

# Tanks, Vessels & Fabrications

GRP/THERMOPLASTICS  
DUAL LAMINATES



# FORBES



PLASTICS TANKS AND  
ENVIRONMENTAL TECHNOLOGIES

# Tanks, Vessels & Fabrications

## THERMOPLASTICS DUAL LAMINATES

- 'Dual laminate' GRP combines the outstanding strength of GRP with the high chemical resistance of a thermoplastics inner shell.
- Dual laminate tank design is not limited to available moulds or mandrels, sizes can be determined to suit the requirements of the application precisely.
- Design freedom extends to tanks in vertical or horizontal cylindrical configurations; even rectangular tanks and irregular fabrications are achievable.
- Choice of thermoplastic inner shell materials allows a wide range of chemical resistance and operating conditions to be accommodated
- Only GRP tanks are covered by the comprehensive standard BS4994:1987
- All Forbes dual laminate tanks incorporate conductive material behind the weld lines and nozzle penetrations so that the integrity of the tank can be proven by spark testing throughout its working life.
- Although light and easy to handle, the substantial strength achievable with GRP dual laminate permits structures to be designed with integral steelwork such as ladders, handrailing, platforms and agitator bridges.
- It is straightforward to include side access manways when building dual laminate GRP tanks.
- Dual laminate tank technology is now accepted as standard in all industries – from chemicals to food, microelectronics and offshore oil and gas.



## BS4994:1987

### THE DESIGN AND CONSTRUCTION OF VESSELS AND TANKS IN GLASS REINFORCED PLASTICS

High quality production has always been vital for Forbes as so many of the company's products are dedicated to specialised and hazardous duties. For many years we have been producing tanks and pressure vessels to this demanding standard which describes various categories of production in great detail – even prescribing working conditions and the structure of fittings. Forbes is approved by leading inspection and insurance companies to manufacture to all categories of the standard.

**The broad compass and thoroughness of BS4994 make it an invaluable aid to those preparing risk assessments and safety plans.**

**BS4994 covers the design, manufacture, transport and installation of tanks and vessels in GRP (glassfibre reinforced plastic) materials. It is a very thorough and stringent standard. IT DOES NOT deal with any aspect of the manufacture of tanks in other materials such as metals or freestanding thermoplastics. For advice talk to Forbes on +44(0)1366 388941.**

**DVS 2205** There is still no universal standard for the design of thermoplastics tanks although a European (CEN) standard is in preparation. In the meantime some manufacturers have been drawn to this German standard. Critics have pointed out that some aspects of DVS 2205 are basic and that in several crucial areas it refers inappropriately to metal design codes. To help specifiers evaluate DVS 2205 against BS 4994 we have prepared some guidance notes, please ask our sales department for a complimentary copy. Please also ask for a copy of our leaflet 'Thermoplastics Tanks'.

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## GRP

Glass fibres have excellent tensile strength, are non-combustible and chemically resistant, yet lack rigidity and form on their own. They are however an ideal reinforcing material when combined with thermosetting resins.

Modern glassfibre technology dates from the 1930s but the material began to be properly exploited in the 1950s with the advent of synthetic resins which led to the development of modern polyester and vinylester resin systems.

The intense research and development of GRP into a predictable engineering material was driven above all by the aerospace industry where its light weight was of course its main attraction.

In the chemical and process industries, corrosion resistance has been the prime benefit and plastics materials are now the materials of choice for many applications, particularly storage and processing tanks, gas scrubbers and other chemical plant.

BS4994, introduced in 1973, revised and expanded in 1987, covers the design and fabrication of GRP tanks and vessels in substantial detail (see P3) and has been the bedrock of Forbes progress as the leading UK manufacturer of custom-designed tanks and vessels.

The corrosion barrier/contact surface of a GRP tank or other fabrication may be a resin rich layer or a thermoplastics inner shell, forming a dual laminate. The choice of manufacturing process depends very much on the duty for which the product is designed.

