Rework/Regrind Panel
Background and PHMSA Perspective

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Introduction

- **What are we talking about?**
  - Standard Update Rule, specifically ASTM D2513.
  - Committee vote last time concurred with the standard, with the exception of rework
- **Why?**
  - Establish public record, with as much information as possible to help make informed decision
  - Understand all sides of the issue

Outcomes today and going forward

- Obtain committee advice
- Consider big picture with this standard and overall standard update package
  - D2513-09a also includes important changes such as UV exposure limits, transition to a more focused PE only standard, and others

Technical discussions

- PHMSA perspective: Max Kieba
- NAPSR perspective: Massoud Tahamtani
- Manufacturer perspective: Karen Lively
- Gas operator/LDC perspective: Sue Fleck
- Independent Expert perspective: Gene Palermo

Technical Presentation

- What is rework/regrind?
- What does version currently IBR say?
- What does this version and associated technical note say
- Issues with rework/regrind in general
- Issues with wording in standard
- Field perspective
- Other industries/countries

What is rework/regrind

- In PE pipe extrusion process raw material (usually in form of pellets) is melted, mixed and conveyed into die and shaped into pipe
- Rework (also known as regrind) is a process by which pipe that does not fall within acceptable specifications following the extrusion process can be reused if material is reduced in size through appropriate stages (i.e., regrinding the material) and contamination is avoided.

What does ASTM D2513-99 currently IBR say?

- 4.2 *Rework Material-Clean* rework material of the same commercial designation, generated from the manufacturer's own pipe and fitting production shall not be used unless the pipe and fitting produced meet all the requirements of this specification.

What does ASTM D2513-09a say?

- 4.2 *Rework Material*—Clean rework material of the same commercial designation, generated from the manufacturer's own pipe and fitting production shall not be used unless the pipe and fitting produced meet all the requirements of this specification. **The use of these rework materials shall be governed by the requirements of 4.3 and PPI TN-30/2006 In pipe, rework materials shall be limited to a maximum of 30 % by weight.**
- 4.3 *Documentation* —A documentation system to allow for traceability of raw materials including percentage and material classification (or designation, if applicable) of rework materials used in the manufacture of the pipe product meeting the requirements of this specification shall exist and be supplied to the purchaser, if requested.

Concerns with rework/regrind

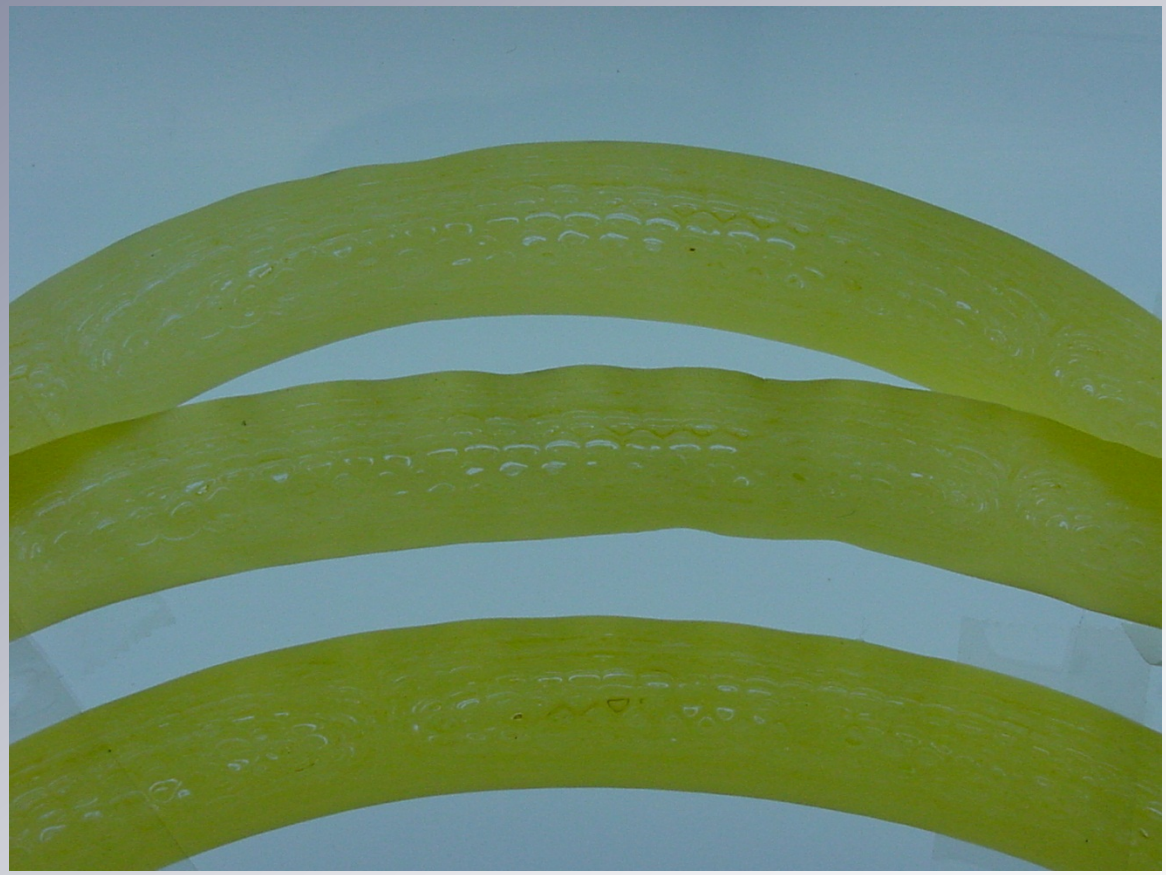
- From PHMSA, PHMSA/NAPSR Plastic Pipe Ad Hoc Committee, and others
  - Potential for contamination
  - Effect on material properties such as dielectric, resistance to slow crack growth (SCG), and resistance to rapid crack propagation (RCP)
  - Issues with plant quality control or lack of standards
- No definitive reports saying whether or not it's an issue
  - OTD report many point to that might support rework has a number of gaps and conflicting statements
  - Other reports on pinhole leaks lean toward rework as a possible contributor, but not definitive
- Lack of reportable incidents directly attributable to rework, but also lack of true root cause(s) analysis on non-reportable incidents to say it's not an issue. Observations through inspections and anecdotal information indicates issues (more in later slide)

