanical mandrel, and also in the new Rieber version, involves two heating stations and a final belling station. In details:

1. a **first hot-air oven station**: the pipe end temperature is closed to, but below, the PVC Tg temperature (73°C±2°C); there is no pipe shrinkage;



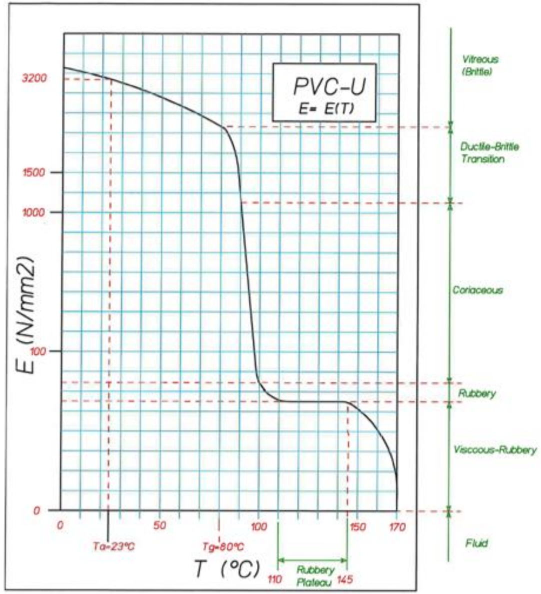
2. a **second contact oven station**: the pipe is supported internally by an internal heating element that prevents the pipe from contracting diametrically. After this final heating cycle, the pipe temperature is approximately 97°C at the pipe-end (accuracy ±1°C) and decreases to 80°C at the beginning of the pipe-socket connection area.

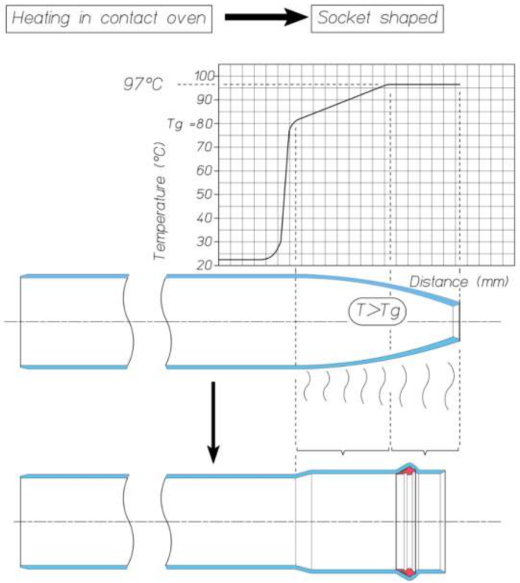




Lifetime value for pipes

Heating process

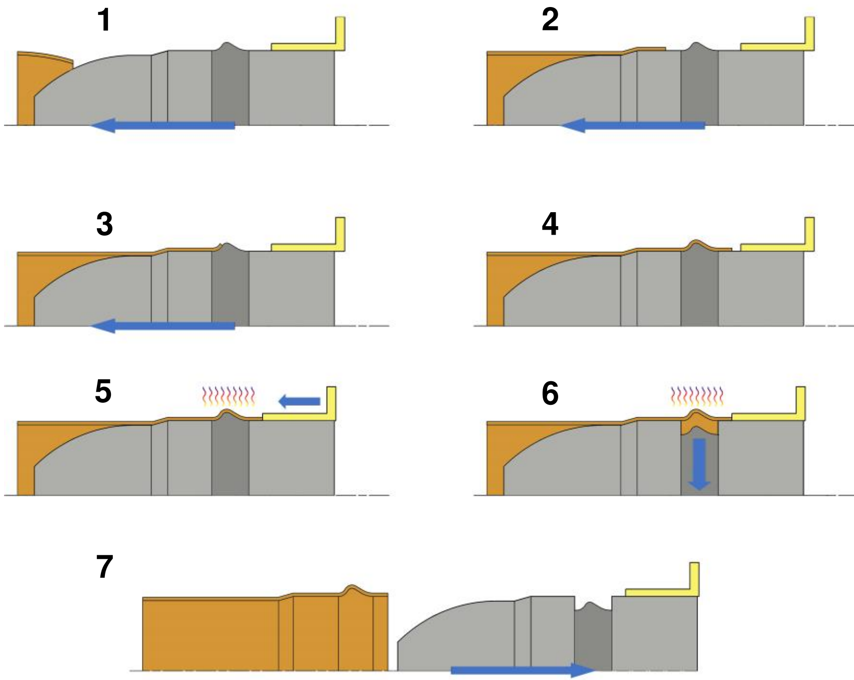




Mechanical Mandrel Process

Mechanical Mandrel process for **OPVC** pipes can be summarized as follows:

