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Oxidation and Polyethylene Piping Systems:
"A Closer Look"
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The polyethylene pipe industry continues to pioneer research and development of new higher performing materials and innovative test methods that provide utilities and consulting engineers with data and knowledge on state-of-the art HDPE potable water piping systems. To that extent, the Plastics Pipe Institute, the Alliance for PE Pipe, and Jana Laboratories, the world's leading authority on oxidation testing, published a report in cooperation with several U.S. water utilities that assesses the service lifetimes of HDPE pipes in selected disinfected potable water applications. This report is the first comprehensive document that examines and explains the potential failure mechanisms of PE piping systems in disinfected potable water systems and forecasts the service lifetimes based on actual operating conditions and materials. Utilizing the research and testing methodologies that have been developed and refined over the last decade, the report identifies that high performance, current generation HDPE pipe materials are projected to have greater than 100 year service life in a wide range of potable water systems as summarized in Table 1. The research project is ongoing and will result in design criteria to assess HDPE performance in oxidative environments that will be proposed to the AWWA 263 Polyolefin Pipe Standards Committee.

Table 1: Standard operating conditions in specific US utilities and projected service life per ASTM F2263-07[2, *] for higher performing, current generation HDPE AWWA C901* service tubing materials

	Indiana	Florida	North Carolina	City of Palo Alto, CA	Utility with Average Operating Conditions	Utility with Aggressive Operating Conditions
DR (C901* ½" CTS Service Tubing)	11	11	11	11	11	11
Avg. disinfectant residual and type	1.6 ppm Chloramine	1.4 ppm Chloramine	0.9 ppm Chlorine	1.9 ppm Chloramine	-	
Avg. pH	7.7	9.3	8.6	9.0	-	-
Estimated ORP**	650 mV	650 mV	680 mV	650 mV	650 mV	825 mV
Avg. water temperature	57 °F	79 °F	68 °F	61 °F	57 °F	59 °F
Avg. operating Pressure	70 psi	70 psi	70 psi	65 psi	70 psi	70 psi
Projected performance of an AWWA C901* ½" CTS in the brittle oxidative regime	All >100 years					

*for larger AWWA C906 water mains operating at the referenced conditions, the projected life will approximately be twice as much as shown in Table 1

**50% of US population receives water with an ORP below 650mV and 80% with an ORP below 750mV; refer to Jana Lab Report[1].

PPI's goal is to ensure that the decision to use a material for potable water piping applications is made considering all accurate, complete and valid data. It is urged that readers reference the comprehensive Jana Labs research report which examines these specific issues and is available online at www.janalab.com/pdf/disinfection.pdf. Details upon which the new report has shed fresh light include answers to questions like:

1. Can the analytical methods (Bend back, FTIR and OIT) used to quantify oxidation and antioxidant content in PE pipe be used to project service life? ***While these methods may be used to characterize aging mechanisms in many different materials, they do not correlate, by definition, to lifetime or to long term performance. For the whole story, a detailed discussion of these methods and a presentation of a technically proven method of lifetime projections are provided in the Jana Labs Report[1].***

2. Have AWWA or ASTM addressed the issue of oxidative degradation in PE pipes in a manner useful to designers and owners of water pipelines? ***At present, and consistent with the practice of other pipe and material standards, strength ratings in AWWA standards are not reduced for potential in-service degradation mechanisms such as internal or external corrosion and oxidation. Nevertheless, the HDPE industry is leading a development of performance requirements as illustrated in the Jana Labs Report[1] so as to help designers address this topic.***

3. Has the PE industry been able to correlate the performance of PE pipe under aggressive operating conditions vs. the performance in the lab? ***Jana Labs applied the validation technology as described in the Report[1] to a utility which recently reported shorter than initially expected life cycle. Based on testing to ASTM F2263, it was shown that the older generation PE materials are projected to have an average service life of about 24 years; consistent with field experience. Further, higher performing current generation materials are projected to have greater than 50 years performance in this very aggressive environment. This provides a field validation of the ASTM F2263 methodology and offers confidence in the performance of the higher performing current generation materials in potable water applications.***

4. Can designers and owners use the PPI standard chemical compatibility charts that are based on unstressed samples to predict field failures? ***PPI TR-19 for Chemical Resistance is a good reference to see whether there may be chemical factors that should be considered, but it is not meant to be a final recommendation. Alternately, extrapolations in the Jana Labs Report[1] are based on stressed pipe specimens tested at accelerated conditions and exhibit the same failure mechanism as observed in field-aged specimens, so this methodology would be more directly applicable to potable water service conditions.***

5. Can designers and owners predict service life of HDPE piping systems nationwide based on performance in systems that use chlorine dioxide for a secondary disinfectant? ***In short: No. Surveys conducted by Jana Labs indicate that chlorine dioxide is used by less than 1% of water utilities in the US as a secondary disinfectant[1].***

6. Can designers and owners predict service life of distribution and transmission HDPE piping systems based almost exclusively on AWWA C901, small diameter tubing? ***The Jana Lab research discussed the effect of disinfectants on small tubes and large diameter mains and is detailed in the Jana Lab Report[1].***

REFERENCES

1. M. Conrad and K. Oliphant, *Impact of Potable Water Disinfectants on PE Pipe*, 2010, Jana Laboratories, Inc., Aurora, Canada, prepared for Plastics Pipe Institute, Irving, TX http://www.janalab.com/pdf/disinfection.pdf
2. ASTM F 2263-07, *Standard Test Method for Evaluating the Oxidative Resistance of Polyethylene (PE) Pipe to Chlorinated Water*, West Conshohocken, PA, 2007.