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BOREALIS بروج Borouge

# BorECO™ PP pipe materials – made for generations

**Sustainable solutions for waste water management**

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## Contents

# Addressing global challenges

**Climate, water and sanitation, energy and communication, healthcare and food – there are many challenges facing the world today.**

As part of Borealis' strategy of value creation through innovation, the company contributes to addressing these challenges through providing innovative materials for sustainable pipe systems, reliable energy networks, advanced food-preserving packaging, leading edge healthcare and automotive solutions.

**Every single day Europeans generate around 60 billion litres of waste water – approximately 120 litres per head of population. Managing the disposal of this huge volume of waste presents a number of complex challenges.**

For the most part waste water is conveyed to treatment plants through pipe systems made from traditional materials. Much of these infrastructures are old, leaking, no longer adequate to the task and in urgent need of renovation or replacement. Moreover, new networks are required to keep pace with growing populations and urban developments.

**Even in Europe, in some regions there are still no sanitation infrastructures and untreated waste water and sewage is disposed of by 'soak-away' methods that contaminate ground water and pose environmental and health hazards.**

Borealis is addressing these water and sanitation challenges by delivering reliable, cost-effective and innovative pipe materials that help preserve our endangered resources and ensure quality of life for generations to come.

## CLIMATE

**Climate** – to limit $CO_2$ emissions and keep global warming under control.

## WATER

**Water and sanitation** – to provide access to water and sanitation to an ever growing population and responding to increasing water scarcity due to climate change.

## ENERGY

**Energy access** – to provide for the world's increasing energy needs.

## COMMUNICATION

**Communication** – to extend, secure and strengthen communication networks that are critical to our modern economy and quality of life.

## HEALTHCARE

**Healthcare** – to provide access and an acceptable level of healthcare for a growing and aging global population.

## FOOD

**Food** – to protect and deliver safe food from 'farm-to-fork' across regions to feed the world's growing population.

# Borealis' complete portfolio of pipe solutions

Borealis is the leading global provider of advanced polyolefin plastics solutions for the pipe industry. Through continuous dialogue with our customers and stakeholders, we have developed a broad and innovative product and service portfolio.


**1 Underground drainage and sewage**
BorECO™ PP materials are specifically developed to improve the performance of solid and corrugated wall pipes for underground, non-pressure sewerage systems that meet the industry's demand for speed and ease of production and installation while protecting ground water and the environment.

**2 Domestic soil & waste water disposal**
BorECO™ PP grades provide the ideal platform for sound dampening solutions, a long operating lifetime and resistance to tensides.

**3 Industrial PP solutions**
PP pipe systems support a large number of industries including chemicals, food processing, pharmaceutical and metal processing, due to their high safety performance and superior physical properties.

**4 Water distribution**
BorSafe™ pressure pipe solutions, developed specifically for both large and small pipes for water mains and domestic connection systems, ensure the elimination of drinking water losses through pipe failures.

**5 Gas supply**
BorSafe™ provide optimal solutions for low and medium pressure gas distribution systems. Tough and flexible, they are robust in handling and installation and give the essential leak-free safety demanded by these applications.

**6 Geothermal applications**
BorSafe™ materials bring an outstanding combination of mechanical properties for geothermal pipe applications. Highly durable and flexible, BorSafe PE pipes assure system integrity over a long working life.

**7 District heating**
BorSafe™ PE materials provide the protective solution for multi-layer district heating pipes. Used to form the outer casing, BorSafe PE protects the steel heat-conveying pipes and their thermal insulation layer against external damage from abrasion and corrosion.

**8 Industrial PE solutions**
BorSafe™ pipes deliver superior resistance to abrasion, corrosion and chemicals giving them a long service life and making them an ideal choice for conveying aggressive industrial fluids and semi-fluids such as mining slurries.

**9 Onshore pipeline protection systems**
Borcoat™ PE and PP materials for 3 layer coating systems deliver optimum protection, maximise the lifetime performance of oil and gas pipelines and show an impressive global track record.

**10 Offshore pipeline protection systems**
For challenging offshore projects Borealis can offer 3 layer PE and PP Borcoat solutions as well as multilayer thermal insulation systems based on Borcoat PP.

**11 Plumbing and heating systems**
PEX and PP-RCT (PP-R) materials from Borealis offer the most advanced pressure pipe material solutions currently available for plumbing and heating pipe systems. These include domestic water piping, under-floor heating, radiator connections, wall cooling and heating systems, as well as district heating and industrial pipe networks.

# BorECO™ PP: A superior fit with modern sewerage demands

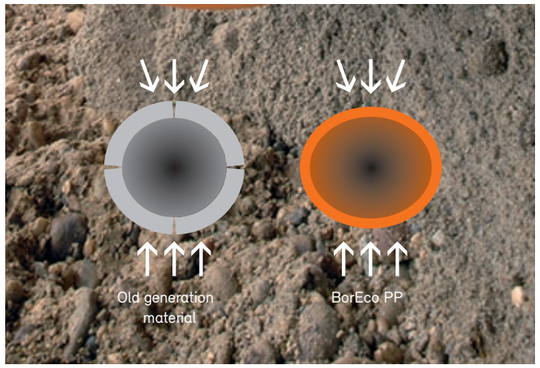
## Sustainable solutions

Today, the majority of sewage pipe systems are still made from rigid materials, like concrete or clay. Such systems can fail due to soil settlement, damaged connections, leaking joints, corrosion or root penetration. These types of damage lead to exfiltration (sewage water leaking into the ground water) and infiltration (ground water entering the pipes), which overloads the sewerage network and, ultimately, the treatment plants. Compared to old-generation material, BorECO™ PP pipes are tougher and corrosion-free and can also be installed in longer sections, thus reducing the number of connections and avoiding potential leakage.

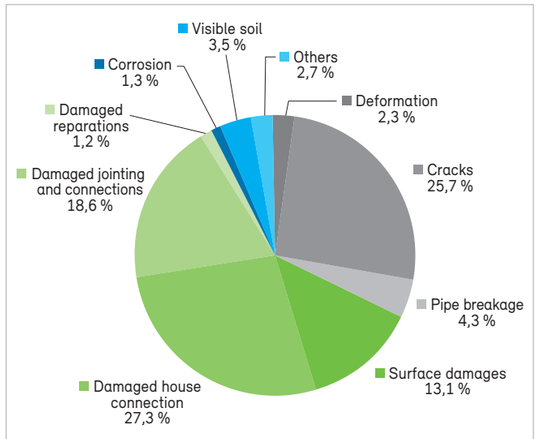
Sewerage pipelines are exposed to continuous static and dynamic loads and require leaktight and extremely durable pipes. BorECO™ PP-based gravity pipe systems have an excellent durability track record and ensure decades of trouble-free pipe operation for the network owner. They contribute to sustainable waste water management reducing material and energy consumption throughout production, transportation and operation.