- the pipe, blocked by specific clamps, goes onto the advancing mandrel and it is gradually expanded (1,2);
- the pipe wall enwraps the surface of the mandrel (3,4);
- the **pipe expansion** (with material in coriaceous thermo-mechanical status) increases the circumferential orientation factor in the socket wall in such a way that the loss of axial orientation is compensated
- The upsetting flange moves forward pushing the material against the socket (5);
- The socket formed on the mandrel and on the gasket is cooled and stabilized in its final dimensions by means of pre-cooled ventilated air on the socket (5,6);
- A diffuser homogeneously distributes this ventilated air on the whole socket
- The mandrel retracts the segments moves back (7)

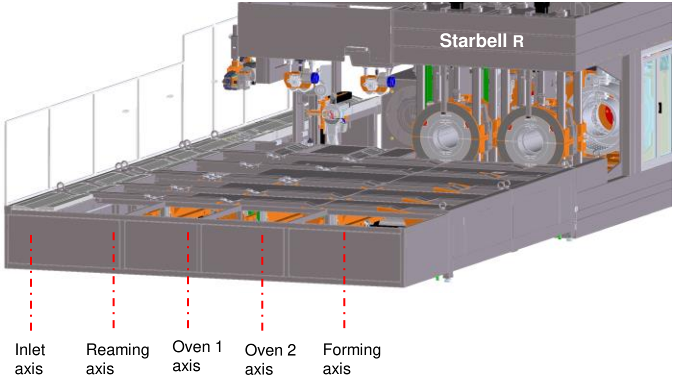


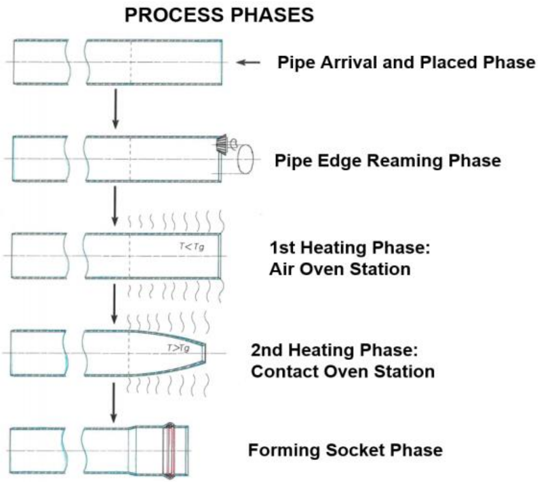
Video 1

Rieber Process

The method for joining OPVC pipes for drinking water piping distribution systems is the socket joint integrated in the pipe.
Typical methods include:

OPVC Rieber method: the socket is formed on a metal mandrel with a gasket previously installed on the mandrel itself. When the socket is cooled, the gasket is permanently locked inside the formed socket. The gasket cannot be replaced.





Rieber Process

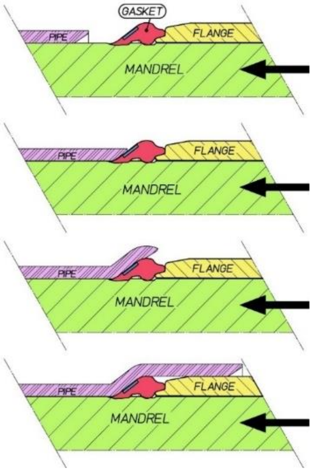
There are 3 additional complex technical issues for belling with the Rieber method in OPVC pipes, such as:

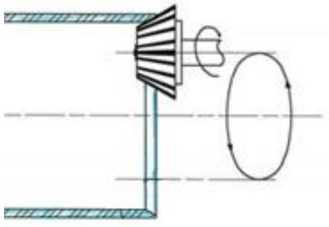
1) **gasket Irreversible collapse** in the mandrel and **high axial compression** of the pipe wall, reducing the OPVC socket orientation factor and compromising the socket hydrostatic pressure resistance;
2) **pipe wall Imperfect adhesion** to the gasket, particularly in the area close to the edge of the socket;
3) **inner dimension** of the gasket area socket **smaller** than useful values for regular pipe-socket coupling.