GRP structures have excellent strength to weight performance and are very versatile, but the most economical configuration for dual laminate tanks is as self supporting vertical cylinders. Manual fabrication, including hand lay up of the GRP, allows substantial variation of the height and diameter of a tank – a very useful consideration when a site has limited space.

## RESIN SYSTEMS

There are many resins available for GRP fabrication, by no means all of them suitable for high specification applications. Orthophthalic polyester resins are perhaps most widely used. NPG isophthalic polyesters offer increased chemical resistance and higher temperature performance. Bisphenols and vinyl esters are generally employed only for particularly demanding tasks. While specifying the resin for an application the design engineer also determines the suitable grade of glass reinforcement.

## IMPARTIALITY

We are equipped to manufacture in a wide range of materials and will always endeavour to offer objective solutions to your requirements.



## THERMOPLASTIC INNER SHELL MATERIALS

- **PP** (polypropylene) (*Celmar®*) is the material of choice for a vast range of applications. It has superb chemical resistance and a higher operating temperature than polyethylene. It is free from taint or toxicity, is highly cost-effective, and has gained widespread acceptance across many industries.
- **HDPE** has in practice been superseded by PP. There is no price advantage and HDPE is mechanically inferior and less suitable for higher temperature applications.
- **UPVC** (unplasticised polyvinyl chloride) is used in particular applications for its resistance to strong oxidising and reducing chemicals, especially chlorine-based compounds.
- **PVDF** (polyvinylidene fluoride) is especially resistant to aggressive chemicals at higher temperatures.
- **ECTFE** (ethylene and chlorotrifluoroethylene copolymer) (*Halar®*) is another exceptionally high performance material. At temperatures up to 120°C the polymer is not affected by stress cracking nor attacked by the majority of chemical reagents.

## REGULATION 25(1)a PRODUCTS FOR WATER UNDERTAKERS

We have for many years supplied the water industry with a wide range of high specification products, including storage tanks for water, sludge, effluent and chemicals, dosing tanks, salt saturators, fume and odour scrubbing systems and stripping towers in plastics materials.

The full implementation of Regulation 25 of the Water Supply (Water Regulations) requires Water Undertakers to provide proof to the Drinking Water Inspectorate that their equipment complies with very demanding criteria.

To meet the criteria Forbes has developed product ranges especially for the water industry and they have been approved by the Secretary of State for the Environment, Transport and Regions.

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## POST CURING

The principle of post-curing GRP tanks and vessels to achieve maximum performance from the laminate is well known and is referred to in BS4994.

Curing, by linking free styrene monomers and other organic residuals within the laminate ensures optimum physical and chemical properties and reduces the possibility of taint in higher temperature, taste-sensitive, applications.

Resin manufacturers specifications outline the time and temperature requirements for post-curing their products. Without post-curing, laminates can suffer from chemical degradation and the risk of taint. Also because of the lower ultimate tensile strength of the laminate increased safety factors in the design of the tank would result in greater wall thickness to achieve the required strength.

Our massive post-curing oven, fitted with a calibrated chart recorder, is over 5 metres in diameter and 13 metres long. It is capable of sustaining temperatures in excess of 100°C over long periods.

Customers can benefit when post-curing is specified by greatly improved chemical resistance, increased strength, and avoidance of taint.

## A QUALITY COMPANY

We are an independent privately owned business, soundly managed by a tightly knit team and with strong technical and financial bases. We are dedicated to supplying our customers with high quality products at competitive prices without jeopardising the well-being of our staff, the public at large, or the environment.

Forbes stands by its products – you will find our after sales service second to none.

We strive towards continual company improvement and aspire to provide standards of excellence, efficiency and service that make Forbes a comfortable organisation to deal with.



## RANGE OF MANUFACTURE

We manufacture storage tanks in various materials from 200 to 200,000 litres capacity. All our products are custom designed and manufactured but where appropriate we will suggest an adaptation of a standard design to minimise costs and lead times.

