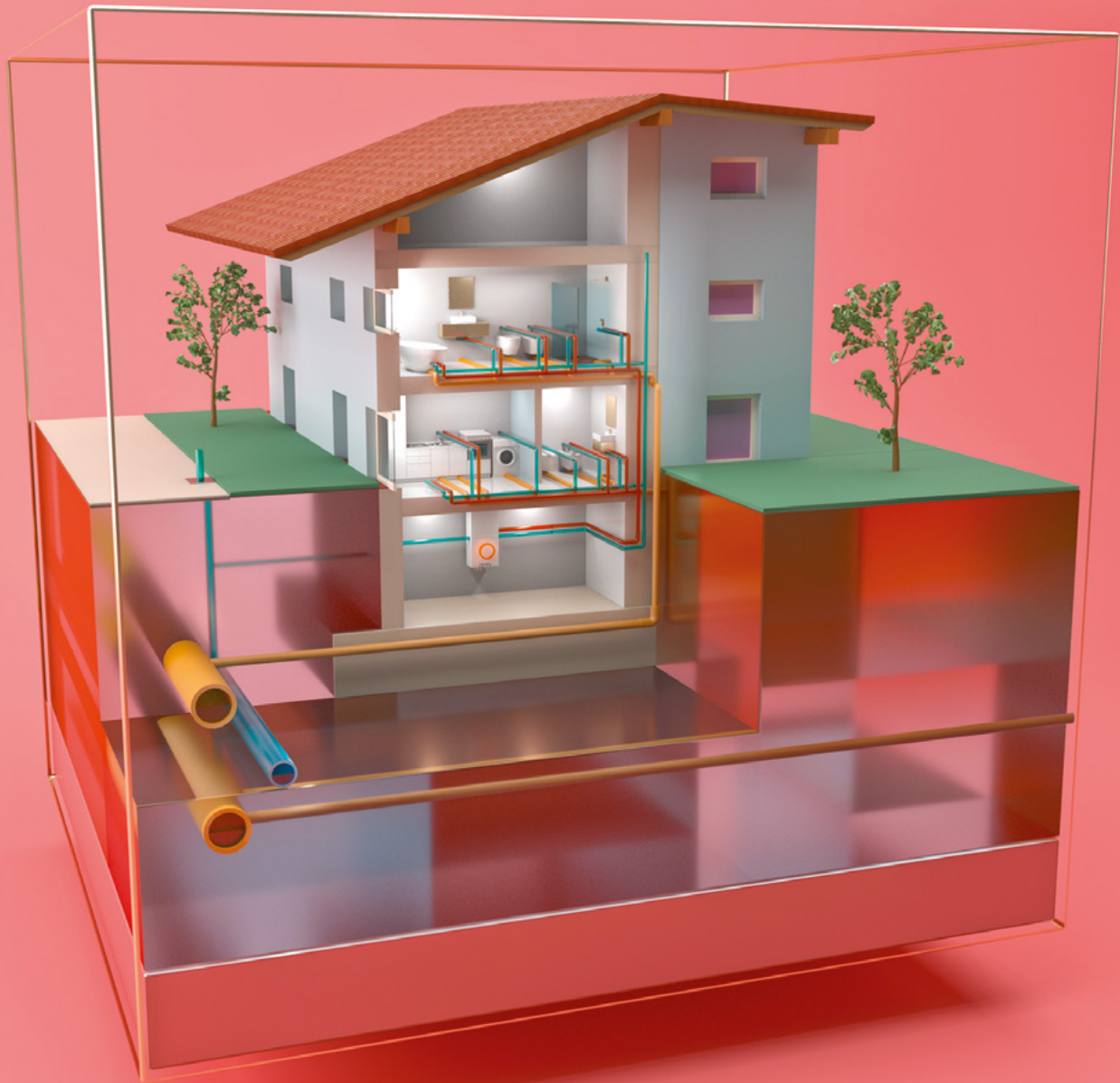


HIGH PERFORMANCE POLYMERS **WATER MANAGEMENT**

RadiciGroup High Performance Polymers, leading global supplier of high-performance thermoplastics, offers a comprehensive range of engineering grades targeted for water equipment suppliers.



Introduction

Water Management and Sustainability

Similar to all ancient civilizations, contemporary society relies its progress on water availability, quality and efficiency. Better or more water management is becoming more and more crucial for the long term sustainability of our modern age.



