

Project Report 16



Composite tank structures made of
SIMONA® PVDF-GK/FRP

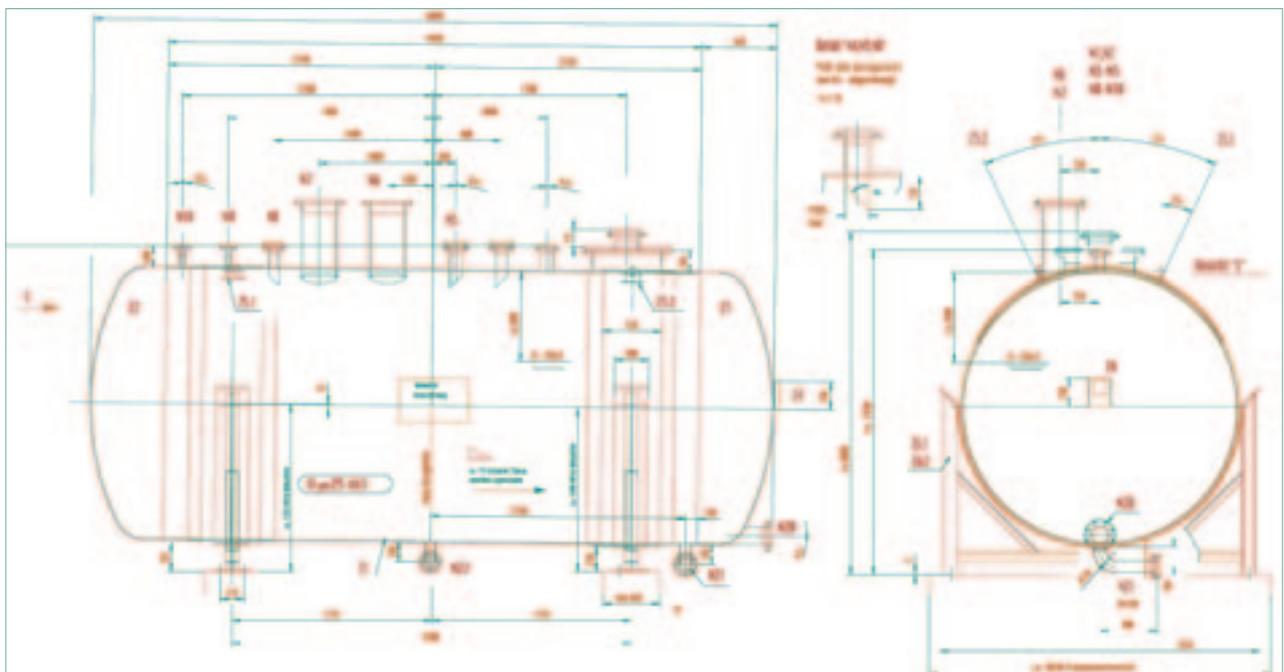
Composite tank structures made of SIMONA® PVDF-GK/FRP

Client	Bayer AG
Contractor	Christen & Laudon GmbH
Component	Horizontal tank on base
Diameter	2,400 mm
Length	6,000 mm
Inliner	4 mm SIMONA® PVDF-GK sheets
Resin type	Epoxy vinyl ester resin DERAKANE-MOMENTUM 411-350
Medium	Hydrochloric acid: 17 % to 30 %
Service temperature	-25 °C to +60 °C
Service pressure	-0.10/+0.50 bar

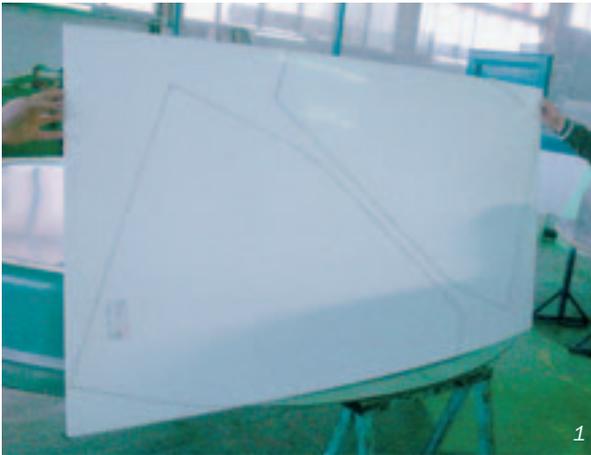


**Christen
& Laudon**
Staffelstein

Engineering drawing of the tank



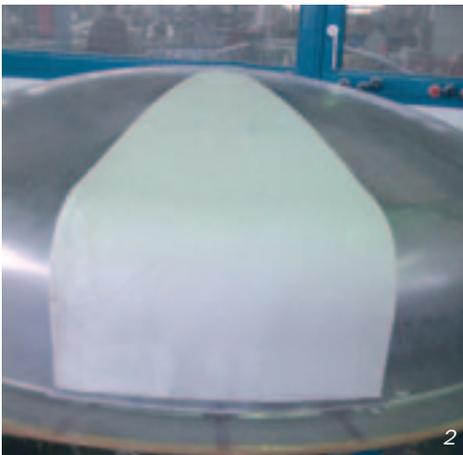
Composite tank structures made of SIMONA® PVDF-GK/FRP