Contamination and other issues

- The most problematic contaminant is strapping scraps from the strapping used to hold coils together.
- Rework produces roughly shaped particles of PE which melt differently in the pipe extrusion process. This can cause problems in the extrusion of smaller diameter thinner wall tubing and pipe.
- In past, at least one manufacturer prohibited the use of rework in pipe $\leq$ 2". All rework was sent to larger diameter pipe extruding lines where the thicker walls and slower extrusion rates were considered a much better place to put the rework.
- Generally operator grinding pipe for rework is lowest paid, least experienced worker in the plant. Feeding the grinder in grinding pipe for rework is not a highly desired job in any plant. It is a process where mistakes can easily take place.

Contamination examples

Uneven Mixing of Regrind



Current methods to help reduce contamination – still some issues

- Screen packs on the pipe extrusion line will typically catch many contaminants but cannot completely eliminate contaminant inclusions from occurring.
- Thermoplastic contaminants will typically be held up on the screen pack but extrusion pressures can push them through the screen pack.
- Nylon, polyester and clear strapping contamination have been found in both black HDPE gas pipe and yellow MDPE gas pipe production. With the case of the yellow MDPE gas pipe there were screen packs on the extrusion line.

Cross Contamination

- Other types of contaminants include inorganic salts and other materials caused by cross contamination in the manufacturing process.
- In a PE pipe plant manufacturing both water and industrial pipe and gas pipe, cross contamination of these other pipes could occur.
- Cross contamination of PE water pipe scrap with PE gas pipe scrap has occurred in the past. This would be less of a problem with black HDPE pipe compounds but would be a problem with yellow MDPE gas pipe.

Concerns with standard and PPI-TN 30

- Standard says up to 30% rework allowed… with respect to what?
  - Neither standard nor PPI TN specify if that's limited to one run or overall. It appears there are unlimited times that manufacturer can keep running 30% through. Does this converge towards 100%? Regardless, how can you properly measure and track?
- Is 30% too high?
  - High levels of rework (on order of 30%) are indication that the manufacturing process for making pipe is not in control.
  - Rough measure of good manufacturing is first pass in-specification product should meet the three sigma rule (97% in specification) for standard deviation. This would allow for level of 3% rework. Industry sources have confirmed this indicator as a good rule of thumb.
  - The same industry sources have indicated that levels of 6% rework did occur in plants that were considered as having more manufacturing upsets and problems.

Other issues with standard

- Section 4.3 calls for documentation on amount of rework
  - Many manufacturers have claimed that is difficult if not impossible to do, particularly if reworking multiple times
  - Operators have requested manufacturers to put percentage of rework on print line of pipe; manufacturers have been resistant
- Two separate but interrelated work group items underway
  - Eliminating rework from D2513
  - Addressing contamination

Field Observations - anecdotal

- Evidence of pinholes in PE pipe due to contaminated rework. Leak repair requires O&M dollars. May create long term integrity and safety issues
- Rework mixing not homogeneous; as result voids have been observed. Could result in stress risers and slow crack growth initiation.
- The antioxidant content diminishes with cycling of rework material
- Process control and QA/QC in plant is lacking or subject to human error
  - Potential for mixing resins and other materials are great as same plant produces pipe for different applications than natural gas.
  - Observed cases were material comes out of the grinder on to floor, and just swept right up back into grinder
- Many operators in U.S. do not allow rework. Don't have to per current code and standard, but based on issues observed, "right thing to do" and best practice. After prohibiting, reduction in many of these issues.

Other Industries in U.S.

- In U.S.
  - Nuclear does not allow scrap or regrind for HDPE used in safety critical systems via code case N-755. Virgin material required.
  - Electric
    - Poor performance of polyethylene insulation materials subjected to chronic voltage stress
    - Studies have shown there are factors which initiate the dielectric material breakdown process. Material breakdown characterized by microscopic channel-like growths in solid dielectric materials (“treeing”).
    - Tight standards and quality control procedures are employed to insure the cleanliness of insulation compounds.

Other countries

- Considerations at Canadian CSA to prohibit rework
- Many operators overseas don't allow rework
- Other countries have pre-compounded materials vs. salt and pepper in U.S., so overall process is different

References

- GRI-96/0014, *Analysis of Microscopic Leaks in Polyethylene Gas Distribution Piping*.
- Electric Power Research Institute (EPRI) and the Phelps Dodge Cable and Wire Company, *Electrochemical Treeing in Cable.* (January 1978)
- Takao Miyashita (IEEE Member), *Deterioration of Water Immersed Polyethylene-Coated Wire by Treeing*. (March 1971)