Moreover, BorECO™ PP gravity pipelines have structural integrity and are flexible to withstand ground movements and consequently make an important contribution to environmental protection.

Source: Unsplash




Failures of a pipe made from old-generation material. The rigid pipe has no deflection capability and breaks under load.



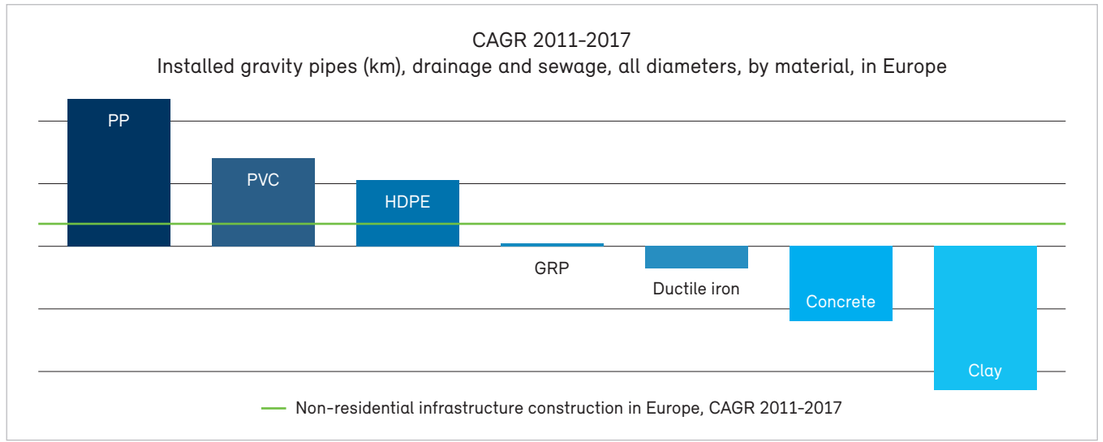

Causes of pipe damage in Germany. Source: DWA, 2020

## Proven long-term track record

Polypropylene is a high quality material which has been proving its performance advantages since the 1950's. (It began being specified for the production of sewerage pipes from the 1970's.) Since 1950, there has been an average global increase of 9% per year in the production and consumption of plastics. This has been driven by a track record of continuous material innovation. Polypropylene's intrinsic properties of high stiffness, good stiffness/impact balance and inertness toward acids, alkalis and solvents have secured its position in a wide range of consumer and industrial applications.

Solid wall pipe

Structured-wall pipe




Source: Plastic Gravity Pipes in Europe, AMI Consulting, October 2018
IHS Markit, Global Construction Outlook, March 2021

## High quality material innovation

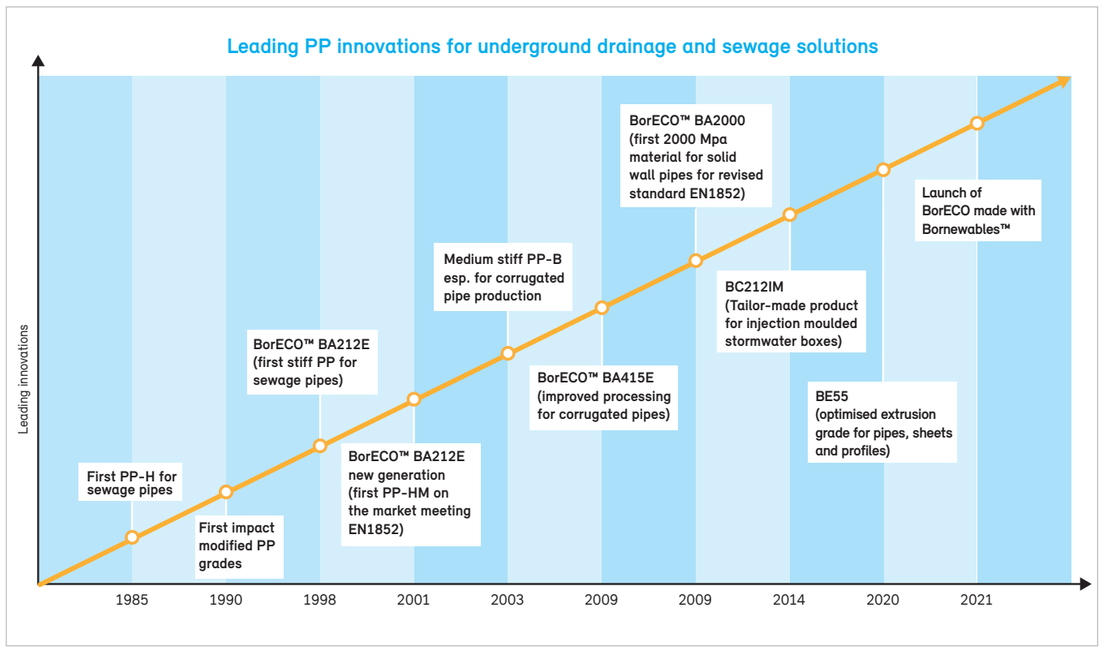
Borealis has a long-standing and ongoing commitment to continuous innovation and product improvement. And, value creation through innovation is at the core of Borealis' strategy of bringing new high quality BorECO™ PP materials to the market.

High impact resistance combined with good stiffness and excellent chemical resistance and temperature performance, make BorECO™ PP highly suitable for sewage applications. Particularly for systems in cold climates, where it enables installation periods to extend into the winter months.

According to the Darmstadt abrasion test method, polyolefin pipes show the lowest abrasion compared to other materials due to a very low surface roughness of approximately 0.007mm. Because of this, PP pipes have excellent hydraulic capacity allowing them to drain off waste water even at low inclination falls.

This factor enables trench depths to be reduced making installation more cost-efficient. The smooth inner-pipe surface also prevents encrustation and inevitable pipe blockage. Moreover, cleaning frequency can be reduced significantly compared with that for pipes of old-generation materials like clay or concrete.