Photo 1 | Roman aqueduct

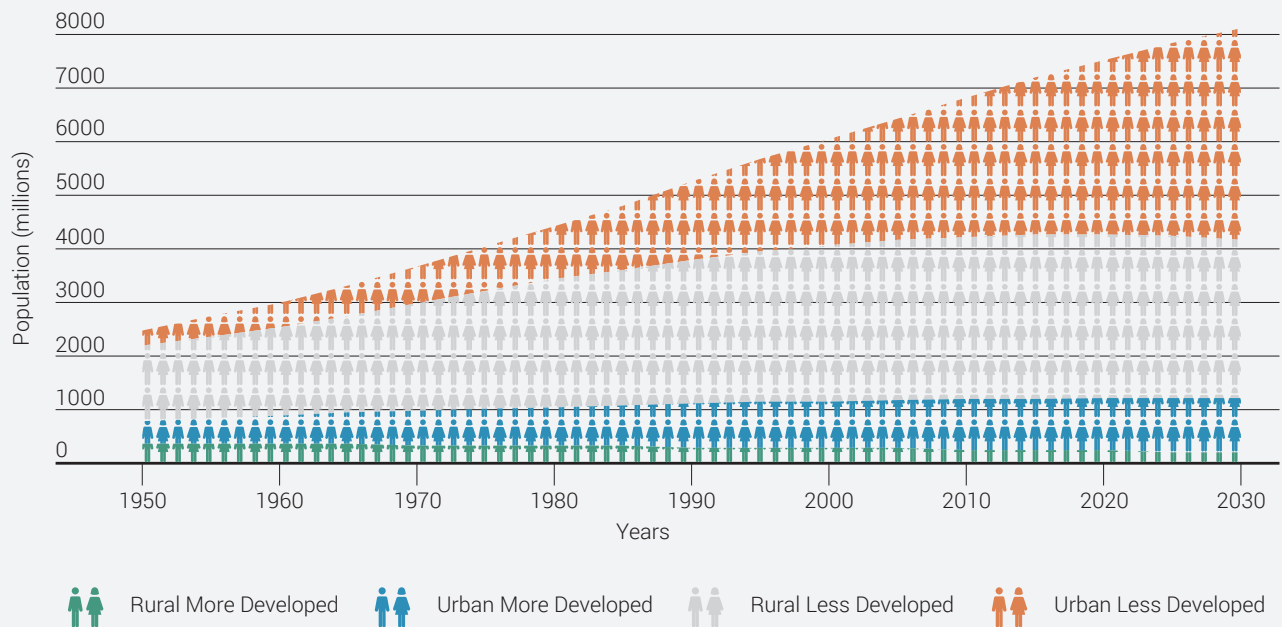
Five main trends are increasing pressure to more or better manage fresh water^[1]:

- **Population growth**
Current 7 billion world population is expected to reach over 8 billion in 2030 and hit the 9 billion mark by 2050. More world population causes more world fresh water demand.
- **Increasing affluence**
Increasing poverty alleviation determines more water consumption pro-capita.
- **Expansion of business activity**
Increasing business activity in the industry and service sector requires higher demand in water services in both supply & sanitation.
- **Rapid Urbanization**
Current increase of urbanization in the developing countries causes private wells or septic tanks becoming obsolete. High density urban areas require significant investments in water infrastructure in order to deliver water to individuals, dispose and treat waste water.
- **Climate Change**
Climate change & the uncertainty that it brings, poses a series of risks to water availability and water management systems.

Trends that affect fresh water use > better/more water management

Population Growth projected to reach over 8 billion in 2030 and to level off at 9 billion by 2050.

Population trends 1950-2030



⁽¹⁾Source: UN DESA, World Urbanization Prospects

Figure 1 | Five main trends are increasing pressure to more or better manage water

The increasing use of engineering plastics in water management systems contributes to increasing efficiency of these systems due to significant reduction of infrastructure cradle to gate footprint, lower system & maintenance costs and easier handling.



Photo 2 | Water Management and sustainability

RadiciGroup High Performance Polymers contribution to Water Management

RadiciGroup High Performance Polymers water management portfolio includes the following family of materials:

