ABSTRACT

The use of composite materials is increasingly diverse along with technological advances in various fields. Carbon fiber is a composite material which is widely used because it has good mechanical properties, corrosion resistant, has a high strength-to-weight ratio. One application of the use of carbon fiber composite materials which are very open development opportunities is for pressure vessel.

This research presented the design, manufacturing process, and testing of carbon composite pressure vessel. The design process included composite pressure vessel design, mold design, and bladder design. Composite pressure vessel were made of carbon fiber and epoxy resin matrix as much as six layers on the tube wall, this research was done by varying the angle of orientation of carbon fiber on the shell which was a variation of $[(0/45)_3]$, $[(0_2/45)]_s$, and $[(45/0_2)]_s$. The manufacturing process was carried out by wet bladder compression molding method by using two molds of upper and lower fiberglass material, and by using bladder or pressure bags from latex to press composite material. Pressure vessel testing included hydrostatic testing, flexural testing, compressive testing, and density testing. Hydrostatic tests were performed by a manual test pump to test the strength of the tube.

Hydrostatic testing results showed carbon composite pressure vessel could withstand hydrostatic pressures of up to 18 bar in variation of $[(45/0_2)]_s$ with porosity value of 1.88%. In flexural testing, the highest bending strength was obtained at 274 MPa in variation of $[(0_2/45)]_s$. Variation of $[(45/0_2)]_s$ had the best resistance to force of 15 kN in vertical and horizontal directions with an average deformation of 5.025 mm.

Keywords: bladder compression molding, composite pressure vessel, carbon fiber.

INTISARI

Penggunaan material komposit semakin beragam seiring dengan kemajuan teknologi di berbagai bidang. Serat karbon merupakan material komposit yang banyak digunakan karena memiliki sifat mekanik yang baik, tahan korosi, memiliki rasio kekuatan terhadap berat jenis yang tinggi. Salah satu aplikasi penggunaan material komposit serat karbon yang sangat terbuka peluang pengembangannya adalah untuk tabung gas.

Penelitian ini akan menyajikan desain, proses manufaktur, dan pengujian tabung gas komposit karbon. Proses desain meliputi desain tabung gas komposit, desain cetakan, dan desain *bladder*. Tabung gas komposit terbuat dari serat karbon dan matriks epoksi resin sebanyak enam lapis pada dinding tabung, penelitian dilakukan dengan memvariasikan sudut orientasi serat karbon pada dinding tabung (*shell*) yaitu $[(0/45)_3]$, $[(0_2/45)]_s$, dan $[(45/0_2)]_s$. Proses manufaktur dilakukan dengan metode *wet bladder compression moulding* yaitu dengan menggunakan dua buah mould dari material *fiberglass* bagian atas dan bawah, dan dengan menggunakan *bladder* atau kantung bertekanan dari *latex* untuk menekan material komposit. Pengujian tabung gas meliputi pengujian hidrostatis, pengujian *bending*, pengujian tekan, dan pengujian densitas. Uji hidrostatis dilakukan menggunakan manual test pump untuk menguji kekuatan tabung.

Hasil pengujian hidrostatis menunjukkan tabung gas komposit karbon dapat menahan tekanan hidrostatis hingga 18 bar pada variasi $[(45/0_2)]_s$ dengan nilai porositas sebesar 1.88%. Pada pengujian *bending* didapatkan kekuatan *bending* tertinggi sebesar 274 MPa pada variasi $[(0_2/45)]_s$. Variasi $[(45/0_2)]_s$ memiliki ketahanan terbaik terhadap gaya tekan 15 kN arah vertikal dan horisontal dengan deformasi rata-rata sebesar 5.025 mm.

Kata kunci *: bladder compression moulding,* tabung gas komposit, serat karbon.