Our client Christen & Laudon in Bitburg-Staffelstein, the leading manufacturer of tanks made of FRP, FRP composite and pure thermoplastic, constructed two storage tanks of FRP composite design (FRP= glass-fibre reinforced plastic) for Bayer AG in 2003. SIMONA® PVDF-GK sheets were used for this project.

We encounter chemical products in all areas of daily life. The processes for manufacturing such products are often highly complex. In many cases the chemicals required for various chemical processes have to be kept in storage. Owing to their good corrosion and media resistance, thermoset plastics and thermoplastics are ideal materials for storage tanks. In addition to FRP solutions, we usually deploy the following thermoplastics: polyethylene (PE), polypropylene (PP), polyvinyl chloride (PVC) and polyvinylidene fluoride (PVDF). On account of the size of storage tanks it is often impossible to construct a full thermoplastic tank in a manner that is commercially feasible, particularly if PVDF has to be used because of the aggressive nature of the medium. In such cases the tank will take the form of a FRP composite tank. A FRP composite tank is a combination of a chemically resistant thermoplastic, the so-called inliner, with a supporting laminate made of FRP.

1 SIMONA® PVDF-GK sheet is prepared for segment blanks | 2 Making the convex tank end in segments | 3 SIMONA® PVDF-GK sheets shaped to make the convex tank end, welded, seams backed with carbon tape



FRP is a composite material made of resin and glass. The liquid reaction resins used are unsaturated polyester resins and vinyl ester resins. The glass used for reinforcement is integrated in the form of roving, matting and meshing. The join of resin and glass to create a load-bearing structure is termed laminate.

Owing to the high chemical resistance and anti-adhesiveness of SIMONA® PVDF, it is not possible to bond a resin to the PVDF surface directly. A join with the FRP can only be achieved by physical means. SIMONA® PVDF-GK is a glass mesh backing. About 50% of the thickness of the glass mesh is pressed into the thermoplastic surface during production of the sheets. The other 50% of the glass mesh projecting from the surface of the sheet is responsible for the physical bond to the supporting laminate. Only with the help of this approach can a FRP composite be manufactured with PVDF as an inliner.

A basic requirement for a good join is high bond strength between the backing and the substrate. In order to establish this parameter, the pull-off strength of the glass-backed PVDF sheets is determined in the process of quality monitoring. According to Bayer company standard 1250 Part 2, a minimum of 5 N/mm² is specified for glass-backed PVDF sheets. This minimum value is one of the release criteria for SIMONA® PVDF-GK sheets. Within the scope of a goods inward inspection this value is also checked at Christen & Laudon and is only released for processing if the result is positive.

Making the convex tank end

In order to make the ends of the tank the PVDF-GK sheets are cut to form cake-like segments. The segment blanks are heated to the necessary forming temperature in a hot-air oven and formed in a mould which has the shape of the tank end. The pre-formed segments are laid up with their unbacked sides, adjusted, joined together with PVDF welding rod by means of hot-gas string bead welding and finally reinforced with FRP.

4 Convex tank end with supporting laminate |

5 Coiled SIMONA® PVDF-GK sheets are welded together on the butt welding machine





6 Welded SIMONA® PVDF-GK sheets on the winding spindle

Making the tank cylinder

To make the tank cylinder the PVDF-GK sheets can be supplied by SIMONA as strips to fit the circumference of the tank. Another method is to weld the sheets on a Christen & Laudon butt welding machine to make a strip matching the unwound area of the cylinder.

The unbacked side of these strips is mounted on a cylindrical winding spindle and connected at the joins using PVDF welding rods and hot-gas string bead welding. In order to avoid soiling the welded seam with threads of mesh, the backing is first machined down to the substrate at the sides of the seam. After applying the inliner for the tank cylinder the prepared tank end is slid onto the winding mandrel and welded to the cylinder inliner.

7 Cylinder and convex end on the winding spindle | 8 Winding the FRP cylinder supporting laminate



Electrically conductive, adhesive carbon tape with the same width as the welded seams, is applied to all the seams. This carbon tape is used to check the welded seams for leaks from inside the tank using a high-voltage spark tester.

After welding has been completed the FRP cylinder supporting laminate is wound onto the PVDF inliner with a winding machine according to the calculated specifications. When the cylinder has been finished and hardened the prefabricated nozzles and the second prefabricated tank end are welded onto the cylinder and then laminated.

