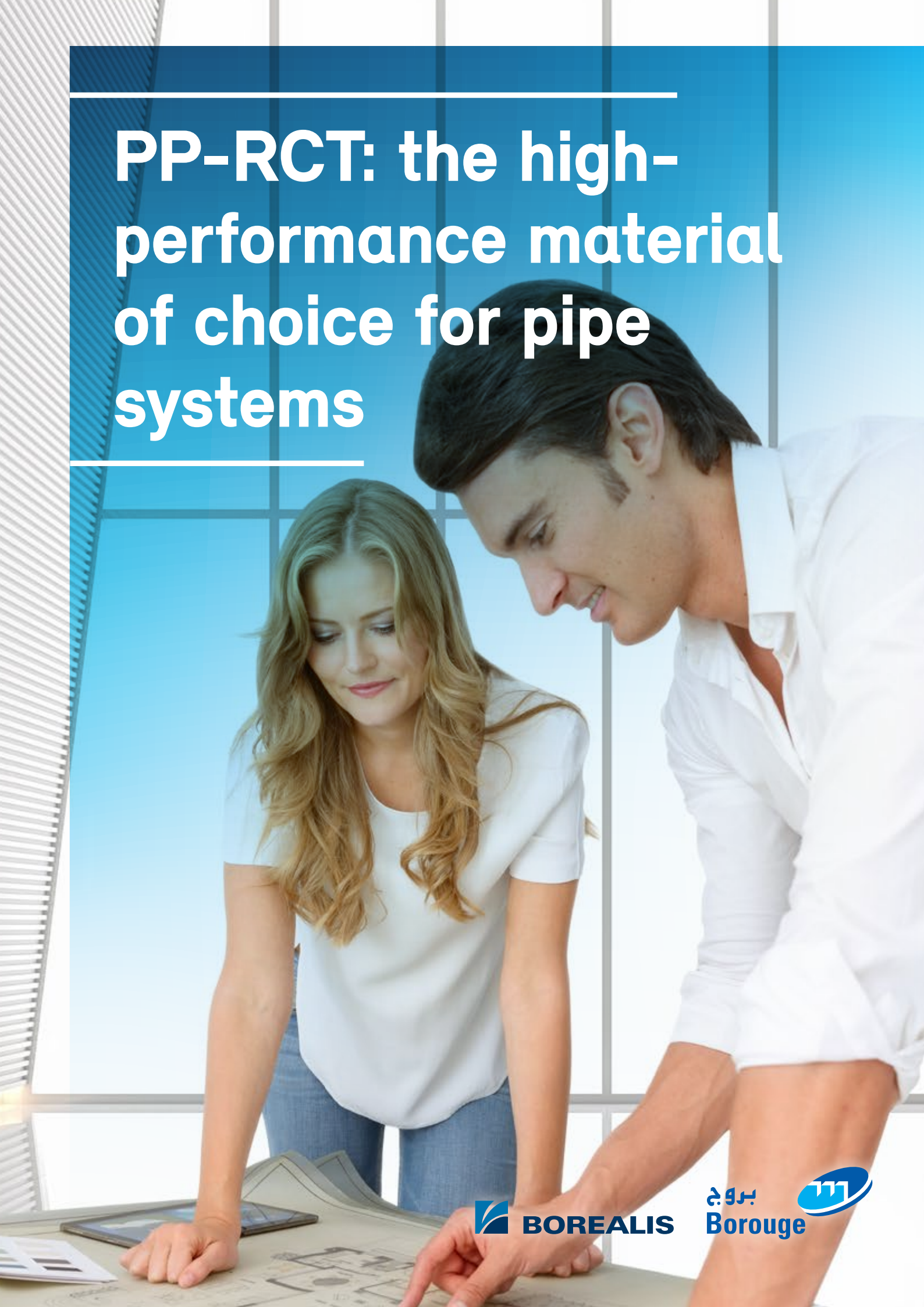
# PP-RCT: the high-performance material of choice for pipe systems



BOREALIS

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Borouge

## Reliable and committed industry leader with a global reach

Global population growth and ageing infrastructure have increased the need for durable, dependable and sustainable plumbing and heating pipe systems. As a leading global innovator with a track record of over 50 years in the industry, Borealis offers breakthrough polyolefin solutions that have revolutionized the piping sector. Our high-performance resins are based on proprietary technologies and offer unparalleled production efficiency, ease of installation, and peace of mind to end users. Thanks to our collaboration with Borouge, a joint venture with the Abu Dhabi National Oil Company (ADNOC), we are able to supply a broad portfolio of resins for the full range of pipe applications to customers around the world from our state-of-the-art, ISO 9001:2015-qualified production facilities.