The smooth inner surface prevents encrustations and inevitable pipe blockage




## Quality standards and specifications

PP-based pipe systems for underground drainage, sewage and industrial waste follow the highest quality standards, as laid down in international and national standards and specifications, throughout the whole value chain – from the production of the raw material to pipe manufacturing and final installation.

The requirements for raw materials for pipes and fittings are defined in the standards EN1852 for solid wall pipe systems and EN13476 for structured wall pipe systems.

In 2009, EN1852 was revised and a new pipe series, S14, added to support materials with an E-modulus of 2000MPa.

BorECO™ PP pipe grades are produced in Borealis' plants located in Porvoo, Finland, and Schwechat, Austria, both sites are ISO9001 certified. Furthermore, Borealis PP products for underground drainage and sewage exceed the material requirements in all the standards.

| Requirements of the standard | EN1852<br>Solid wall pipes | EN13476<br>Structured wall pipes |
|---|---|---|
| Type of polymer | PP | PP |
| Resistance to internal pressure<br>water/water, EN ISO 1167-1, -2 | 80 °C/4.2 MPa/140 h<br>95 °C/2.5 MPa/1000 h | 80 °C/4.2 MPa/140 h<br>95 °C/2.5 MPa/1000 h |
| Ring stiffness, EN ISO 9969 | S 20 ≥ 2 kN/m²<br>S 16 ≥ 4 kN/m²<br>S 14 ≥ 8 kN/m²<br>S 12.5 ≥ 8 kN/m²<br>S 11.2 ≥ 16 kN/m²<br>S 10.5 ≥ 16 kN/m² | Corresponds to classification<br>≥ relevant SN |
| Impact resistance<br>- Round the clock method, EN ISO 3127<br>- Staircase method, EN ISO 11173 | $d_{im\ max}$ = 110 mm: 0° C/1.6 m/1 kg: TIR* ≤ 10%<br>$d_{im\ max}$ = 110 mm: -10° C/4 kg: H50 ≥ 1 m,<br>max. one break below 0.5 m | $d_{im\ max}$ = 110mm: 0 °C/1.6 m/0.8 kg: TIR *≤ 10% |
| Thermal stability (OIT), EN ISO 11357-6 | OIT (200°C) ≥ 8 min | OIT (200 °C) ≥ 8 min |

Mechanical requirements of a pipe according to EN 1852 and EN13476.
* TIR: True Impact Rate

BorECO™ PP materials withstand static and dytnamic loads and chemically aggressive substances, thereby providing a durable and reliable solution that lasts for generations.

# BorECO™ PP: Underground drainage and sewage pipes

Sewage and waste water created by residential, institutional, commercial, industrial establishments and hospitals includes waste water from toilets, baths, showers, kitchens and sinks, that is disposed of via sewerage pipelines. In many areas, sewage also includes liquid waste from industry and commerce.

Sewage and domestic waste water treatment involves processes to remove physical, chemical and biological contaminants. Its objective is to produce a waste stream of treated effluent and a solid waste or sludge, suitable for reuse or harmless discharge back into the environment.

Borealis BorECO PP materials are designed to meet and exceed the highest demands of modern non-pressure sewerage pipe systems. Their flexibility allows them to adjust to inevitable ground movements, thereby reducing the risk of leakage. Moreover, their smooth inner walls ensure high gravity flow rates and minimise the risk of blockage.

Sewerage systems have to accommodate static and dynamic loads, withstand chemically aggressive substances and be resistant to temperature fluctuations. BorECO PP pipe materials have proven their ability to match those demands and provide a durable solution that lasts for generations.

In addition to their tough performance and long in-service lifetime, the advantages of PP pipe in respect of speed and ease of installation are unmatched.

picture courtesy of Stabilplastic SpA


picture courtesy of REHAU

## Solid wall pipe systems

Since 2009, the European Standard for non-pressure underground drainage and sewerage solid wall pipes, EN1852, covers PP materials with an E-modulus of 2000MPa or higher (PP-HM), that make it possible to manufacture thinner wall PP pipes by keeping the same ring stiffness performance compared to conventional PP. Consequently pipes with an even lower weight per metre can be produced based on BorECO PP materials. For solid wall pipes, the established BorECO BA2000, with more than 10 years track record, offers the lowest possible weight per pipe metre for drainage and sewage. Compared to old-generation material, the weight per metre is reduced even further.

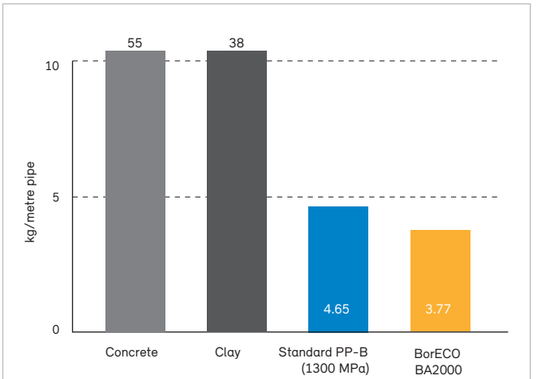
## Structured wall pipe systems

BorECO PP grades offer a new dimension for structured wall pipe (SWP) systems: higher modulus, excellent impact strength and the beneficial properties of PP in general, allow more flexibility in pipe design. The additional benefits of new generation PP-B for SWP systems need to be considered case-by-case based on the different structural designs.

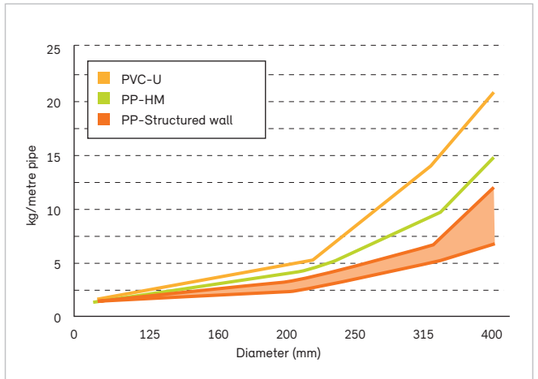
## Manholes and fittings

Manholes such as inspection and control chambers have to resist high loads and provide safe and leaktight connections with sewage pipes. For a complete pipeline, high performance manholes and fittings with high value raw material property requirements are necessary to achieve durable leaktight systems.

