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A.V. Kreptiuk Ph.D.
Mykolaiv, Ukraine

OVERVIEW OF CURRENT STATE IN DESIGNING AND BUILDING OF COMPOSITE PRESSURE RESISTANT HOUSINGS FOR UNDERWATER APPLICATION AND PERSPECTIVE DIRECTIONS FOR FURTHER IMPROVING DESIGNS

А.В. Крептюк канд. техн. наук

ОГЛЯД СУЧАСНОГО СТАНУ КОНСТРУЮВАННЯ ТА ПОБУДОВИ МІЦНИХ КОРПУСІВ ІЗ КОМПОЗИЦІЙНИХ МАТЕРІАЛІВ ДЛЯ ТЕХНІЧНИХ ЗАСОБІВ ОСВОЄННЯ ОКЕАНУ ТА ПЕРСПЕКТИВНИХ НАПРЯМКІВ ДЛЯ ПОДАЛЬШОГО УДОСКОНАЛЕННЯ КОНСТРУКЦІЙ

For unmanned autonomous underwater vehicles and manned submersibles pressure resistant housing are usually designed from sections of traditional forms: cylinder, sphere, cone etc. and fiber reinforced composites are widely used as construction materials for them (fig. 1).

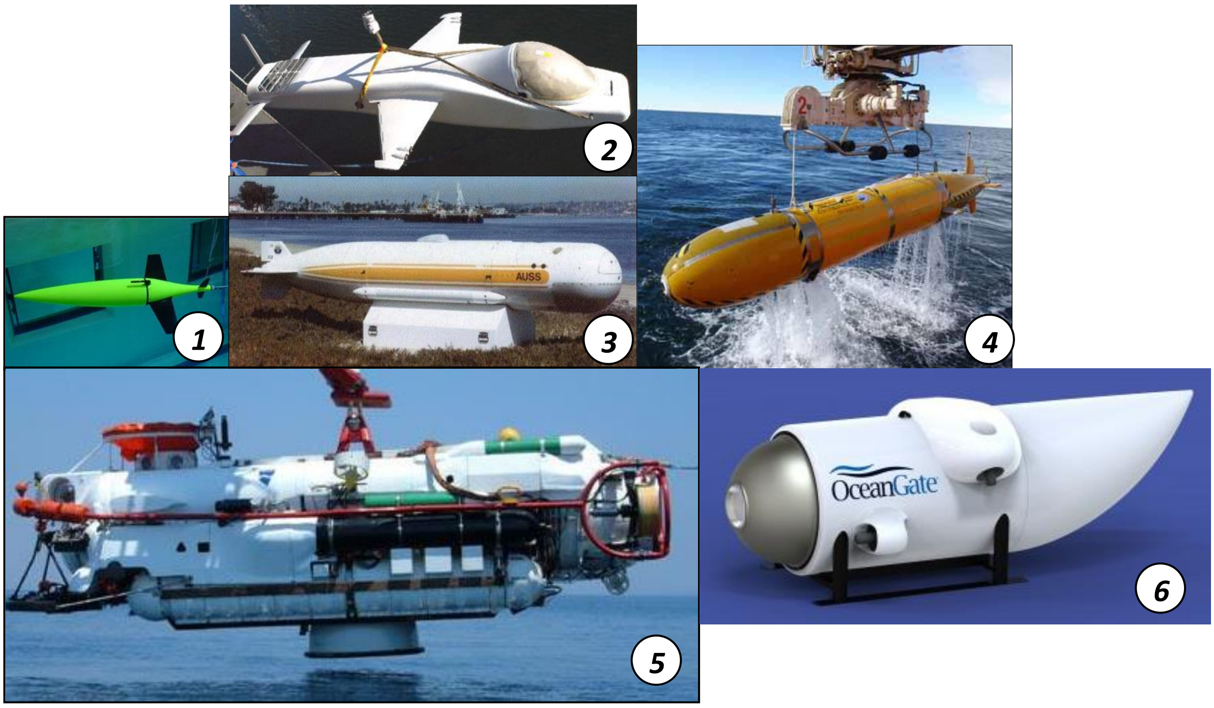

Figure 1. Unmanned autonomous underwater vehicles and manned submersibles with carbon (glass) fiber wound center section of the pressure resistant housings:

1 − underwater glider Deepglider* (University of Washington, USA); 2 − DeepFlight Challenger (Hawkes Ocean Technologies, USA); 3 − AUSS (SSC SD, USA);

4 − Autosub-3 (Southampton Oceanography Center, Great Britain);

For today laminated composite shell components (cylindrical, spherical, conical, toroidal hulls (sections), end closures, hatches) of pressure housings are manufactured using different fabrication methods: filament winding (or hybrid lay-up/filament winding), vacuum injection or lay-up. The most composite sections are manufactured by filament winding. Filament wound tubes are center sections of many pressure resistant housings of underwater vehicles (fig. 1 (2-4, 6)) and such hydrostatically loaded structures as submarine missile torpedoes, profilers (fig. 2 [1]) and others. The vacuum injection method makes it possible to produce cost-effective and durable structures of complex shapes for ocean engineering: end closures and hatches for pressure housing, underwater storage tanks.

The pressure housing for underwater application is a pressure vessel. [2] And some engineering firms designing and manufacturing composite pressure vessels and tanks for transportation and storage corrosive liquids had been developing composite storage tanks for undersea conditions (for example, Brigham City company for NASA).

Figure 2. Deep-Arvor

New developing fabrication methods such as additive manufacturing, automated fiber placement (AFP) and tailored fiber placement (TFP – so called “fiber printing” [3]) are perspective for building hydrostatically loaded shell structures with thickness variations.

German researchers (University of Rostock) [4] have investigated the capability of additive manufacturing technologies to build pressure housings from titanium and ceramic. The investigations demonstrate that it is possible to build pressure housings designed with a stiffened variation in an additive manufacturing process. By the way today some components from metal alloys for shipbuilding are successfully built in an additive manufacturing process and Korea is going to build ship hull by 3D-printing in near future. (on the materials of http://www.3ders.org/).

So novel manufacturing techniques give ocean engineers new possibilities to realize advantages of fiber reinforced composites and to simplify building of metal and ceramic shell structures for improving pressure housing designs.

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