The Borealis hot and cold water resin family consists of two main product groups: polyethylene for crosslinked polyethylene (PEX) pipe production; and polypropylene for PP-RCT pipe and fitting production.

## Borealis: a leading global innovator in PP-RCT

Over the past 30 years, the development of polypropylene random copolymers (PP-R) has been a factor in the growing acceptance of plastic pipes for plumbing, heating and industrial applications. While system components have gradually improved over time, so too has the technical performance of polypropylene (PP) intended for pressure pipe and fittings production.

In 2004, Borealis launched one of the most significant resin improvements in decades with the introduction of a next-generation material class with improved hydrostatic pressure resistance: PP-RCT, which stands for "polypropylene random copolymer with modified crystallinity and temperature resistance."

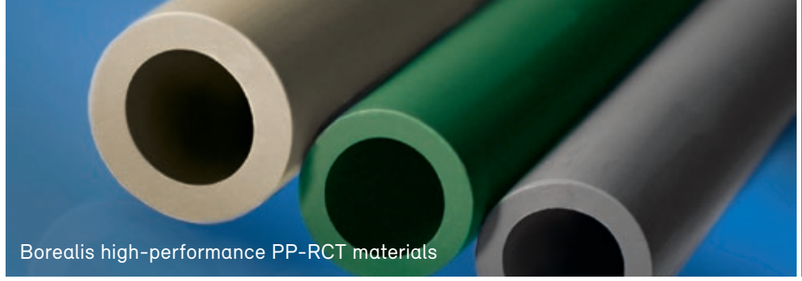
The material class has a strong market presence and is standardized in accordance with ISO 15874, the global standard of reference for PP piping systems for hot and cold water installations in buildings.

With our pioneering and expanding family of RA7050 PP-RCT grades, Borealis continues to be an innovation leader in the evolution of PP for pressure piping applications. Borealis RA7050 materials are produced using a unique, multiple reactor beta-nucleation technology. This yields feedstock resins with significantly higher performance capability in comparison to conventional PP-R materials. Fully compounded and available in three colours – green, steel grey and light grey – these materials enable simpler handling and extrusion while ensuring the highest levels of long-term technical performance.