BorECO PP materials contribute to meeting additional requirements like jetting resistance, pressure tightness and resistance to abrasion. BorECO PP materials fulfill all relevant standards (EN1852, EN13476, EN1451).



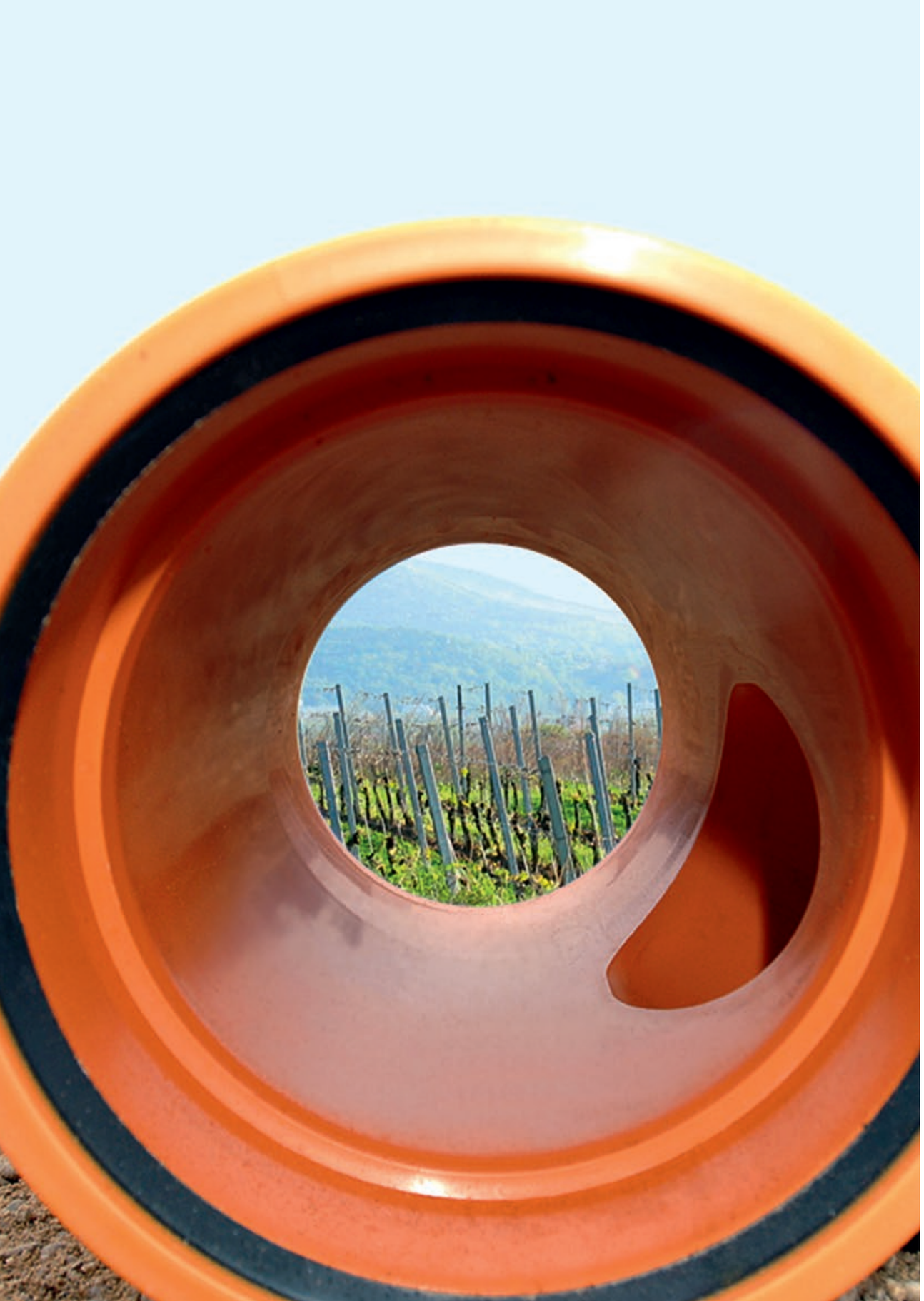

Weight per metre of different solid wall pipes (SN8, DN200mm)




Weight per metre of different corrugated wall pipes

| Requirements | Type of pipe | Standard | Recommended grades | Designation |
|---|---|---|---|---|
| – High durability<br>– Optimised stiffness/impact balance<br>– Flexibility to withstand high loads<br>– Chemical resistance<br>– High hydraulic capacity<br>– Leaktightness of the sewage pipelines<br>– Easy, safe and fast installation<br>– Easy to join | Solid wall pipe | EN1852: 2009 | BorECO™ BA2000 | PP-HM |
| | | | BorECO™ BA212E | PP-HM |
| | Corrugated wall pipe | EN13476 | BorECO™ BA415E | PP-B |
| | | | BorECO™ BA212E | PP-HM |
| | Manholes, Fittings, Storm-Water boxes | EN17152-1 | BorECO™ BC212IM | PP-HM |

Recommended grades for underground drainage and sewage pipes



## Solutions@work

### Solid wall pipe solutions

**Airport drainage**

- 3.5 km runway drainage system with BorECO PP pipes in Hof-Plauen, Germany
- High forces and loads to be carried by the runway
- Corrosion resistant pipes necessary to cope with deicing fluids, defrosting chemicals, leaking oil and fuel

**Sewage pipeline in water protection zone**

- Sewage pipeline of 4.5 km in the water protection zone of Thuringia, Germany
- Importance of leaktight pipes and no corrosion
- BorECO BA212E was selected to comply with strict ground water protection regulations

**Replacement of old-generation material**

- Construction of a new 1.2 km long sewage pipeline in the centre of Cuxhaven, Germany
- The new BorECO BA2000 was selected for heavy duty thin wall pipes
- Major weight savings
- Quick and easy install

### Structured wall pipe solutions

**Highway drainage**

- 4.8 km highway drainage system with BorECO PP pipes for Brescia, Italy
- Pipes to withstand high loads and vibrations
- BorECO PP pipes enabled a three times faster laying rate than old-generation materials for increased cost efficiency

**Sewage pipes for residential project**

- 4 km of sewage mains with BorECO PP in Parma, Italy
- Excellent hydraulic capacity due to low falls were required
- Chemical resistance
- Low weight for quick, safe and cost efficient installation

**Separation of residential sewage and white water**

- 5 km sewerage system with BorECO PP pipes to separate white water from black water for Legnano, Italy
- Key criteria were flexibility to withstand ground movement and ensure leak-free operation
- Excellent stiffness/impact balance for the highest

BorECO™ PP grades provide the ideal platform for sound dampening solutions, a long operating lifetime and resistance to tensides.