### SUGGESTED ECONOMICAL SIZES FOR VERTICAL CYLINDRICAL DUAL LAMINATE TANKS

MODEL	Capacity (litres)	Diameter (mm)	Nominal Wall Height (mm)	Approximate Weight (kg)
SDL 10	10,000	2000	3666	370
SDL 12.5	12,500	2400	3050	400
SDL 15	15,000	2400	3666	460
SDL 20	20,000	3050	3050	670
SDL 25	25,000	3050	3666	780
SDL 30	30,000	3200	4100	950
SDL 40	40,000	3050	6110	1300
SDL 50	50,000	3785	4888	1400
SDL 60	60,000	3500	6720	1650
SDL 75	75,000	4111	6110	2400
SDL 90	90,000	4111	7100	2850
SDL 100	100,000	4111	7950	3300

If you need a diameter/height configuration not shown here, please discuss it with us. We can make practically anything, subject only to road transport limits.

\* for average contents SG 1.2

## NON TANK PRODUCTS

The technologies we use to build tanks are directly transferable to many other items of process plant and we design and manufacture a wide range of custom and standard products such as Salt Saturators, Silos, Scrubbing and Stripping Towers (see page 8) in a variety of materials.

We also apply our substantial experience in process plant in the manufacture of complex one-off fabrications, in skid and container mounted modules and by offering a full turnkey supply, installation and commissioning service.

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## SAFETY MATTERS

Health and safety issues are high on the agenda in all enterprises, especially as legislation has continued to focus the attention of safety officers on avoidable problem areas. During installation the Construction (Design and Management) Regulations detail the responsibilities of the client to appoint a supervisor to manage safety. Once commissioned the plant safety officer must have risk assessments and method statements in place for day-to-day operations.

Tanks have to be entered to satisfy planned maintenance schedules. Awareness of the hazards involved in confined space working has grown, especially in the light of several well-publicised tragedies. It has become more common for safety procedures to demand breathing apparatus, winches and back-up staff – but even 600mm diameter top-mounted manways are too small to winch an inert colleague through.

## SIDE ACCESS MANWAYS

The safest and most practical aid to entering tanks, and providing emergency backup, is the provision of side access manways. The small initial cost is quickly recovered by operational savings, let alone the substantial contribution to safer working practices.

The Health & Safety Commission document L101(section 95) states 'top openings to vessels, tanks etc. should be avoided due to difficulty of access and rescue. Bottom or low manholes are preferable.' The document also states that the minimum size of opening should be 575mm. The implementation of the Confined Space Regulation (CSR) which is now mandatory further emphasises this requirement. It is further suggested that all vertical tanks and vessels with a wall height in excess of 2.4 metres should be fitted with a side mounted access manway no more than 1.3 metres above the base.

It is straightforward to build side manways in GRP tanks during manufacture – design and construction are thoroughly covered by BS 4994.



## PRODUCT RANGE

- ◆ Thermoplastics Tanks
- ◆ Tanks, Vessels & Fabrications  
GRP/THERMOPLASTICS DUAL LAMINATES
- ◆ Tanks, Vessels & Silos  
GRP COMPOSITES
- ◆ MINIBULK<sup>®</sup> Chemical Storage Systems
- ◆ Sectional Tanks
- ◆ Silos FOR SOLIDS & LIQUIDS
- ◆ Salt Saturators
- ◆ Pressure and Vacuum Vessels

- ◆ Fume and Odour Scrubbing Systems
- ◆ Vent Scrubbers
- ◆ CO<sub>2</sub> Degassers
- ◆ Stripping Towers
- ◆ Carbon Adsorption Units
- ◆ Bio Treatment Systems

- ◆ Ancillary Steelwork
- ◆ Skid Mounted Modules
- ◆ Turnkey Projects

For further information visit our website at: [www.forbesgroup.co.uk](http://www.forbesgroup.co.uk)



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