Radilon® S (PA6)	Grades that combine very good mechanical performance properties, excellent processability & colourability for parts not in contact with water that do not require hydrolytic resistance.
Radilon® A (PA6.6)	Grades that combine high mechanical performance properties with good hydrolytic resistance at elevated temperatures (90°C).
Radilon® DT (PA6.12)	Grades that combine high mechanical performance properties with excellent chemical and hydrolytic resistance at elevated temperatures. They offer superior dimensional stability, including low moisture absorption, and superior resistance to oxidation degradation resulting in better weld line resistance to prolonged water exposure up to 60°C. The materials also exhibit high flow, which enables easier design and injection moulding of highly complex and/or thin-walled parts.
Radilon® D (PA6.10)	Grades that combine high mechanical performance properties with excellent chemical and hydrolytic resistance at elevated temperatures. They offer superior dimensional stability, including low moisture absorption, and superior weld line resistance to prolonged water exposure up to 60°C. These products are made partially from renewable sources.
Radilon® Aestus T1 (PPA)	Grades that combine high mechanical performance properties, including excellent creep resistance in hot water and steam, with outstanding chemical and resistance to oxidative degradation at elevated temperatures (120°C).
Radistrong® A (special PA)	Grades that combine superior mechanical performance properties with good hydrolytic resistance at high temperatures (90°C) and excellent surface finish as well as excellent processability.
Raditeck® P (PPS)	Grades that combine good mechanical performance properties with outstanding hydrolytic and chemical resistance at elevated temperatures (120°C) as well as outstanding dimensional stability & creep resistance.

Below find a comparative classification of the RadiciGroup High Performance Polymers family products in relation to key properties for water management applications:

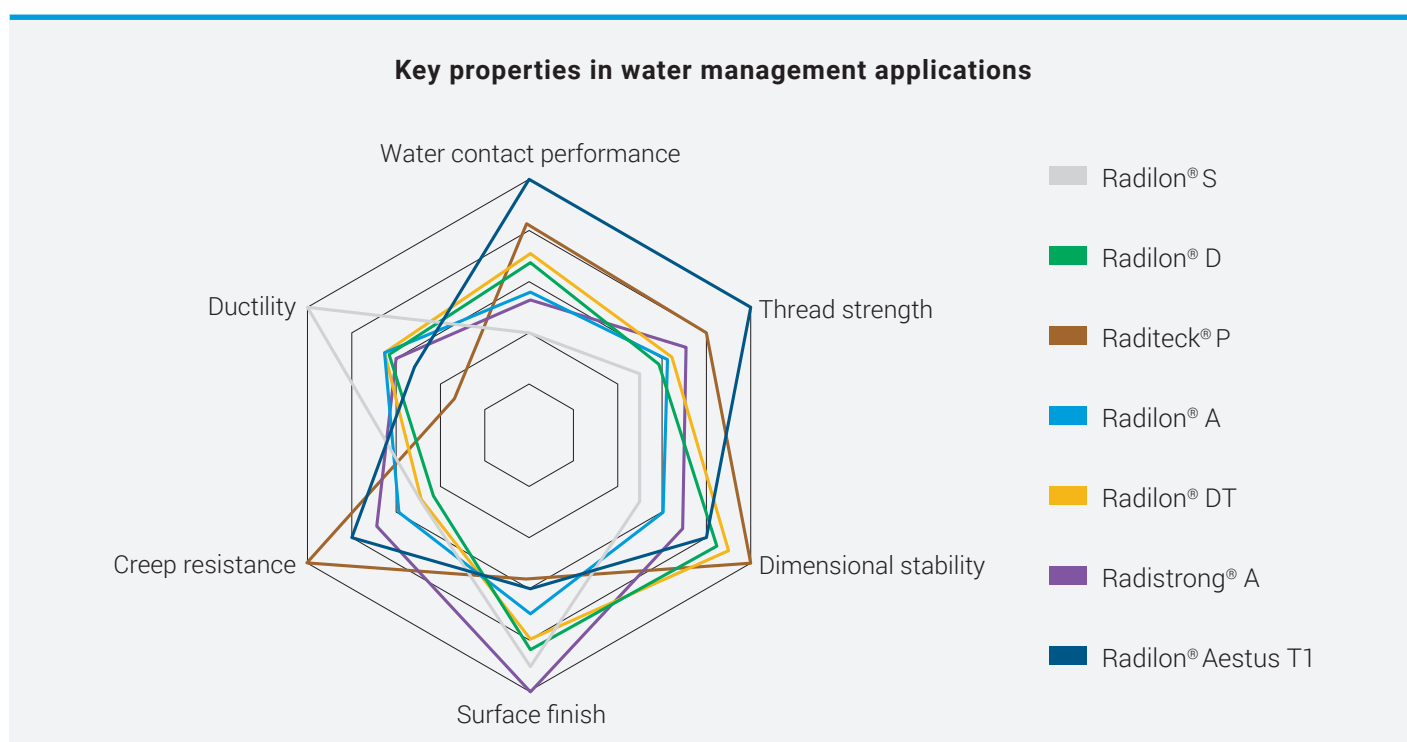


Figure 2 | Water Management key properties for RadiciGroup High Performance Polymers family products

Applications

Our water management product portfolio replaces metals as well as competitive engineering plastics and address major challenges for end-products in water management, such as heat and water meters, boiler components such as hydro-block manifolds along with balancing and other valves, faucets, cartridges, small appliances water contact components. RadiciGroup High Performance Polymers metal replacement materials eliminate the risk of galvanic corrosion and scale build-up; furthermore help reduce costs and facilitate compliance with tighter regulations on permissible levels of lead in drinking water. Our drinking water contact materials are designed to be compliant to the national requirements for potable water in Germany (DVGW), France (ACS), UK (WRAS) and US (NSF 61).



