Hybrid Wound Filaments for Greater Resistance to Impacts

PBO fibers are used in addition to high-strength carbon fibers.

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The immediately preceding article includes an example in which a composite overlap on a pressure vessel contains wound filaments made of a hybrid of high-strength carbon fibers and poly(phenylene benzobisoxazole) (PBO) fibers. This hybrid material is chosen in an effort to increase the ability of the pressure vessel to resist damage by low-speed impacts (e.g., dropping of tools on the vessel or bumping of the vessel against hard objects during installation and use) without significantly increasing the weight of the vessel. Hereetofore, enhancement of the impact resistances of filament-wound pressure vessels has entailed increases in vessel weight associated, variably, with increases in wall thickness or addition of protective materials.

While the basic concept of hybridizing fibers in filament-wound structures is not new, the use of hybridization to increase resistance to impacts is an innovation, and can be expected to be of interest in the composite-pressure-vessel industry. The precise types and the proportions of the high-strength carbon fibers and the PBO fibers in the hybrid are chosen, along with the filament-winding pattern, to maximize the advantageous effects and minimize the disadvantageous effects of each material. In particular, one seeks to (1) take advantage of the ability of the carbon fibers to resist stress rupture while minimizing their contribution to vulnerability of the vessel to impact damage and (2) take advantage of the toughness of the PBO fibers while minimizing their contribution to vulnerability of the vessel to stress rupture.

Experiments on prototype vessels fabricated according to this concept have shown promising results. At the time of reporting the information for this article, research toward understanding and