# BorECO™ PP: Domestic soil and waste water disposal

Silence is often synonymous with ‘quality of life’. That’s why noise, particularly mechanical or plumbing noises such as water hammer, should be eliminated from domestic environments. BorECO PP grades provide the ideal platform for sound dampening solutions in soil and waste water pipe systems for living spaces.

In addition, pipe material must offer a long operating lifetime and be resistant to tensides from laundry detergents. Especially for conveying water discharged from dishwashers and washing machines, the pipe must have the ability to cope with a peak temperature of 95 °C. For cost-efficient installation, pipe diameters should not become over large as pipelines often have to fit preinstalled ducts. The very smooth inner surface of BorECO PP pipes and, consequently, their excellent hydraulic capacity, allow for smaller pipe dimensions and therefore simplified fitting.wWith the recommended BorECO PP grades, Borealis

supports innovative soil and waste water solutions exceeding the material performance requirements laid down in European standards.

| Requirements | Type of pipe | Standard | Recommended grades | Designation |
|---|---|---|---|---|
| – Room to room sound transmission reduction<br>– Noise reduction in vertical stacks<br>– Impact resistance and excellent resistance to hot water discharged from washing machines and dishwashers.<br>– Chemical resistance<br>– Abrasion resistance<br>– Smooth inner surface to inhibit deposits or bacterial flora | Solid Wall Pipe | EN1451 | BorECO™ BA2000 | PP-HM |
| | | | BorECO™ BA212E | PP-HM |
| | | | BorECO™ BA415E | PP-B |
| | | | BEC5012 | PP-B |
| | | | BE55 | PP-H |

Recommended grades for domestic soil and waste water solutions

Borealis polyolefin raw materials are the preferred material for industrial piping systems including industries such as chemicals, food processing, pharmaceutical and metal processing, due to their high safety performance and superior physical properties.

# Industrial solutions

Polypropylene is of major importance to a large number of industries including chemical, food processing, pharmaceutical and metal processing. In many instances pipelines for support systems, process or waste water treatment are made from PP because of its superior physical properties, especially in corrosive environments where frequent facility shutdowns for the repair of traditional piping systems are a heavy burden. A variety of media have to be safely conveyed in an industrial environment and PP exhibits outstandingly robust behaviour, particularly in respect of resistance to elevated temperatures, corrosion, chemically aggressive media and continuous abrasion from wastes such as slurries.

**BE60-7032**

Unique BE60-7032 is a homopolymer with an exceptionally homogeneous, fine structure and much greater impact strength than classic PP.

Moreover, its high crystallinity ensures excellent resistance to chemicals. An impressive track record has proven that Beta (ß)-PP is especially suitable for the exacting requirements of industrial pipe systems and the construction of chemical equipment.

BE60-7032 is an outstandingly tough PP grade. Compared to other commercial PP-H grades it exhibits a significantly higher impact strength throughout the full temperature range.

Ideal for transporting hazardous materials, including corrosive or ground water endangering fluids.

The high toughness of BE60-7032 allows advantages in systems dimensioning and provides a higher degree of tolerance to damage during transportation and installation.

| Requirements | Type of pipe | Standard | Recommended grades | Designation |
|---|---|---|---|---|
| Compared to other applications, increased resistance to<br>– Elevated temperature<br>– Corrosion<br>– Chemically aggressive substances<br>– Abrasion<br>– Pressure | Solid Wall Pipe | EN15494 | BE60-7032 | Beta (ß)-PP-H |
| | | | BE55 | PP-H |
| | | | RA130E-8427 | PP-R |
| | | | RA7050 | PP-RCT |
| | | | RA7050-LG | PP-RCT |
| | | | RA7050-GN | PP-RCT |
| | | | RA7050-GF | PP-RCT |

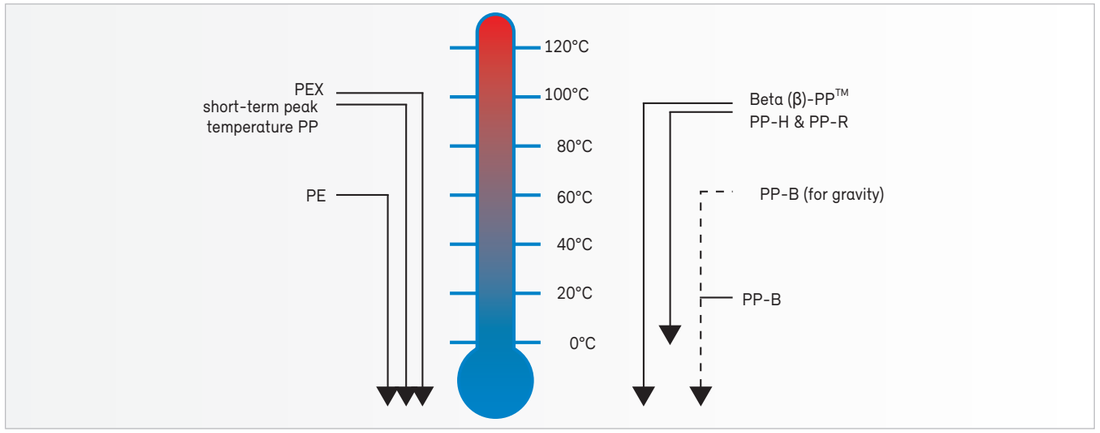
Recommended PP grades for industrial sewage and waste water disposal

| Typical operating limits for PP materials | | |
|---|---|---|
| Max. operating pressure for SDR 11 pipe – 50 years/10 years* | | |
| Temp (°C) | PP-H DIN 8077 | PP-R DIN 8077 |
| 20 | 12.4 bar | 15.4 bar |
| 30 | 10.5 bar | 13.0 bar |
| 40 | 10.0 bar | 11.0 bar |
| 50 | 8.3 bar | 9.2 bar |
| 60 | 7.4 bar | 7.7 bar |
| 70 | 4.8 bar | 5.1 bar |
| 80 | 4.7 bar* | 4.8 bar* |
| 95 | 2.6 bar* | 2.6 bar* |