Water distribution



Sanitary systems



Heating systems



Home appliances

Figure 3 | Water management in domestic applications

Water Distribution

Water distribution covers all the systems that bring to and measure water in a building. These include water filtering and metering systems as well as submersible pumps or shut-off valves. In these systems, long term dimensional stability, mechanical properties and resistance to disinfectants at ambient temperatures are required. The type of disinfectants and concentration levels can influence significantly the long term resistance to oxidative degradation of engineering plastics. The replacement of metal by engineering plastics in metering systems is driven by the global restrictions of lead in water.



Photo 3 | Water meter

Designing with RadiciGroup High Performance Polymers results in lead-free and water regulation compliancy as well as significant system cost reduction due to the high cost of processing and machining new brass alloys with low lead content and the high environmental impact of end-products manufactured in foundries.



Photo 4 | Magnetic sludge separator

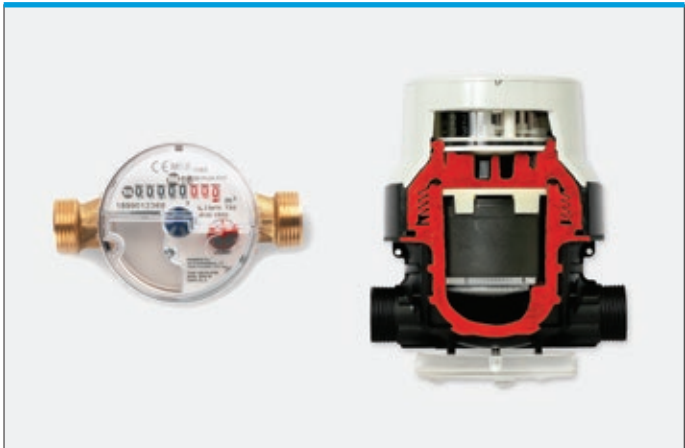


Photo 5 | Brass to engineering plastics replacement in volumetric water meters driven by lead in water global restrictions

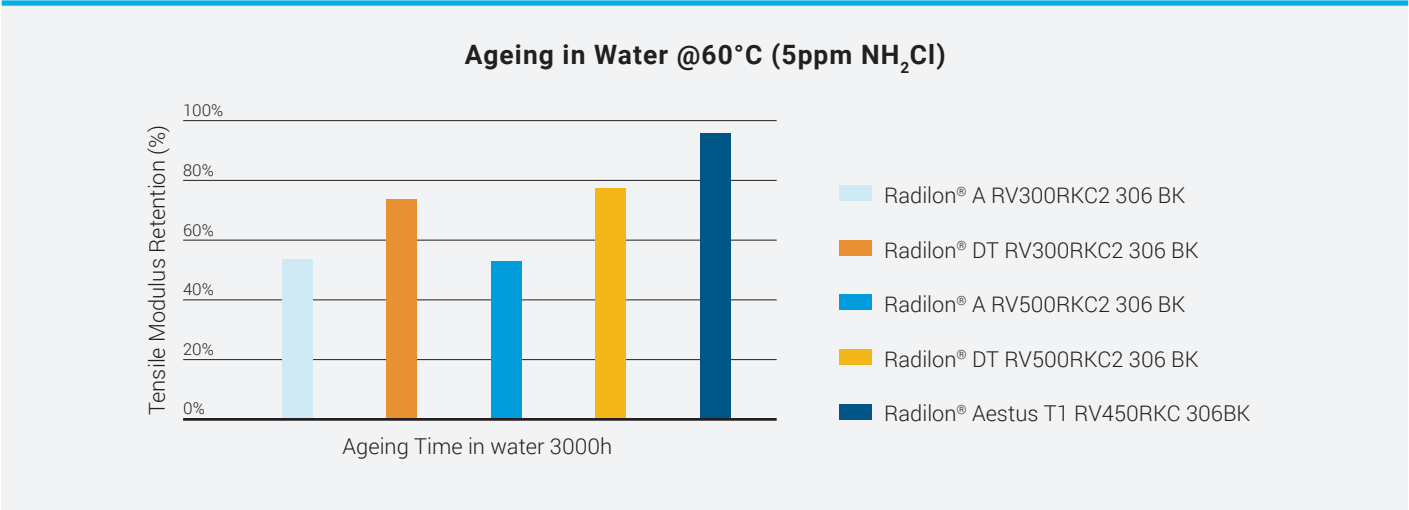


Figure 4 | – Radilon® WM grades tensile modulus retention after ageing at 60°C in water with 5ppm monochloroammine (NH₂Cl)

In these systems long term dimensional stability, mechanical properties and resistance to disinfectants at ambient temperatures are required. The type of disinfectants and concentration levels can influence significantly the long term resistance to oxidative degradation of engineering plastics.