Rieber Process

Technical issue 1 (*gasket collapse/pipe axial compression*) depends on the collision between the gasket and the front end of the pipe during the belling process.

- The **selected gasket** consists of an EPDM rubber body with an integrated reinforcing steel ring band;
- with Rieber OPVC new system it is **drastically reduced** the contact pressure between the back shoulder of the gasket and the pipe face;
- a front surface of the pipe edge is **internally chamfered** with an angle comparable to the rear gasket' shoulder angle installed on the mandrel;
- during the first impact between the pipe edge and the gasket, there is **contact** between the inner pipe-edge conical surface and the gasket's shoulder surface (facing, at least partially, the metal reinforcement ring);
- this internal conical surface is realized with an **additional station** installed before the heating stations; it is equipped with a milling tool that creates, by material removal, the desired internal conical surface.

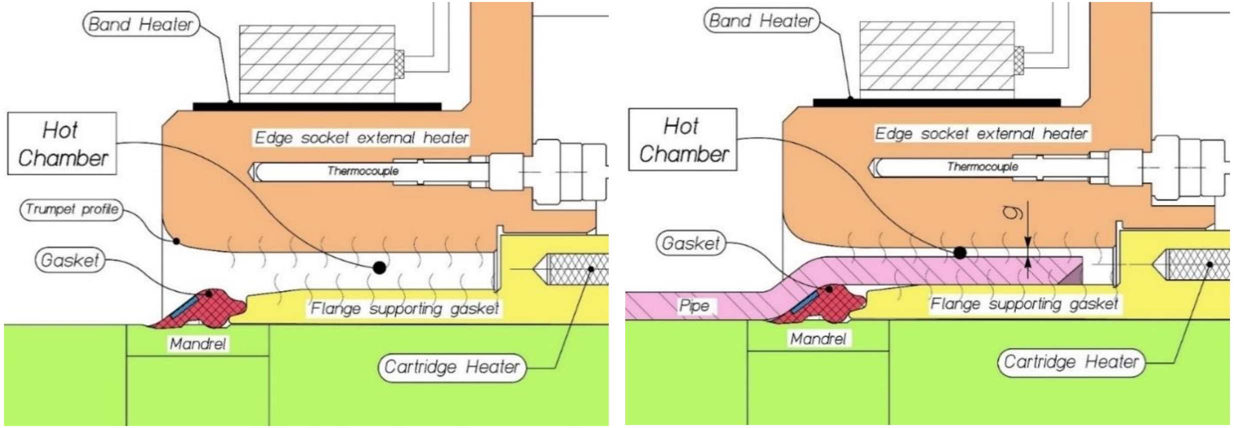




Rieber Process

Technical issue 2 (*Imperfect adhesion between pipe and gasket*) is a consequence of the settling of socket wall caused by the cooling of the material during the pipe insertion into the mandrel and gasket.

- Rieber's new system introduces an **annular-shaped metal heating element**, that surrounds both the supporting flange and the pipe-end (which lies on the flange outer surface).
- This element forms with the flange a special **cylindrical hot chamber**.
- The annular heating element is **thermoregulated:** it is equipped with heating resistors and a thermocouple (as the flange).
- The pipe-end is ultimately contained in such a chamber: the <u>inner surface</u> in contact with the flange surface; the <u>outer surface</u> next to, but detached from, the inner surface of the heating element.

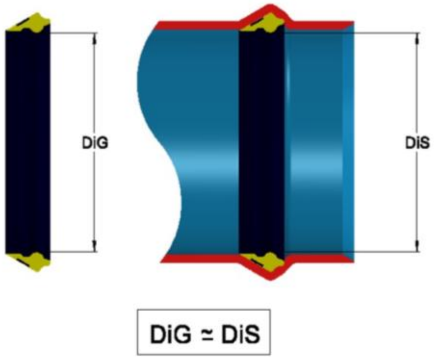


Rieber Process

Technical issue 3 (*socket Inner dimension of the gasket area smaller than useful values for regular pipe-socket coupling*) is solved through the active control of the deformation of the socket wall forming on the gasket.

