FILAMENT WOUND COMPOSITE PRESSURE VESSELS FOR HYDROGEN ENERGY STORAGE

*Pranjali Sharma, Swati Neogi**

[*]Department of Chemical Engineering, Indian Institute of Technology Kharagpur, West Bengal – 721302, India

ABSTRACT

The adverse effects of global warming are increasingly deteriorating the quality of life, disturbing the ecosystems, and misbalancing the flow of many natural phenomena. The energy-consuming sectors are in dire need of transformations promoting decarbonization of the carbon-emitting sources. The transportation sector being one of the top contributors, need to increase its reliance on renewable energy sources. We are in strong need of reformations capable of replacing fossil fuels with green energy sources by building efficient utilities for production, transportation, distribution, storage, and refueling solutions for renewable energy sources. Commonly used green energy sources include batteries, hydrogen, bio-fuels, bio-methane, wind power, thermal/photovoltaic/concentrated solar power, hydropower, nuclear power, tidal power, geothermal energy, and ambient heat captured by heat pumps. Most of them cannot be potentially used as ultimate solutions in the transportation sector, as they are capable of powering some but fail for the other sub-sectors. Therefore, hydrogen is identified as the ultimate solution for decarbonizing the entire transportation sector. The research community is continuously working on developing better production, distribution, transportation, storage, and refueling solutions for hydrogen utilization. This study focuses on enhancing the developmental technique of filament wound composite pressure vessels for storing compressed hydrogen gas. They are developed following a classical route of optimizing the design, manufacturing parameters, and raw material properties using manufacturing trials followed by preliminary testing based on the performance requirements for a particular application. This study

investigates the development of a performance-based design, virtual manufacturing, and testing platform to obtain the optimal design of a composite cylinder with any volumetric capacity, working pressure, service temperature, fatigue life, and weight. The cost of manufacturing such cylinders for determining their techno-commercial viability is also estimated using the developed platform. Four prototypes with different composite overwrap designs, liner geometries, liner materials, and manufacturing parameters have been manufactured and performance tested for validating the developed platform. The details of a parametric study, conducted to obtain the optimal liner geometry and the composite overwrap design yielding better performance using the obtained platform, are included in this study.

Keywords: *Composite cylinders, virtual manufacturing platform, virtual testing platform, optimal composite overwrap design, fiber volume fraction, filament winding technique*