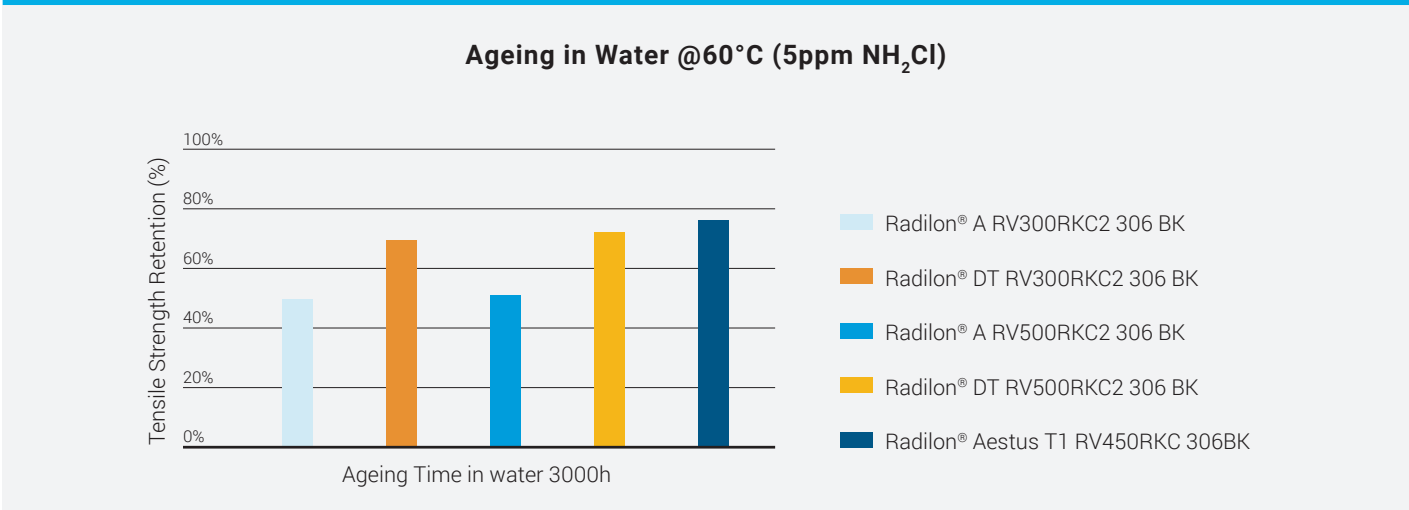


Figure 5 | – Radilon® WM grades tensile strength retention after ageing at 60°C in water with 5ppm monochloroammine (NH₂Cl)

Sanitary Systems

Sanitary systems cover all the water systems or accessories that are in contact with water in kitchens or bathroom both in domestic and commercial buildings. Typical applications are faucets, cartridges and shower head components.

In these systems, depending on application, long-term dimensional stability and mechanical properties, resistance to disinfectants at high temperatures and sometimes wear resistance are required.

Solutions with RadiciGroup High Performance Polymers bring the following benefits:

- lead-free solution
- drinking water regulation compliancy
- no scale build up or corrosion
- system cost reduction

In these systems, depending on application long term dimensional stability, mechanical properties and resistance to disinfectants at warm temperatures and sometimes wear resistance are required.



Photo 6 | Shower head

Heating Systems

Heating systems are all those systems that provide heat to a building. These include heating systems like heat pumps, furnaces and boilers. Water management focuses on boilers that can be considered special purpose water heaters. While furnaces or heat pumps carry heat in warm air, boiler systems distribute the heat in hot water, which gives up heat as it passes through radiators or other devices in rooms throughout the house. The cooler water then returns to the boiler to be re-heated. Hot water systems are often called hydronic systems. Residential boilers generally use natural gas or heating oil for fuel. Nowadays many domestic hot water systems circulate water through plastic tubing in the floor, a system called radiant floor heating.