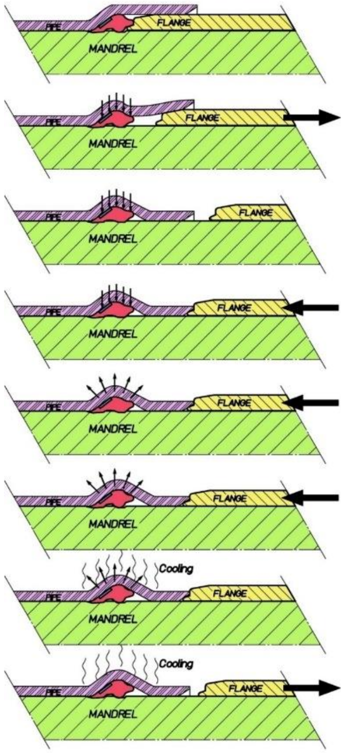
- An advance **movement of the flange** presses the edge of the socket;
- a **mechanical contrast action** to the radial crushing effect of the socket wall on the gasket is generated;
- the **radial contraction** of the pipe wall enveloping the gasket is strongly reduced;
- the resulting **relaxation** of the **gasket** (after the mandrel extraction from the definitively cooled socket) ensures that the internal diameter of the socket **Dis** remains:

1. **above** the minimum value that guarantees the correct insertion of the pipe into the socket;
2. **below** the maximum value that guarantees the hermetic seal of the socket joint.



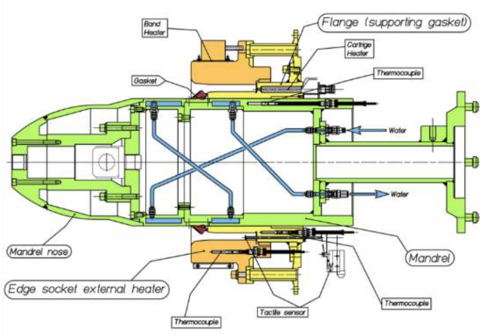
DiG: free gasket internal diameter;

Dis: socket internal diameter measured at the cusp of the internal gasket prominence.



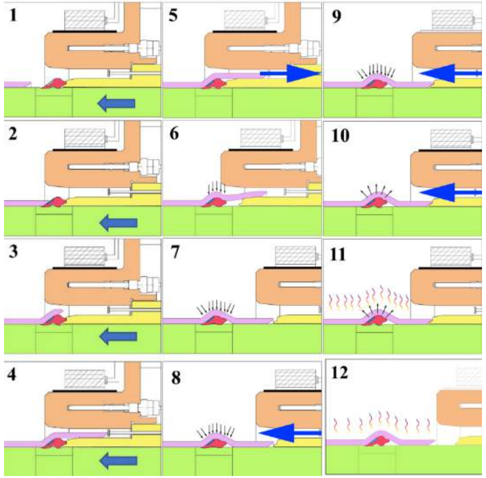
Rieber Process

Rieber belling process for **OPVC** pipes can be summarized as follows:



- the pipe, blocked by specific clamps, goes onto the advancing mandrel and it is gradually expanded;
- the pipe wall enwraps the surface of the mandrel, of the gasket and of the gasket upsetting flange;
- the **pipe expansion** (with material in coriaceous thermo-mechanical status) increases the circumferential orientation factor in the socket wall in such a way that the loss of axial orientation is also compensated

Phases 1-2-3-4



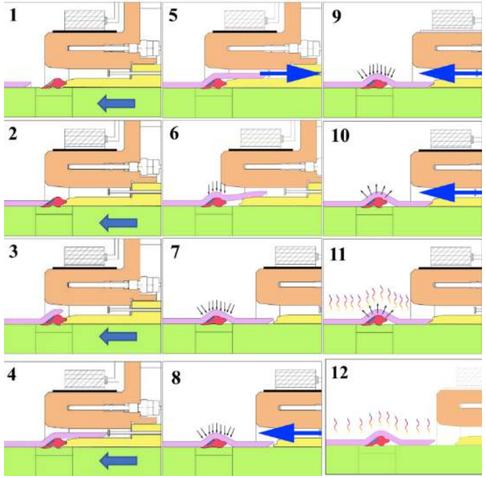
- The gasket upsetting flange moves back, leaving the socket edge;
- the socket edge enwraps and compresses the gasket against the mandrel by means of the internal pipe contraction (due to OPVC circumferential orientation).

