Qualifying a Masterbatch For Use With a Pressure Pipe Resin to Meet PE4710 Pipe Requirements

Dr. Taha H. Abdulla and White G. Jee

Sasol Chemicals North America LLC

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AGENDA

- Background
- Introduction
- Masterbatch Approval Criteria
- Trials
- Barriers
- Conclusion

Background

- **1950**
  - Established
  - South Africa
- **1980s**
  - Polymers (PE, PP, PVC)
- **2017**
  - JV NA (HDPE)
  - Pipe Participant
- **2019**
  - Share Step-by-Step Process

Introduction (1 of 2)

- HDPE Pressure Pipe Applications require the plastics piping system to meet or exceed minimum long-term performance requirements for PE4710 materials/compounds.
- “Salt and Pepper” or machine side blending
- Obtain PPI Independent Listing per TR-4 using guidelines provided in PPI TR-3
- Standard Grade shall meet the requirements of D2837 .

Introduction (2 of 2)

- **Requirements for the Independent Listing for the Standard grade is as follows:**
  - E-10 at 73^{o}F, E-6 at 140^{o}F and 140^{o}F Validation (testing performed at 194^{o}F) on lot 1.
  - E-2 at 73^{o}F, E-10 at 140^{o}F, and 140^{o}F Validation (testing performed at 194^{o}F) on lot 2.
  - E2 at 73^{o}F, E-6 at 140^{o}F on lot 3.

- **Validation:** The process of ensuring that for those materials that exhibit a transition from ductile to brittle failure mode, this transition occurs after 100,000 hours at the rated temperature.

- Based on fulfilling these requirements an Independent Standard Grade listing was granted for a recommended HDB of 1600 psi at 73^{o}F and 1000 psi at 140^{o}F.

Masterbatch Approval Criteria

To ensure a consistent process of selecting a black MB supplier, such criteria was imperative:

- Black Masterbatch shall be Commercially Available
- Black Masterbatch shall be Commonly used in the pressure pipe market
- Black Masterbatch supplier shall be willing to provide a sample and work collaboratively with Sasol during the testing process.
- Black Masterbatch supplier shall be willing to sign a mutual NDA.
- Black Masterbatch supplier shall be willing to undergo Quality Audit.

Working closely with pipe producers on this selection is just as important.

Trials (1 of 4)

- Coordinate Trial with pipe producer, upon agreement with black MB suppliers.

- 1” or 2” pipe is manufactured to the pipe specification based on appropriate ASTM Standards.

- Minimum 100 pipe samples ~ 3 ft long should be collected for each Masterbatch sample to be evaluated.
  - Pipe samples were made using the same natural resin lot so that the black MB samples were the only material component variable during the pipe production.
  - The addition of a black MB could potentially have an effect on the long term service life and thus requires hydrostatic test data to confirm the potential modified compounds’ HDB (Hydrostatic Design Basis) or MRS (Minimum Required Strength).

Trials (2 of 4)

- Per PPI TR-3, the HDB Equivalence requires the following minimum levels of data:
  - E-2 per Part A of TR 3 at 73 ^{o} F
  - E-2 per Part A of TR 3 at the highest other listed temperature (140^{o}F)
  - Validation at the highest listed temperature (testing conducted at 194^{o}F)

Table 1. Equivalency Testing on One Lot of Pipe for each black MB.

LOT ID	73 ° F	140 ° F	Validation	MB
I	Complete	Complete	Complete	A
II	Complete	Complete	Complete	B
III	Complete	Complete	Complete	C
IV	Complete	Complete	Complete	D

Sasol monitored extrusion conditions to understand the impact of adding this black MB

Trials (3 of 4)

