



NORYL™ RESIN BIOFOULING RESISTANCE PROPERTIES

UNIQUE THERMOPLASTIC SOLUTIONS
FOR WATER MANAGEMENT APPLICATIONS

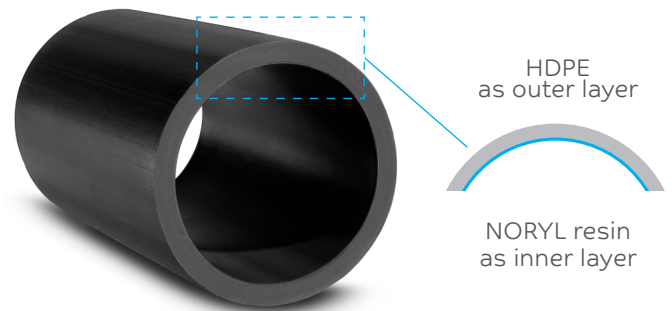
CHEMISTRY THAT MATTERS™

NORYL™ RESIN

BIOFOULING RESISTANCE PROPERTIES

Biofouling or biological fouling can be described as the accumulation of microorganisms, plants or algae on wetted surfaces. This leads to loss of efficiency of membranes and can shorten the lifetime and performance of pipes used in the transportation of drinking water.

NORYL™ resin has unique properties, similar to stainless steel, that result in very low biomass production potential along with excellent hydrolytic stability even in chlorinated environments.



TYPICAL INDUSTRY REQUIREMENTS

- Hygienic and disinfectant (e.g. chlorine dioxide) resistant solution
- Reliable and long term part operation
- Potable water certified applications

NORYL RESIN VALUE

- Low biomass production potential
- Low surface roughness achievable
- High hydrophobicity
- Excellent chlorine resistance
- Potable water approved

NORYL RESIN EXHIBITS BIOFOULING RESISTANCE THAT IS EVEN LOWER THAN STAINLESS STEEL

The table on the right shows the biomass production potential (BPP) per material, using Test Method 1 for EN 16421:2014.

The growth of e.g. Legionella pneumophila, which causes Legionnaires' disease, begins when the biomass production potential is >400 pg ATP/cm²*.

Other factors that influence biofouling:

- Surface roughness
- Degree of hydrophobicity
- Leaching of ingredients from plastics

Material	BPP [pg ATP/cm ²]*
Stainless Steel	45 - 50
NORYL resin, unfilled	40
NORYL resin, glass filled	40
Copper	100 - 193
PVC-C	119 - 417
PVC-U	82 - 365
PVC-P	> 10.000
EPDM	4.129 --> 10.000
SBR	6.281 --> 10.000
PE 40	463 - 1.542
PE 80	355 - 1.750
PE 100	544 - 1.750
PP	352 - 1.393

* Source : "Hydro !", Edition 7, 2015 Article "BIOLOGISCHE ACTIVITEIT IN DRINKWATER" from KWR Institute. pg ATP/cm² = Picogram Adenosine TriPhosphate per cubic centimeter

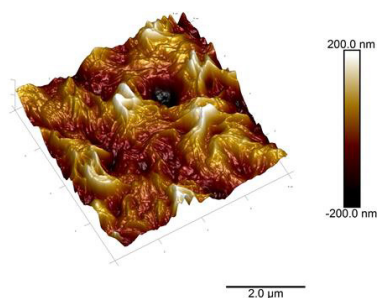
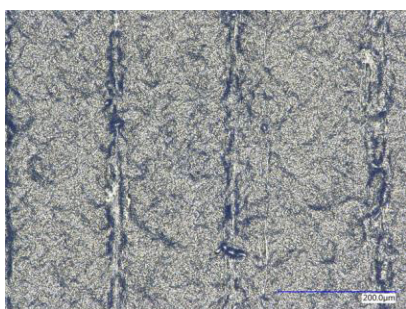
A comparison of surface roughness measured with optical and atomic force microscopy shows that pipes extruded with NORYL™ resin can have smoother surfaces when compared to traditional pipe materials such as HDPE or PVC u.

THE SMOOTHER SURFACE
POTENTIALLY REDUCES
THE RISK OF BIOACCUMULATION

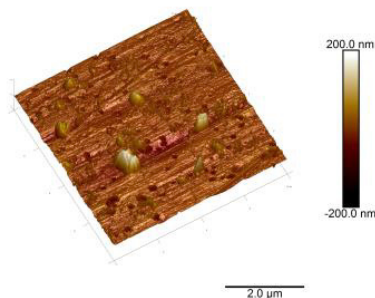
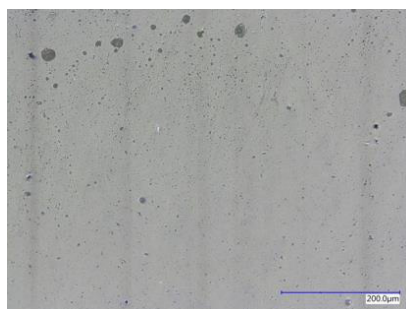
Material	Rq (nm)	Ra (nm)
HDPE	69	54
NORYL™	14	7
PVC	22	11

Table: Measured Surface Roughness

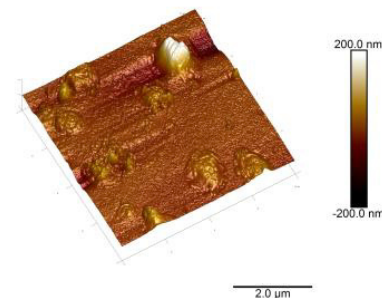
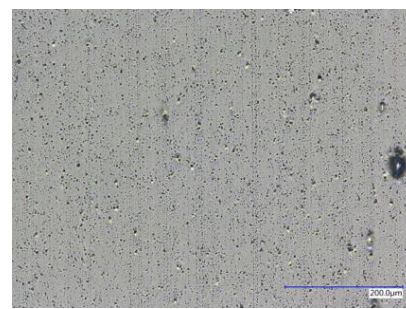
HDPE



UNFILLED NORYL™ RESIN



PVC-u



NORYL™ RESIN CHARACTERISTICS
SUMMARY

- Low biomass p roduction potential
- Smooth surface achievable
- Excellent hydrolytic stability
- Excellent chlorine based disinfectant resistance
- Potable water approved
- Extrusion and injection molding grades available

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