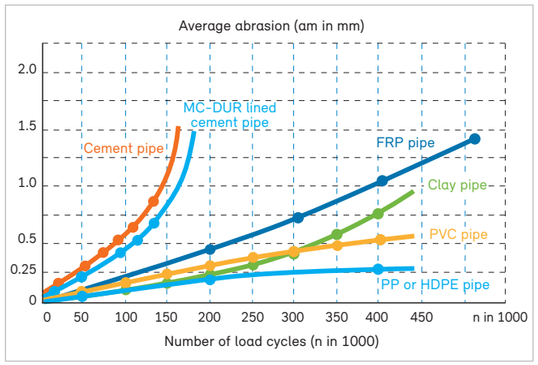
Typical operating limits for PP materials

## Pressure resistance

For buried water and gas distribution systems it is usual to design PP and PE pipelines for operation at 20 °C. However, all polyolefin pipelines are able to operate at higher temperatures as long as their basic properties are respected (see the table on the right). In demanding industrial and chemical applications higher safety margins are crucial, especially when:
– the system is under multi-axial stresses
– subjected to impact loading, which can frequently occur
– sudden surge pressures occur in the pipelines



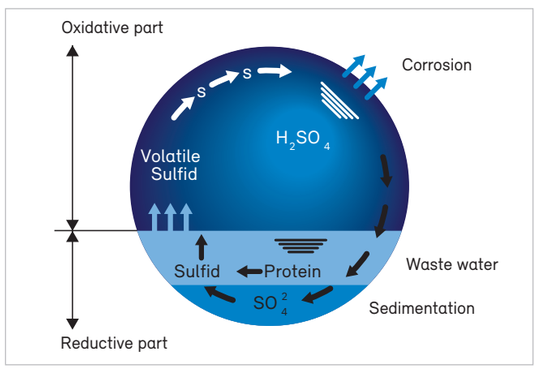

BE60-7032 has an increased operating temperature




Darmstadt test method to determine surface abrasion

## Abrasion resistance

Polyolefins have exceptional abrasion resistance compared to other pipe materials. Compared to steel, for example, the wear rate of PE is 4–6 times lower, which is why PE has replaced metal pipes for mine tailing slurry lines. A comparison with other non-metallic materials such as asbestos cement, GRP and clay pipes using the Darmstadt abrasion test method (EN 295) is shown in the graph. PP and PE pipes clearly outperform each of the alternative pipe materials.




BorECO PP pipes are resistant against corrosion from sulphuric acid

## Corrosion and chemical resistance

All metal pipes are subject to corrosion. However, in most application environments corrosion is not an issue for polyolefin pipes. Even seawater poses no problem, which makes PP ideal for submarine outfall pipes or seawater intake pipelines. Moreover, it is highly resistant to chemicals and other aggressive media (refer ISO/TR 10358). PP pipelines are resistant to most acids and have an operating temperature range up to 90 °C.

## Solutions@work

### Process water at 80 °C in Donauchemie, Austria

– BE60-7032 pipes transporting chemical plant process water at 80 °C
– Installed in the 1980s, at a depth of 5 m, the 1,600mm diameter pipeline was the largest PP pipeline of its day and is still in operation

### Acids and abrasive slurries at Hindustan Zinc, India

– BE60-7032 pipes used to transport abrasive slurries and acids at temperatures of 50–90 °C
– Abrasion resistance is vital
– Pipes have to be tough to withstand the removal of pipeline blockages
– BE60-7032 had an 18% lower fully installed cost compared to a GRP system

### Microbiological processes at Kirchheim, Germany

– BE60-7032 pipes used for a number of industrial systems in a composting plant
– Pipe diameters range from 63–1,200mm, operate at up to 6 bar and 80 °C
– Essential resistance to aggressive bacteria in the process
– Long-term performance unaffected by moisture, temperature, nutrients, oxygen or pH

Borealis is continuously engaged in product developments geared to enhance advantages to both pipe producers and end-users.

# Grades in focus

### BorECO BA415E – A milestone in processing excellence

BorECO BA415E represents a step-change in performance material and leads the field in the 1500 MPa segment. This new polypropylene block copolymer (PP-B) grade has been specially developed to help producers achieve greater efficiency in pipe production, particularly in respect of large diameter pipes. Its excellent processability allows a 15 to 20% higher output and approximately 7% lower energy consumption than alternative materials in the same class, resulting in significant production cost savings. BorECO BA415E substantially improves the overall quality and the aesthetics of the pipe. It allows for a more precise corrugated outer layer. When used as an inner layer, the occurrence of deformations on the inner surface is reduced significantly. This high quality inner surface improves the black water flow and eliminates the risk of the water stagnation that causes bacteria and bad odours.

BorECO BA415E is recommended for structured wall, thin wall corrugated pipes and solid wall non-pressure pipes. As such, it is ideally suited to sewerage waste and drainage applications for which it exceeds the required material standards as set out in EN13476 and EN1852.

### BorECO BA2000 – A step-change in PP-HM material innovation

Sewerage pipelines are continuously subject to static and dynamic loading and to accommodate this, the challenge for manufacturers has been to produce heavy duty solid wall pipes that present good stiffness without compromising good impact resistance. High modulus PP (PP-HM) materials have provided a useful answer to the challenge but Borealis has taken the development to a higher level with the introduction of BorECO BA2000.

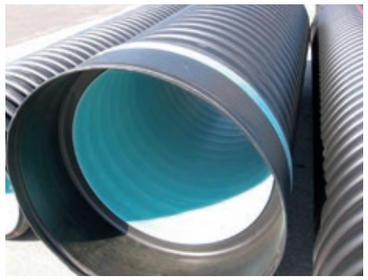
This is the first PP-HM grade to deliver the uncompro-mising performance of a 2000 MPa E-modulus material that also offers good impact resistance, satisfies all the requirements of EN1852 and is the lightest SN8 pipe in class. Moreover, BorECO BA2000 can be processed on existing machines and no investment in additional equipment is necessary.

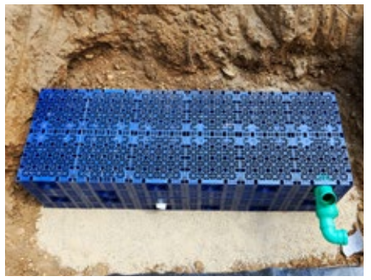
### BC212IM – Tailormade product for stormwater boxes

Due to the combination of climate change impact, resulting in many regions of the world having a heavier and unpredictable rainfall, together with increased urbanization, the possibility for lower natural infiltration of the water into the soil has created a real challenge for storm water management systems.