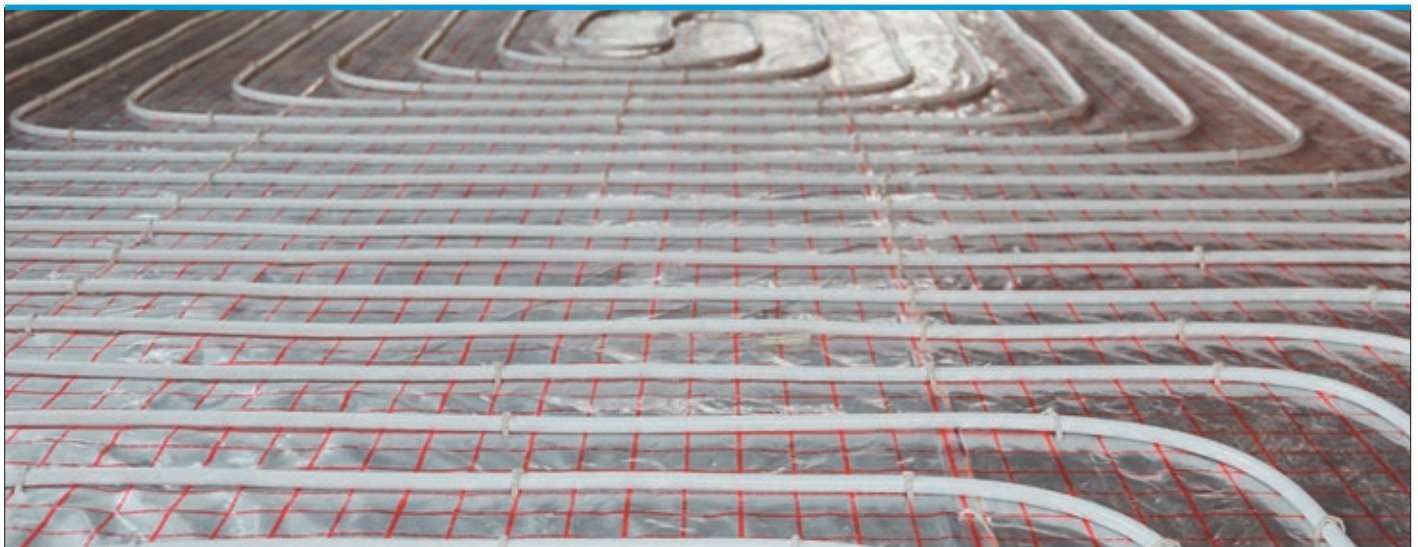


Photo 7 | Radiant Floor heating

The growing use of engineering plastics in these systems allows to design integrated parts that were originally in metal and produce boilers with lower number of assembled parts with the result of achieving significant system cost reductions. Typical example of the benefits in specifying Radilon® materials is the hydro-block manifold, which achieves significant system cost efficiency through design integration of a number of brass parts.

In these systems long term dimensional stability, mechanical properties and resistance to chlorine at high temperatures are required. The combination of fresh water with disinfectants like chlorine & oxygen at high temperature creates a particularly aggressive environment for plastics due to oxidative degradation.

