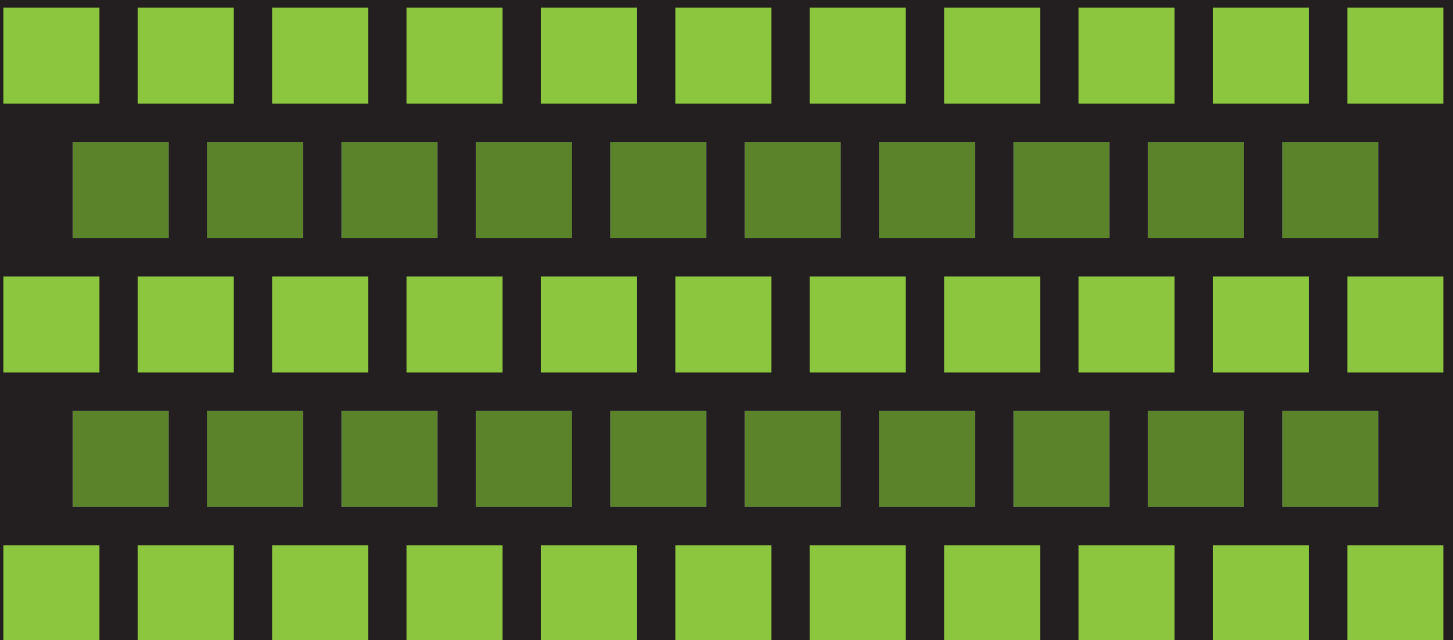


STP-PT-014

DATA SUPPORTING COMPOSITE TANK STANDARDS DEVELOPMENT

FOR HYDROGEN INFRASTRUCTURE APPLICATIONS



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FOREWORD

Commercialization of hydrogen fuel cells, in particular fuel cell vehicles, will require development of an extensive hydrogen infrastructure comparable to that which exists today for petroleum. This infrastructure must include the means to safely and efficiently generate, transport, distribute, store and use hydrogen as a fuel. Standardization of pressure retaining components, such as tanks, piping and pipelines, will enable hydrogen infrastructure development by establishing confidence in the technical integrity of products.

Since 1884, the American Society of Mechanical Engineers (ASME) has been developing codes and standards (C&S) that protect public health and safety. The traditional approach to standards development involved writing prescriptive standards only after technology has been established and commercialized. With the push toward a hydrogen economy, ASME has adopted a more anticipatory approach to standardization for hydrogen infrastructure which involves writing standards with more performance based requirements in parallel with technology development and before commercialization has begun.

The ASME B&PVC Standards Committee appointed a project team to develop new Code rules in the for hydrogen storage and transport tanks to be used in the storage and transport of liquid and gaseous hydrogen and metal hydrides. Rules for gaseous storage tanks with maximum allowable working pressures (MAWPs) up to 15,000 psig (100 MPa) will be needed. Research activities are being coordinated to develop data and technical reports concurrent with standards development and have been prioritized per Project Team needs. This Technical Report has been developed in response to Project Team needs and is intended to establish data and other information supporting separate initiatives to develop ASME standards for the hydrogen infrastructure.

Established in 1880, the American Society of Mechanical Engineers (ASME) is a professional not-for-profit organization with more than 127,000 members promoting the art, science and practice of mechanical and multidisciplinary engineering and allied sciences. ASME develops codes and standards that enhance public safety, and provides lifelong learning and technical exchange opportunities benefiting the engineering and technology community. Visit www.asme.org for more information.

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ABSTRACT

Composite cylinders have been used for over 50 years in commercial, vehicle, defense and aerospace applications. New materials, processes, design approaches and applications have been incorporated during that time. The industry has maintained a high level of safety. The industry has adapted to these changes and has developed new and revised standards to address these changes and to reflect a better understanding of service conditions.

Recommendations are made that the industry:

- Continue to monitor field use and incorporate changes to requirements, standards and codes that reflect knowledge gained for composite pressure vessels,
- Use a failure modes and effects analysis (FMEA) approach to standards, using the knowledge gained from field experience,
- Develop standards for composite pressure vessels that are more performance based to improve both safety and performance,
- Address requirements using performance testing, not by using excessive safety factors,
- Use stress ratios for the various reinforcing fibers that accurately reflect their stress rupture and fatigue characteristics to achieve high reliability,
- Harmonize testing requirements where practical,
- Use qualification tests that are appropriate for the application and for the materials and design features of the pressure vessels being used, and
- Consider using fleet leader programs for new materials, designs or applications if there is likely to be a significant safety issue

To support these recommendations, history of use of composite cylinder in aerospace/defense, commercial and vehicle applications is reviewed. This includes review of applications, materials of construction; standards used and field service issues.

The use of performance-based requirements is discussed, as is the background of safety factors used for various reinforcing fibers. Recommendations are made for validation testing of materials and pressure vessels, with consideration for failure modes and effects analysis (FMEA) involving the field use of the vessels.

Cyclic fatigue and stress rupture are discussed, with examples of laboratory testing and correlation from field experience.