The key requirement for infiltration boxes is a high load bearing capability to enable the design of light weight boxes with a high void ratio. In terms of material properties the resistance to vertical and lateral compressive loading can be translated into high creep resistance and high stiffness. In order to keep the box weight as low as possible, it is essential to select a material which shows high creep resistance and high stiffness without extensive use of fillers.The infiltration boxes need to exhibit sufficient toughness to withstand handling and installation. This means that the plastic material chosen for box production needs to exhibit a certain level of impact resistance at installation temperatures.

The tailor made material BC212IM for infiltration boxes combine excellent processability for the injection molding of large parts with superior load bearing resistance and long term thermal stability.





Borealis is implementing the EverMinds™ mindset in practice to facilitate the transition from a linear to a circular economy.

# Embrace circularity with our renewable and recycled solutions

EverMinds™
Accelerating Action on Circularity

## Bornewables™ – Renewable PP infrastructure solutions

The Bornewables line of BorECO are produced with renewable feedstock derived entirely from waste and residue streams. These premium polyolefins offer the same material performance as virgin polyolefins, yet with a reduced carbon footprint.  Using these innovative and more circular products will help enable Borealis customers to meet their own sustainability targets while maintaining existing quality standards.

## Borcycle™ – The All-Round Solution for Closing The Loop on Plastic Waste

**Borcycle™ M: the solution for high quality with a lower carbon footprint**

An ever-advancing transformational technology  for mechanical recycling that gives polyolefin-based, post-consumer waste another life; a solution for lowering carbon footprints whilst raising material quality fit for demanding applications.

**Borcycle™ C: the solution for high purity, high performance materials**

Transformational technology solutions for chemical recycling that gives polyolefin-based, post-consumer waste another life; a solution creating both virgin-level grade materials and high safety and performance qualities fit for demanding applications.

Please get in touch with our experts to learn more about our portfolio of circular polyolefins.

## Together for a more Circular Economy.

**We take action to shift towards a circular mindset.**

**EverMinds™ is a platform that brings stakeholders together to constantly innovate our technologies and product portfolio with circularity of plastics at the core.**
The platform is a catalyst for better economic, environmental and societal outcomes and an inspiration constantly reminding us to always act consciously with the lifecycle of materials in mind.

Borealis is committed to climate protection through the advancement of innovative plastics solutions that use less material, consume less energy and result in lower $CO_2$ emissions than alternative materials.

# Advancing sustainability

The carbon footprint of polyolefins is among the lowest in the plastics industry with an average 'cradle-to-gate' footprint of 1.7 kg $CO_2$ per kg PP and 1.6 kg per kg HDPE.

To better understand the impact on and contribution to the environment of PP sewage pipes, leading German pipe and sewerage system producer REHAU commissioned independent research from the Brandenburg Technical University* (BTU), Cottbus, Germany. The research objective was a life-cycle assessment (LCA) – from the production of the plastic raw material to recycling – and comparison of the energy consumption of sewage pipe systems in both PP and vitrified clay and system canal shafts made from PP and those constructed from cement.

### PP assessed against vitrified clay

The comparison was made between 500 m of PP SN 10 pipes and 500 m of vitrified clay pipes each measuring DN 200. Analysis showed that the PP pipeline expended 60,000 megajoules less energy than its equivalent in vitrified clay. As an indication of value, this saving equates with the energy consumed by a 60 watt lamp burning continuously for a period of 45 years.

### PP assessed against concrete

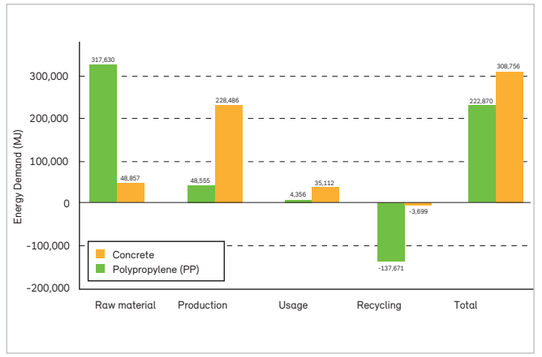
Providing the basis of this life-cycle assessment, 10 canal shafts moulded in PP were compared with 10 shafts constructed in concrete, each having a total height of 2.5 metres. This study demonstrated that the PP shafts gave an energy saving of 26,000 mega-joules over that of the concrete alternative. An energy saving equal to that consumed by a 60 watt lamp over 13 years.

### A sustainable improvement

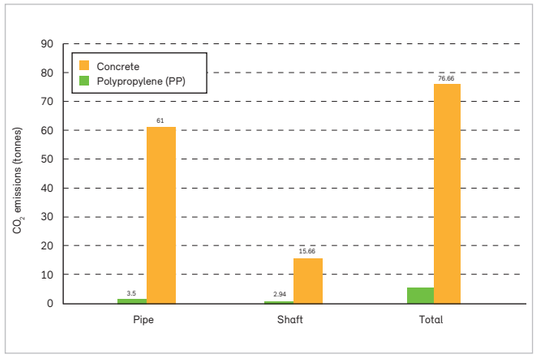
Overall the study concluded that PP provides a significant step-improvement in sustainability over other materials commonly used in the construction of sewerage systems. The energy savings achieved through the use of PP materials in these applications contributes to both the conservation of resources and the minimalisation of impact on the environment.

### Renewable PP infrastructure solutions

The Bornewables line of BorECO are produced with renewable feedstock derived entirely from waste and residue streams. These premium polyolefins offer the same material performance as virgin polyolefins, yet with a reduced carbon footprint.  Using these innovative and more circular products will help enable Borealis customers to meet their own sustainability targets while maintaining existing quality standards.




Impact balance of the total sewerage pipeline based on 'Cumulative Energy Demand'




$CO_2$ emissions (tonnes) over the complete product life-cycle

* Research undertaken by Dipl.-Ing. Stefan Just; Prof. Dr. rer. nat. Jürgen Ertel. Charts courtesy of REHAU.

Water for the World™ is an initiative established by Borealis and Borouge that aims to contribute to solutions that address the global water challenge.