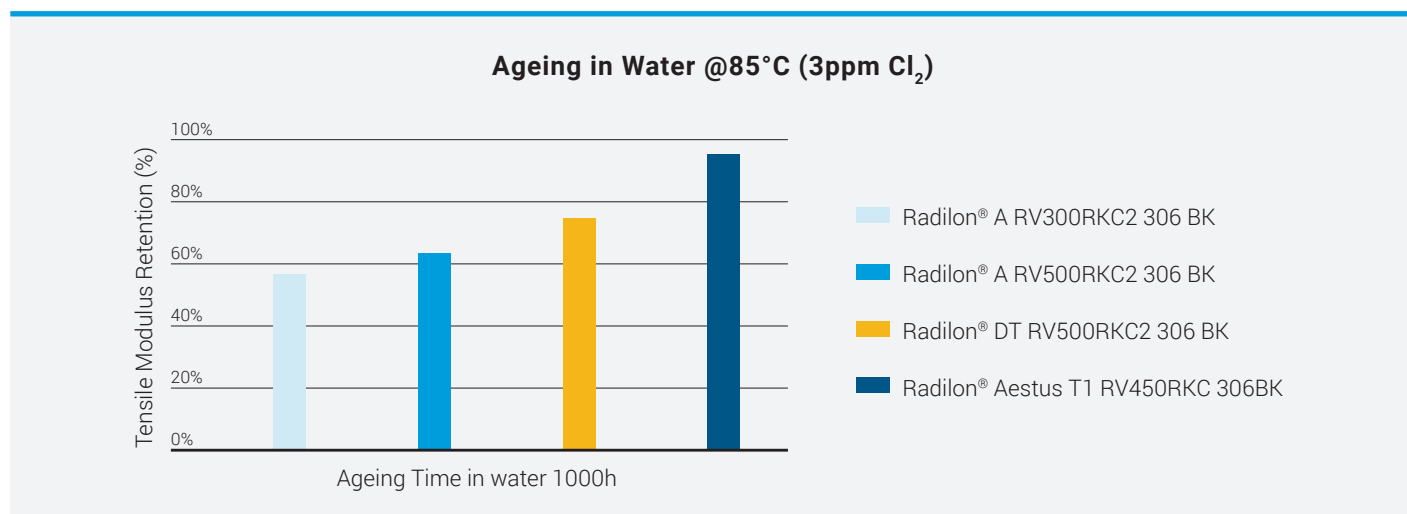


Figure 6 | – Radilon® WM grades tensile modulus retention after ageing in water at 85°C in 3ppm chlorine (Cl₂)

Other typical heating systems applications currently using Radilon® materials include:



Photo 8 | Heating system manifold



Photo 9 | Heating system flow-meters



Photo 10 | Cap fittings in under-floor heating systems

Home Appliances

RadiciGroup High Performance Polymers has provided for many years solutions for the home appliances market that are cost effective, reliable and suitable for high productivity end products.

Applications such as power module housings for refrigerators or dish washers requiring material robustness & flame retardant properties; oven ventilation ducts requiring high thermal and chemical resistance or washing machine door levers requiring high fatigue resistance as well as excellent surface finish, electrovalves for large & small appliances requiring excellent water resistance as well as water potability compliance, are just a few examples of RadiciGroup High Performance Polymers long track record in home appliances.

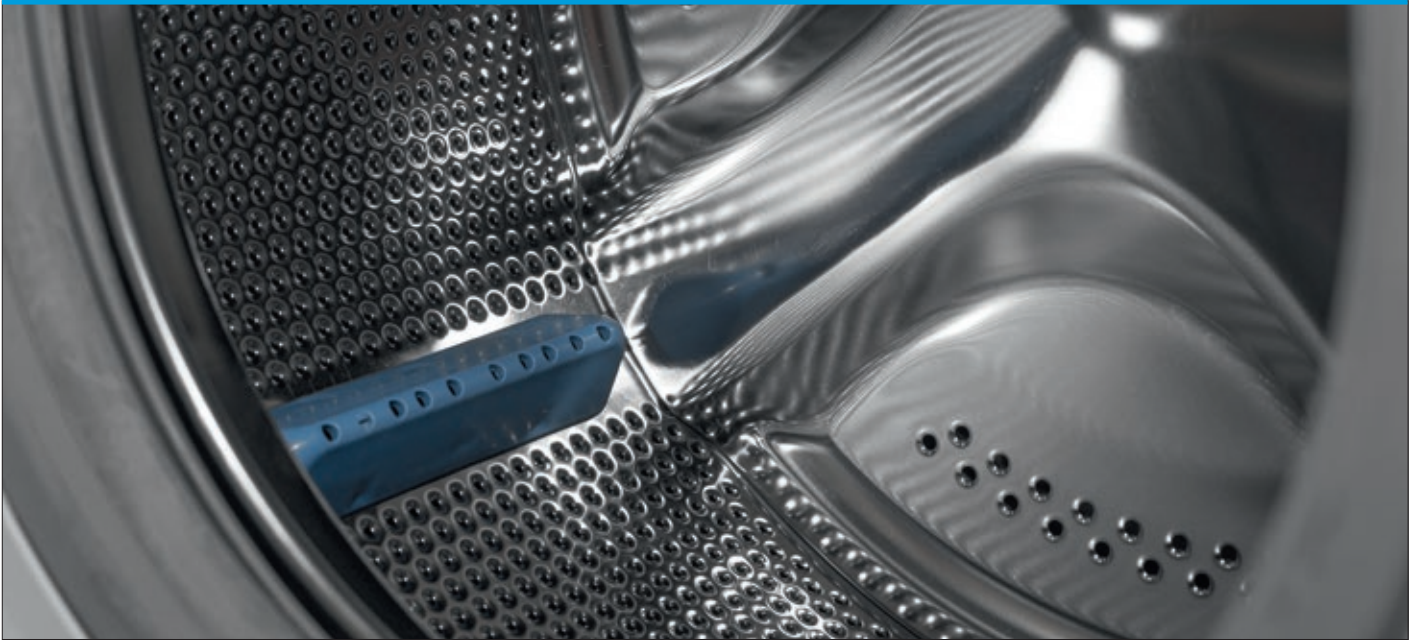


Photo 11 | Washing machine drum

The home appliances market also requires products for applications that are food or even water compliant. In the last years there is an increasing trend to specify materials not only based on performance and regulatory compliance but that also include a more holistic approach to product design, such as:

