Hydraulically Smooth Bore Pipe.

A good reason for choosing BorECO™ Polypropylene (PP) for gravity sewage and drainage systems.

Introduction

Hydraulically smooth means that the roughness on the wall of the pipe is less the thickness of the laminar sub layer of the turbulent flow. A hydraulically smooth pipe has excellent hydraulic properties that allow fluids to be flow with a minimum head loss. The high abrasion resistance of PP also helps minimize any increase in surface roughness due to abrasion by particles being carried in the fluid.

Hydraulic Considerations - Gravity Flow Systems

The actual sizing of pipes can be an iterative process. The most commonly used simple engineering formula for calculating gravity flows in open channels and partially full pipes is the Manning Formula shown below, which is suitable for using in the structured wall pipe selection process. The Manning formula, known also as the Gauckler–Manning formula, or Gauckler–Manning–Strickler formula in Europe, is an empirical formula for open channel flow or free surface flow driven by gravity.

\[ V = \left( \frac{R^{2/3} \times S^{1/2}}{n} \right) \]

Where:

- \( V \) = is the cross sectional average velocity (metre /second)
- \( n \) = Manning “n” (no units)
- \( R \) = hydraulic radius (m); area of flow divided by the wetted perimeter
- \( S \) = pipe slope or hydraulic gradient (metre fall per / metre length)

When used for calculating pipe flow the cross sectional area of the flow (A) has to be added to the equation, as shown below:

\[ Q = \left( \frac{A \times R^{2/3} \times S^{1/2}}{n} \right) \]

The “n” factor varies both with the degree of roughness of the inside of the pipe and the flow velocity. Higher flow velocities tend to reduce the “n” factor in sewers as solids deposition and slime build-up on the bottom of the pipe is reduced. The relatively low “n” values for BorECO™ PP-B pipes are a result of various factors:

- Smooth, non-porous inside surface of the pipe
- Longer laying lengths (i.e. fewer joints)
- Lower profile gap at the joints
- Higher chemical and abrasion resistance of the material
**BorECO PP grades an ideal solution.**

According to the Darmstadt abrasion test method polyolefin pipes show the lowest abrasion compared to other materials. This is due to their very low surface roughness of approx. 0.007 – 0.011. Because of this, PP pipes have an excellent hydraulic capacity allowing them to drain off waste water even at low gradients. This in turn enables trench depths to be minimized making installation more cost-efficient. The smooth inner-pipe surface also reduces encrustation and the risk of pipe blockage. By designing BorECO™-PP-B gravity systems with Manning value of 0.009, sewers can be installed at shallower gradients thus reducing excavation costs and disturbance. In some cases, it may even be possible to downsize the pipe while maintaining the required flow capacity.

**Example:** For a specific hydraulic radius and the same gradient, if we compare a pipe produced from BorECO™ PP-B and concrete then using Manning’s formula we find that:

\[ Q = (A \times R^{2/3} \times S^{1/2}) / n \]

\[ Q_{pp} \times n_{pp} = Q_{concr} \times n_{concr} \]

\[ Q_{pp} = 0.012 \times Q_{concr} / 0.009 \]

\[ Q_{pp} = 1.34 \times Q_{concr} \]

BorECO™ PP-B pipe provide approx. 34% higher capacity than a concrete pipe for same hydraulic radius and gradient. On the other hand by keeping capacity constant, a BorECO™ PP-B pipe can lead to material’s saving and reduced production/installation time and cost.

**Concluding Remarks**

In the highly competitive segment of sewage and drainage pipes, pipe producers are striving for higher efficiency during the whole production process. BorECO™ PP-B substantially improves the overall quality and the aesthetic appearance of the pipe through a smoother inner surface and reduced waviness for better hydraulic capacity. This high quality inner surface improves the black water flow and eliminates the risk of water stagnation.

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**Typical values of the Manning roughness factor (“n”) for different pipe materials**

<table>
<thead>
<tr>
<th>Material</th>
<th>Manning “n”</th>
</tr>
</thead>
<tbody>
<tr>
<td>BorECO™ PP-B</td>
<td>0.009</td>
</tr>
<tr>
<td>GRP</td>
<td>0.010</td>
</tr>
<tr>
<td>Glazed Clay</td>
<td>0.011</td>
</tr>
<tr>
<td>Smooth Concrete</td>
<td>0.012</td>
</tr>
<tr>
<td>New Cast iron</td>
<td>0.015</td>
</tr>
<tr>
<td>Rough Concrete</td>
<td>0.017</td>
</tr>
</tbody>
</table>

**Additional reading**

3. American Soc. of Civil Eng & Water Pollution Control Fed, Gravity Sanitary Sewer Design and Construction. N.Y

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