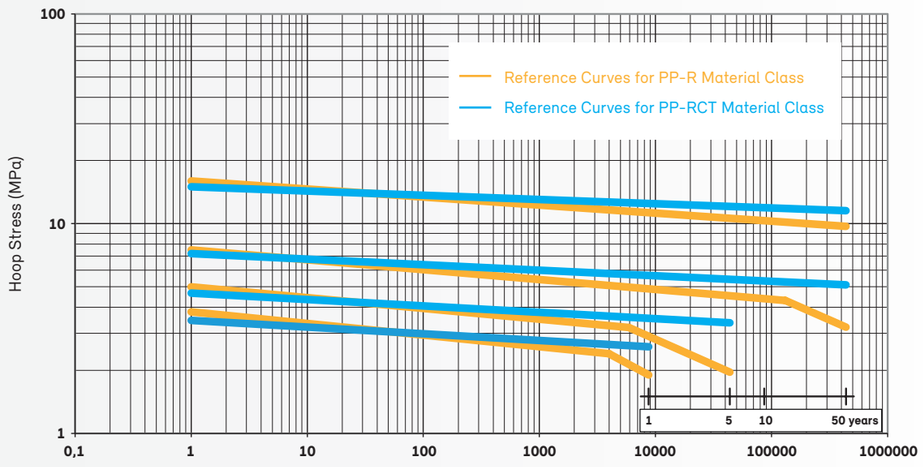
## Long-term hydrostatic strength

Borealis beta-nucleation technology yields PP-RCT resins with improved pressure resistance, especially at elevated temperatures. Pressure tests conducted in accordance with ISO 9080 demonstrate a 50-year service life of 5 MPa (725 psi) at 70°C (160°F) for pipe produced with Borealis PP-RCT resins, as compared to 3.2 MPa (465 psi) for conventional PP-R materials at the same temperature. These higher temperature stress ratings refer to Categorized Required Strength (CRS) ratings at 70°C and 50 years, or more simply, $CRS_{70°C,\ 50\ years}$, in accordance with ISO 9080. This higher level of technical performance allows for improved competitiveness and greater flexibility in system design and operation.

Borealis PP-RCT resins have been designed to meet or even exceed the current North American standards of ASTM F2389 and CSA B137.11 for PP pipe. CRS values of Borealis PP-RCT grades are listed in accordance with the Plastics Pipes Institute's Hydrostatic Stress Board (PPI-HSB) Listing Programme.



Borealis high-performance PP-RCT materials




## Chlorine resistance

The Borealis family of PP-RCT resins has been tested at independent laboratories and evaluated for oxidative resistance to the effects of chlorine in accordance with ASTM F2023.

Even under these demanding test conditions, Borealis PP-RCT exhibits exceptional resistance to the effects of chlorine ions at elevated temperatures. Test results have been categorized in accordance with the ASTM F876 classification system.

| Borealis Designation | RA7050 | RA7050-GN | RA7050-LG |
|---|---|---|---|
| **Colour** | Steel grey | Green | Light Grey |
| **RAL colour code** | 7042 | 6024 | 7032 |
| **MRS** | 11.2 MPa (1624 psi) | 11.2 MPa (1624 psi) | 11.2 MPa (1624 psi) |
| **$CRS_{70°C,\ 50\ years}$** | 5.0 MPa (725 psi) | 5.0 MPa (725 psi) | 5.0 MPa (725 psi) |
| **$MFR_{230,\ 2.16}$** | 0.3 g/10 min | 0.3 g/10 min | 0.3 g/10 min |
| **Density** | 905 kg/m³ | 905 kg/m³ | 905 kg/m³ |
| **Modulus of Elasticity** | 900 MPa (130 kpsi) | 900 MPa (130 kpsi) | 900 MPa (130 kpsi) |

Table 1: Borealis RA7050-range of materials

| Test Parameter | Test Value |
|---|---|
| pH | 6.8 |
| Chlorine concentration | 4.3 ppm |
| Oxidation reduction potential | > 825 Mv |
| Test temperature #1 | 95°C (203°F) |
| Test temperature #2 | 105°C (221°F) |
| Test temperature #3 | 115°C (239°F) |

Table 2: ASTM F2023 Chlorine Test Conditions

| Class | Temperature | Time Fraction | Extrapolated Time to Failure |
|---|---|---|---|
| Class 1 | 73°F (23°C)<br>140°F (60°C) | 75%<br>25% | > 50 years<br>137 years |
| Class 3 | 73°F (23°C)<br>140°F (60°C) | 50%<br>50% | > 50 years<br>71.2 years |
| Class 5 | 140°F (60°C) | 100% | 36.3 years |

Table 3: ASTM F876 Chlorine Classification, Borealis PP-RCT

### Fully-compounded formulations

Because the Borealis family of PP-RCT resins is already fully compounded, no additional colour concentrates or special additive blends need to be used in the production of pipes and fittings. Producers benefit from simpler inventory management and production procedures, and end users enjoy reliable, long-term performance and serviceability.