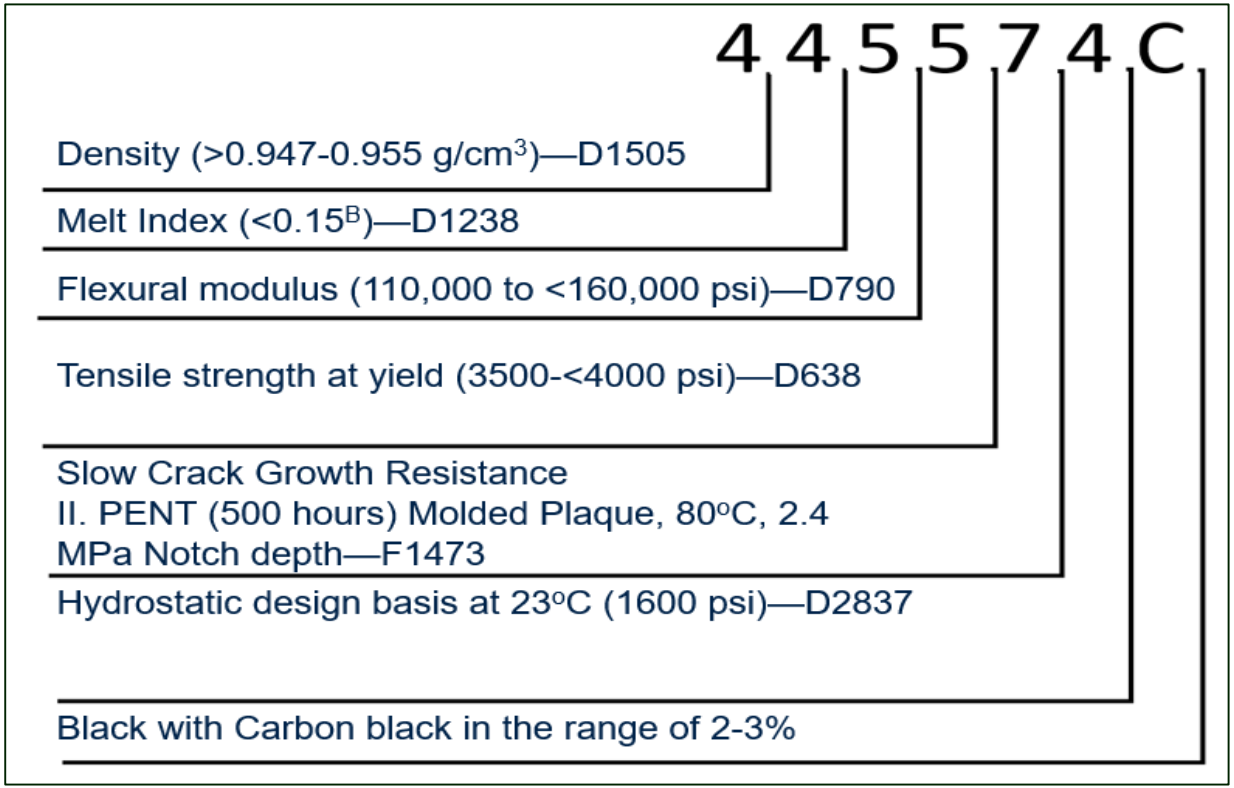
- Since the original black product formulation in which an independent listing was granted had a D3350 cell classification of 445574C or 445576C, it was important to verify that the black MB impact (if any) on the D3350 cell classification short-term properties as follows:

  - For Elongation at Break, all pressure rated materials shall have a minimum extension at break of 400% when tested with 10.1.6 of D3350.

  - Thermal Stability: The material shall contain sufficient antioxidant so that the minimum induction temperature shall be 220 ^{o}C

Trials (4 of 4)

- **Understanding D3350 cell classification of 445574C or 445576C:**



Barriers

There could be some barriers that can potentially prevent a black MB from being approved to qualify for the pressure pipe industry. Some of these barriers are:

- Dispersion of black MB may be less than satisfactory which can result in early failure during hydrostatic pressure tests.
- The black MB carrier resin could be of a material that is not compatible to maintain the long-term HDPE pipe resin performance properties necessary for pressure pipe applications.
- During pipe manufacturing, extrusion settings could result in jeopardizing the integrity of the pressure pipe
- Improper raw materials used for black MB composition

Conclusion

- The intention of this presentation and paper is to serve as a reference as a Step-by-Step guideline on how one would qualify a Masterbatch for use with a pressure pipe resin to meet PE4710 Pipe requirements.

- Following this step-by-step process, Sasol pressure pipe product (natural resin blended with black MB) achieved the following:
  - Listed in PPI TR4 as a PE4710 compound with a recommended HDB of 1600 psi at 23^{o} C and 1000 psi at 60^{o} C.
  - Listed in PPI TR-4 as a PE100 compound with a recommended Minimum Required Strength (MRS) of 10 MPa at 20^{o} C.
  - Listed with NSF International as meeting the requirements of ANSI/NSF Standard 14 for potable water and ANSI/NSF Standard 61 for toxicology components in drinking water.
  - Listed with NSF International as meeting the material requirements in CSA Standard B137.1.
  - Listed with NSF International as having a CC3 chlorine resistance category as defined in ASTM D3350.
  - To-date, there are four black MB products that are approved with the natural pipe resin. Other black MB products are under evaluation using the same step-by-step criteria.

References

1. Plastic Pipe Institute (PPI). TR-4/2018 HDB, HDS, PDB, SDB, MRS, CRS Listed Materials.
2. Plastic Pipe Institute (PPI). TR-3/2018 HDB, HDS, PDB, SDB, MRS, CRS Policies.
3. ASTM D2873, “Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products”.
4. ASTM F17, “Plastic Piping Systems.”
5. ASTM D2513, “Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings.
6. ASTM F714, “Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter.
7. ASTM D3035, “Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.”
8. ASTM D2239, “Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter.
9. ASTM D3350, “Standard Specification for Polyethylene Plastic Pipe and Fittings Materials.
10. ASTM D1603, “Standard Test Method for Carbon Black Content in Olefin Plastics.”
11. ASTM F1473, “Standard Test Method for Notch Tensile Test to Measure the Resistance to Slow Crack Growth of Polyethylene Pipes and Resins.”

Thank you

Questions?

Contact information of presenters:

Taha H. Abdulla

Email: taha.abdulla@us.sasol.com

White G. Jee

Email: white.jee@us.sasol.com