An overview of Composite Pressure vessel development and manufacture

The need to have easily transportable high pressure gases has led to the development and manufacture of Composite Pressure vessels. The trend first started with the requirement for lightweight high pressure vessels for breathing equipment in fighter aircraft and today has developed into more commercial higher volume applications. Typical volume applications now include lightweight breathing apparatus for the fire fighting services and high pressure Compressed Natural Gas (CNG) applications in the transport industry.

These types of pressure vessels are designed to have a working pressure in the region of 300 bar (4,300 psi) and traditionally were manufactured from deep drawn and spun steel making the vessels extremely heavy.

With the drive to manufacture lighter vessels, aluminium was used, although the weight savings were not so great as the vessel wall thickness had to be increased considerably due to the lower physical properties of aluminium.

In the early 1980’s composite reinforcement was introduced commercially as a means of reducing the overall weight of the aluminium vessels. Initially these were thinner walled aluminium vessels that were ‘hoop’ wrapped with glass fibre and resin on the parallel wall.
Many of these types of vessels are still produced but now include more exotic materials such as ‘S’ type glass, carbon and aramid fibres.

As carbon and aramid raw material costs reduced and the drive for weight saving became more crucial ‘full wrap aluminium cylinders were produced to further reduce the overall weight whilst still maintaining the same pressure capabilities. These vessels are typically in Glass or carbon with glass over-wrap for abrasion resistance.

Currently work is underway in developing plastic lined vessels although there are still issues to resolve between the liner and fitting interface and this is proving technically challenging. 99.9% of all commercial vessels still use aluminium liners.

The production of ‘full wrap’ cylinders requires a more sophisticated winding machine typically 4 – 6 axes of CNC control. Typical production machines are usually multi-spindle (2 –5 spindles depending on the vessel size and product quantities) and have 4 axes of CNC. For more sophisticated requirements such as ‘Delta winding’ these use 6 axes and are typically single spindle.

Composite pressure vessels have to go through a series of stringent tests to comply with the regional regulatory authority. In the UK this is British Standards, USA – DOT (Department of Transport) Germany - TUV etc etc. Europe is now moving towards a European standard throughout the European community.
Data Acquisition:

As part of this qualification procedure Pultrex have designed and developed special data acquisition software to enable the full traceability of both the winding and cure processes. This greatly eases the process of attaining qualification by the regulatory authority. The software is windows based and allows the following Data to be acquired and logged:

- Vessel serial number
- Aluminium liner lot code and batch number
- Fibre type, size and batch number
- Fibre band width
- Number of fibres/vessel
- Quantity of fibres used
- Fibre tension setting
- Estimated fibre volume
- Fibre break occurrence during the wind
- Fibre spool change during the wind
- Oven cure temperature
- Wind time
- Month and year of manufacture
- ‘Do not use after’ date
Typical Data Acquisition screens
The above gives some indication of Pultrex’s expertise and capability in the manufacture of Composite pressure vessels. Collaboration with Pultrex will allow you to become one of the world leaders in composite pressure vessel manufacture.

Pultrex has over 38 years’ experience in the manufacture of High quality, precision Filament winding machines.

Our MODwind range of filament winding machines is fitted with Siemens control systems allowing local worldwide support and repair in your native language.

With our MODwind range of MODular Filament winding machines we are able to tailor the equipment requirements to meet your specific needs from a multi-spindle, multi axis production machine to a very high specification single spindle research and development machine.