# Water for the World

More than one third of the world's population does not haveaccess to clean water and/or proper sanitation and more than 2.2 million people die each year from diseases associated with poor water and sanitation conditions. This situation represents a major and growing threat to human health and the environment. The majority of communities in developing countries still lack even the most basic drainage. As a result, effluent is left untreated in the environment to pollute rivers and ground water, giving rise to widespread serious health problems.

Even in industrialised countries which have long benefitted from on-tap drinking water, flush toilets and sewerage networks, the rapid population growth of towns and cities is beginning to outstrip services. Today it is estimated that in the European region 120 million people do not have access to safe drinking water and adequate sanitation. From fresh water supply to sanitation systems the plastics industry can make a substantial difference. Going beyond business, Borealis and its joint venture partner Borouge have established Water for the World, an initiative that aims to contribute to solutions that address the global water challenge. Within this programme, Borealis and Borouge have established a number of projects focused on three main areas in the fields of society, business and environment:

– supporting water access projects
– raising awareness in communities
– advancing sustainable water-management/promoting best-practices

## Solutions@work

### The water footprint of plastics

In a world of diminishing fresh water supplies a company's water footprint provides a valuable environmental indicator which can help advance sustainable development.

In 2009 Borealis was the first petrochemicals and plastics producer to assess the water footprint of its polyolefins operations and products.

### Water for Nairobi, Kenya

Borealis and Borouge joined forces with the OPEC Fund for International Development (OFID) and Water & Sanitation for the Urban Poor (WSUP) to deliver safe and reliable water to over 50,000 residents of the Korogocho slum in Nairobi, Kenya.

The new infrastructure is produced from PE100 material to ensure a long maintenance free life.

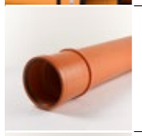
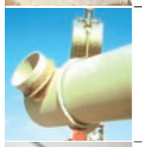
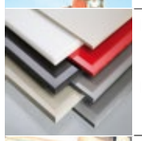
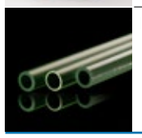
### Awareness building and education

Working with Finnish water authorities, Borealis launched the Virtual Water School, an educational website for school-children that aims to create interest and increase understanding of the importance and functioning of water and sanitation systems.

The Virtual Water School is an example of how Borealis is working in partnership to foster knowledge and contribute solutions.

# Technical overview

**Solutions for non-pressure underground drainage and sewage, industrial soil and waste**

| | Grade | Designation | MFR (230 °C/ 2.16 kg) | Flexural Modulus (MPa) | Typical applications | Description |
|---|---|---|---|---|---|---|
|  | **BorECO™ BA2000** | PP-HM | 0.25 | 2,000 | Underground drainage & sewage, soil & waste, solid wall systems | High molecular weight, low melt flow rate PP-HM with a good balance of mechanical properties; superior stiffness while keeping good impact resistance and excellent processability. |
|  | **BorECO™ BA212E** | PP-HM | 0.25 | 1,800 | Underground drainage & sewage, soil & waste, solid & structured wall systems | High molecular weight, low melt flow rate PP-HM with very high stiffness and impact strength. |
|  | **BorECO™ BA415E** | PP-B | 0.45 | 1,500 | Underground drainage & sewage, soil & waste, Corrugated wall systems | High molecular weight, low melt flow rate PP-B with high stiffness and impact strength. |
|  | **BEC5012** | PP-B | 0.25 | 1,400 | Underground drainage & sewage, soil & waste systems | High molecular weight, low MFR, PP-B with very high impact strength. |
|  | **BorECO™ BC212IM** | PP-HM | 4.5 | 1,800 | Stormwater boxes, sewage and underground drainage systems | Block copolymer combining high stiffness and good flowability for injection moulding. |
|  | **BE60-7032** | PP-H | 0.3 | 1,300 | Industrial pipes and fittings | High molecular weight, low melt flow rate PP-H with fine grained ß-modification crystalline structure leading to excellent impact strength even at low temperatures, increased hydrostatic strength and improved chemical resistance. The material is coloured grey based on RAL 7032. |
|  | **BE55**<br><br>**BE50** | PP-H<br><br>PP-H | 0.35<br><br>0.3 | 1,650<br><br>1,650 | Non-pressure pipes, fittings and sheets<br><br>Non-pressure pipes, fittings and sheets | High molecular weight, low melt flow rate PP-H.<br><br>High molecular weight, low melt flow rate PP-H. |
|  | **RA130E-8427** | PP-R | 0.25 | 900 | Pressure pipes and fittings for industrial applications | High molecular weight, low melt flow rate PP-R. The material is coloured grey. |
|  | **RA7050, RA7050-GN, RA7050-LG** | PP-RCT | 0.3 | 905 | Plumbing and heating | Low melt flow rate, ready-made PP-RCT compounds in colours steel-grey, green and light-grey. |
|  | **RA7050-GF** | PP-RCT | 0.3 | 4,500 | Industrial pipes | Glassfibre reinforced PP-RCT colour compound. |



# Borealis and Borouge polyolefin pipe solutions are enabling life's essentials

As a trusted and experienced partner with more than 50 years of experience, Borealis offers market leading polyethylene and polypropylene materials for pipe systems in water and gas distribution, waste water and sewage disposal, plumbing, heating, and industrial, along with multi-layer steel pipe coating solutions for onshore and offshore oil and gas pipelines. With the proprietary Borealis Borstar® technology as the main foundation, complimented by selected other processes, Borealis can offer a wide variety of tailored pipe solutions.

In addition, Borcycle™ M and the ISCC Plus certified Borcycle™ C compounds based on mechanically and chemically recycled feedstock as well as the ISCC Plus certified Bornewables™ compounds using renewable-based feedstock meet a growing demand for high-sustainability building and infrastructure pipe polymers.

At the same time, they align with Borealis's EverMinds™ platform to promote and accelerate the transformation of the plastics industry towards circularity.

By offering more durable and reliable as well as circular pipe solutions, Borealis' step-change innovations continue to boost the sustainability of pipe networks by making them safer, leak free, longer lasting and more efficient with installation costs reduced by up to 60% compared to the traditional pipe material.

Based on Borealis' European assets, its Middle Eastern joint venture Borouge as well as the American joint venture Baystar®, Borealis confirms its position as a partner of choice for global pipe customers, helping to meet the growing needs and requirements of the building and infrastructure industry today and in the future.

Enabling life's essentials | Date of issue: August 2025



**For more information visit:** www.borealisgroup.com · www.borealiseverminds.com