- Addressing potential risks when materials come in contact with food or water
- Meeting consumer concerns or expectations that are not yet covered by government regulations
- Need for a global supply chain
- Environmental footprint



Photo 12 | Coffee machine



Photo 13 | Large appliances water-line electro-valve housing

Application Development

An integrated CAE virtual environment aids in the design of a component, from the concept phase to the numerical simulation of the moulding process and the optimization of geometry and performance through structural analysis. The use of CAE technology allows for a more efficient development process, while simultaneously enhancing product features, such as lighter weight, safety and performance

RadiciGroup High Performance Polymers CAE Service capabilities include: Process Simulation, Structural Simulation and Integrated Approach.

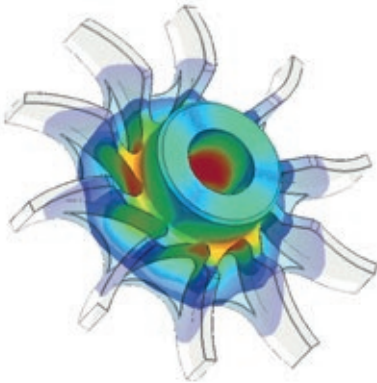
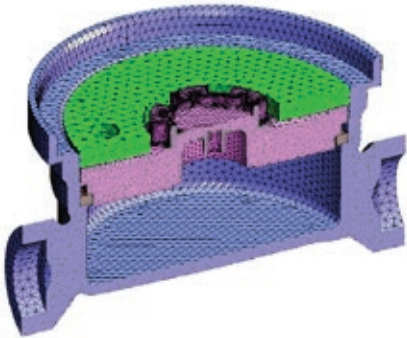
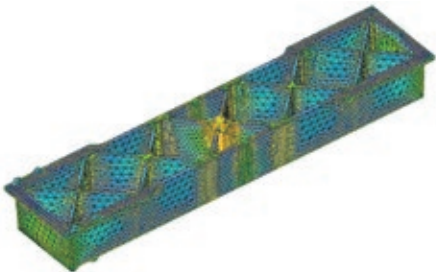
PROCESS	
	<p>Injection moulding</p> <p>Flow, packing, cooling, warpage</p> <p>Prevision of process-related output and defects</p>
STRUCTURAL	
	<p>Static non linear, contact</p> <p>Stiffness, strength, failure</p> <p>Dynamic, impact, vibrations</p> <p>Thermal and thermo-mechanical</p>
INTEGRATED	
	<p>From Process to Structure</p> <p>Anisotropic behavior, GF orientation, welding lines</p> <p>Multi-scale material model</p>

Table I – RadiciGroup CAE services capabilities

RadiciGroup High Performance Polymers CAE Service together with Marketing and Application development team, can provide full support during all phases of the design process. These include:

- Concept phase proposals and consulting.
- Translation of functional requests into material properties.
- Selection of optimal material, either Standard or Special, from RadiciGroup High Performance Polymers range of engineering plastic grades.
- Support and consulting on comparative cost analysis.
- Support and consulting during re-design phase.
- Support with CAE analysis, both process simulation and structural simulation (integrated approach available for advanced projects).
- Environmental impact and LCA analysis: full, certified support on the material side.
- Technical service support during prototyping, moulding trials and part testing.

To request consulting service by the RadiciGroup High Performance Polymers team of experts, please contact:
marketing.polymers@radicigroup.com

HIGH PERFORMANCE POLYMERS

DRINKING WATER APPROVALS



All RadiciGroup High Performance Polymers drinking water contact materials are designed to be compliant to the national requirements for potable water in Germany (DVGW), France (ACS), UK (WRAS) and USA (NSF 61) and meet the current regulations for food contact use according to EU 10/2011 and FDA Title 21.

Although test methods and requirements can vary between different approval agencies, compliance is commonly tested based on stability in water at determined temperature by measuring the release of inorganic and organic substances due to the migration in water from compounds as well as evaluating water odour, flavour and colour.

NATION	STANDARD	REQUIREMENTS
UK	WRAS	Microbial growth, organoleptic & chemical properties
DE	KTW	Organoleptic properties, migration tests
DE	W270	Microbial growth
FR	ACS	Migration tests and cytotoxicity
USA	NSF 61	Migration tests and site audit

Table | Main drinking water certifications

RadiciGroup High Performance Polymers materials are approved by regulatory authorities based on grades, colour and sometimes the manufacturing site. Agency approval certification documents can be used by potable water equipment suppliers to facilitate potable water compliance of the final product. It is the responsibility of our customers to test and certify conformity of their products for the specific end-use.



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