

Challenges of Using Low-Sag HDPE Resins in Large-Diameter Thick-Wall Pipe Extrusion

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Introduction

Low-sagging behavior during the extrusion process of high-density polyethylene (HDPE) pipes is a critical challenge, especially when dealing with large-diameter thick-wall pipes. Sagging, caused by the downward flow of the material due to gravity, leads to uneven wall thickness and distribution, increased ovality, non-optimal final product quality, and increased production costs. However, the development of modern "low sag" HDPE resins has revolutionized the production of large-diameter pipes, allowing for thicker walls and improved dimensional control. In this article, we explore the significance of low-sag HDPE resins and their role in enhancing the extrusion process for large-diameter, thick-wall HDPE pipes.

Challenges in Producing Large-Diameter Thick-Wall HDPE Pipes

1. **Sagging Phenomenon:** As the diameter of HDPE pipes increases during extrusion, the thickness of the pipe walls also increases. The slow cooling process during extrusion, governed by the thermal conductivity of PE, results in molten material remaining inside the pipe walls for an extended period. This causes sagging, leading to non-uniform wall thickness, increased ovality, and suboptimal product quality.
2. **Crystallization:** HDPE extrusion processes involve crystallization, with a significant portion occurring during the cooling phase and within the first week of processing. The remaining crystallization may take months to complete, depending on ambient temperature, until a stable crystal structure is achieved.

Importance of Low-Sag HDPE Resins

1. **Counteracting Sagging:** Low-sag HDPE resins possess a tailored polymer architecture with higher molecular weight fractions and low melt flow rate (MFR) that effectively counteracts the sagging phenomenon. These resins prevent the hot melt from flowing downward during extrusion, resulting in more uniform wall thickness and improved dimensional control.
2. **Efficiency and Waste Reduction:** The use of low-sag HDPE resins in the extrusion process enhances efficiency by allowing faster start-up to reach the required dimension tolerances for pipe diameter and wall thickness. Additionally, the reduction in sagging leads to decreased scrap rates and overall waste, resulting in cost savings.
3. **Development of Thick-Wall Pipes:** Low-sag HDPE resins have enabled the production of pipes with larger diameters and thicker walls than previously possible. This breakthrough has opened up opportunities to create pipes with diameters up to 1,200mm and wall thicknesses of 100mm or more.

The Role of Low-Sag PE100 Pressure Pipe Material

Low Sag PE100 Pressure Pipe resin that offers several advantages in large-diameter pipe extrusion:

1. **High Melt Strength:** This material's tailored molecular weight distribution increases the viscosity at low shear rates, providing superior melt strength. The enhanced melt strength prevents sagging during extrusion and ensures better dimensional control.
2. **Improved Mechanical Properties:** BorSafe™ HE3490-SLS-H resin meets PE100 requirements, exhibiting excellent mechanical properties and pressure resistance, crucial for large-diameter pipe applications.
3. **Savings and Quality:** Trials with this material have demonstrated up to 7% material savings and better dimensional control compared to standard PE100 when producing thick-walled pipes. The use of the correct tooling and low-sag material can reduce overweight values, leading to cost savings and improved pipe quality.

Challenges with Low-Sag PE Resins

1. All low sag resins are not the same. Low sag resins that have very stiff rheology have lower stress crack resistance and perform poorly in fatigue testing especially in welded pipes.
2. Butt fusion welding of very thick wall pipe greater than 3inch wall needs to be performed with lower welding pressure. Efforts are under way to propose a new ASTM welding procedure to utilize lower welding pressure for thick wall HDPE Pipe.

Conclusions

Low sag HDPE resins play a vital role in the extrusion of large-diameter thick-wall HDPE pipes. Their unique molecular design, high melt strength, and excellent mechanical properties enable efficient production and dimensional control while minimizing waste and production costs.

By countering the sagging phenomenon, these resins ensure uniform wall thickness and enhance the overall quality of the final product. With ongoing efforts to propose new ASTM welding procedures and advancements in HDPE resin technology, the industry continues to improve the performance and reliability of large-diameter, thick-wall HDPE pipes.