Phases 5-6-7

Rieber Process

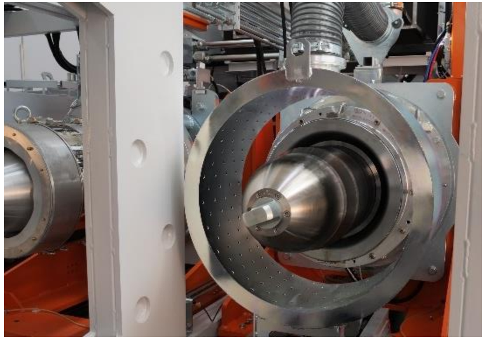
- The **gasket rubber radial compression** against the metal mandrel is compensated and eliminated introducing an **axial compression force** of the flange-front against the socket edge (the pipe is also blocked by the clamps);
- the positioning control and duration of this flange action are parameters set and controlled by the PLC of the machine;
- when the mandrel is removed from the socket, the internal diameter of the gasket in the socket is similar to the dimension of any free gasket. This results in dimensions suitable for the socket function;

Phases 8-9-10-11



- The socket formed on the mandrel and on the gasket is cooled and stabilized in its final dimensions by means of pre-cooled ventilated air on the socket;
- A diffuser homogeneously distributes this ventilated air on the whole socket.

Phase 12



Video 2

Hydrostatic Pressure Resistance

The OPVC pipe with socket can be produced with the equipment and process described. In detail, the socket complies with the **functionality requirements** for:

1. composition of the socket junction;
2. tightness of the socket joint;
3. resistance to hydrostatic pressure of the socket joint.

The **junction hydrostatic pressure resistance** has been validated by subjecting pipes with socket to hydrostatic pressure resistance tests (the **most severe tests** of all those prescribed by the various national and international standards for OPVC pipes use in pressure water distribution).

That is, long-term, high-temperature endurance testing as prescribed by ISO 16422:2014 (i.e. in the mode of 1000 hours at 60°C) with test pressure calculated considering a minimum stress level MRS x 0.625. These tests, as well as being successful, have always shown a **superior strength and rigidity of the socket** compared to the pipe.

OPVC Belling Machine Portfolio

OPVC Belling Machine; Workable Pipes: Pressure class				
Machine Model	**PVC-O pipe standard**	**OD min**	**OD max**	**Pressure Class or Pressure Rating**
Starbell 250 **Starbell 250R**	ISO 16422	63 mm	250 mm	PN12.5; PN16; PN20; PN25
	ANSI/AWWA C909	4in (121,9 mm)	8in (229,9 mm)	165psi; 235psi; 305psi
	ASTM F1483	4in (114,3 mm)	8in (219,1 mm)	160psi; 200psi; 250psi
Starbell 500 **Starbell 500R**	ISO 16422	110 mm	500 mm	PN12.5; PN16; PN20; PN25
	ANSI/AWWA C909	4in (121,9 mm)	18in (495,3 mm)	165psi; 235psi; 305psi
	ASTM F1483	4in (114,3 mm)	20in (508 mm)	160psi; 200psi; 250psi
Starbell 630 **Starbell 630R**	ISO 16422	110 mm	630 mm	PN12.5; PN16; PN20; PN25
	ANSI/AWWA C909	4in (121,9 mm)	24in (655,3 mm)	165psi; 235psi; 305psi
	ASTM F1483	4in (114,3 mm)	24in (609,6 mm)	160psi; 200psi; 250psi

Lifetime value for pipes

THANK YOU

Contatti
Via Stroppata, 28 48011 Alfonsine (RA) Italy
tel +39 0544 88711| info@sica-italy.com
www.sica-italy.com