### The many benefits of using Borealis PP-RCT

Below are some of the many benefits that can be realized when using Borealis PP-RCT high-performance resins to produce pipe and fittings for applications like industrial process water handling, district heating, hot and cold water distribution, and multi-family dwelling risers:

- Superior, long-term hydrostatic strength offers greater flexibility in system design
  - Increased pressure class with same outside diameter (OD) and wall
  - Higher hydraulic capacity with same OD
  - Potential for smaller diameter pipes depending on system design requirements
- Weight reduction potential of 14% to 25% versus traditional PP-R pipe
  - Improved ease of installation
  - Enhanced cost effectiveness due to beneficial dimensioning
  - Higher extrusion speeds and potentially lower costs based on optimized pipe dimensioning
  - Potential for production of larger diameters for industrial and high-rise applications
- Utilization of existing extrusion and/or injection moulding equipment with minimal adjustment
- Exceptional resistance to slow crack growth in demanding applications
- Compatible with established PP fusion welding procedures
- Fully compounded, ready to extrude or mould, thus simplifying inventory and production processes
- Fully compliant with globally recognized standards such as ISO, ASTM, DIN and NSF Standard 61

### PP-RCT case study: South Dakota State University

With a growing student population and increasing demand for heating and cooling, South Dakota State University decided to build the new North Chiller Plant to supplement the Central Chiller Plant on its main campus. The project was originally designed for steel pipe to operate at 150 psi (10 bar) and 80°F (27°C).

The project was, however, redesigned to use Borealis PP-RCT as the primary indoor chilled water piping. While the Borealis track record in pipe application innovation was one decisive factor in doing so, specific material benefits also played a crucial role:

- Superior chemical and corrosion resistance of PP-RCT when compared to steel
- Hydrostatic strength of PP-RCT at elevated temperatures
- Integrity of fusion joining procedure
- Ease of installation due to lower overall weight and prefabricated assemblies
- Dimension stability of glass fibre reinforced PP-RCT

The glass fibre reinforced PP-RCT was produced in accordance with ASTM F2389 and joined using the DVS 2207 socket and butt fusion procedures. South Dakota State University installed a total of 2120 feet (650 meters) of 20" (500 mm) and 24" (630 m) DR 17 glass fibre reinforced PP-RCT. The new system commenced operations in 2016 and now serves around 400,000 square feet (37,160 $m^2$) in a highly cost-effective and environmentally-efficient way.



# Borealis pipe solutions: enabling life's essentials

As a trusted partner with more than 50 years of experience, Borealis supplies materials for advanced polyolefin pipe systems that help the pipe industry better serve a variety of communities worldwide.

Using its proprietary Borstar® technology as a base, Borealis offers polyethylene and polypropylene materials for pipes used in many different industries: water and gas supply, waste water and sewage disposal, plumbing and heating, and oil and gas, including multi-layer steel pipe coating solutions for onshore and offshore oil and gas pipelines.

By offering more durable and reliable pipe solutions, Borealis' step-change innovations continue to boost the sustainability of pipe networks by making them safer, longer lasting and more efficient, by helping eliminate wastage and loss whilst at the same time offering energy savings. Borealis has been a solution provider and one-stop shop for polyolefins in the oil and gas industry, providing reliable service and quality from one end of the pipeline to the other. Water and sanitation systems can be made more efficient and reliable by using proprietary Borealis materials. While systems made of conventional materials struggle with water losses of up to 30% to 50%, new thermoplastic pipe systems can avoid such leakage. Trenchless technology may reduce installation costs by up to 60%.

Enabling life's essentials | Date of issue: January 2019

**About Borealis** Borealis is a leading provider of innovative solutions in the fields of polyolefins, base chemicals and fertilizers. With its head office in Vienna, Austria, the company currently has around 6,600 employees and operates in over 120 countries. Borealis generated EUR 7.5 billion in sales revenue and a net profit of EUR 1,095 million in 2017. Mubadala, through its holding company, owns 64% of the company, with the remaining 36% belonging to Austria-based OMV, an integrated, international oil and gas company. Borealis provides services and products to customers around the world in collaboration with Borouge, a joint venture with the Abu Dhabi National Oil Company (ADNOC).

Borealis and Borouge aim to proactively benefit society by taking on real societal challenges and offering real solutions. Both companies are committed to the principles of Responsible Care®, an initiative to improve safety performance within the chemical industry, and work to solve the world's water and sanitation challenges through product innovation and their Water for the World programme.

**For more information visit:** www.borealisgroup.com · www.borouge.com · www.waterfortheworld.net

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