The various stages of production are backed up by quality assurance both from Christen & Laudon and Bayer AG. The inspections required by the quality inspection plan are also performed.



9 FRP composite tank ready for transporting

10 Nozzles welded into the cylinder | 11 Checking the nozzles | 12 Integrating the nozzles by lamination | 13 Connection between the convex tank end and the cylinder, prepared for over-lamination. Welded seams backed with carbon tape to allow testin



PVDF range

Materials (available ex stock)

PVDF	Partially fluorinated high-performance material, highly crystalline Polyvinylidene fluoride, natural
PVDF-SK	Polyvinylidene fluoride, backed with polyester mesh
PVDF-GK	Polyvinylidene fluoride, backed with glass fibre mesh

Materials (available on request)

PVDF-CL	Polyvinylidene fluoride, stabilised to resist chlorine radicals
PVDF-EL	Polyvinylidene fluoride, electrically conductive
PVDF-EL-SK	Polyvinylidene fluoride, backed with polyester mesh
PVDF-EL-GK	Polyvinylidene fluoride, backed with glass fibre mesh



PVDF semi-finished products (dimensions in mm)

	PVDF	PVDF-SK	PVDF-GK
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Extruded sheets (format/thickness)

	2000 x 1000	1 – 15	2 – 6	2 – 6
	3000 x 1500	2 – 10	2 – 6	2 – 6
	20000 x 1500 ^①		2 – 5	2 – 5
	Colour	natural	natural	natural

Pressed sheets (format/thickness)

	2000 x 1000	10 – 80		
	4120 x 2010	10 – 50		
	Colour	natural		

Welding rods

	Type	Round, triangular TA 90		
	Thickness	3 – 5		
	Colour	natural		

Solid rods (length/diameter)

	1000	10 – 500		
	2000	10 – 500		
	Colour	natural		

^① Coils

SIMONA consulting services

Committed to excellence, our Applications Technology Department and global sales units offer a comprehensive range of consulting services – worldwide. Our highly qualified team provides a full-service package, from project planning to application-specific advice regarding on-site implementation. SIMONA's service portfolio also includes tailor-made staff training programmes, held either on your premises or at our Academy in Kirn. Our consulting services within the area of chemical equipment and plant engineering are centred around the following topics:

SIMONA Consulting – Chemical Resistance

Our “SIMCHEM” CD-ROM focuses on key issues relating to the chemical resistance of SIMONA materials. For further information, please feel free to get in touch with a SIMONA member of staff:

Phone (0 67 52) 14-252/-718

Fax (0 67 52) 14-302

E-Mail ata@simona.de

Other services include:

- Immersion tests in accordance with DIN 16888 Parts 1–2 and ISO 4433 Parts 1–4
- Assessment of reduction factors by means of immersion tests or determination by creep-depending-on-time test under internal compression

- Examination of the potential of a liquid with regard to tension cracking
- Assessment of permeation during use in composite construction and in lining processes with appropriate material recommendation

SIMONA Consulting – Tank/Vessel Construction

SIMONA AG offers a range of specialist services within the area of tank/vessel construction:

- Assessments and verifiable structural analyses for rectangular tanks (perimeter reinforcements, cross-ribbed) and circular tanks in accordance with DVS 2205
- Design-specific consulting
- Processing instructions
- Static calculation for shafts
- Theoretical and practical training

SIMONA Consulting –

Composite Construction and Lining

Drawing on many years of experience in this field, we offer a wide range of services for the following areas:

- Lining process
- Welding process
- Gluing technique or selection of reaction resin
- Surface pretreatment
- Composite construction

For further information about our products and services, please visit our website at www.simona.de or refer to the following publications:

Catalogues

- Pipes, Fittings, Valves
- Sheets, Rods, Profiles, Welding Rods

Electronic catalogues

- SIMCAT (Pipes, Fittings, Valves)
- SIMCHEM (Chemical Resistance)
- SIMPLAST (Sheets, rods, profiles, welding rods)

Brochures

- Product Range
- Semi-finished Products for Tank and Apparatus Construction

Processing instructions

- Welding
- Gluing
- Lining and Composite Construction
- Vacuum Forming, Thermoforming, Bending
- Machining

Product information leaflets

- SIMONA® PE-HWU/HWST
- SIMONA® PE-HML/HMG
- SIMONA® PP-DWU/DWST
- SIMONA® PVC-CAW/MZ
- SIMONA® PVC-GLAS
- SIMONA® PVDF
- SIMONA® E-CTFE
- Electrically Conductive Semi-finished Products

Company profile

Offering a comprehensive product range, SIMONA AG is recognised as one of Europe's leading manufacturers of semi-finished thermoplastics:

- Sheets with a thickness of 0.5 to 200 mm,
- Sheets with a diameter of 10 to 1,000 mm,
- Pipe fittings with a diameter of 16 to 1,000 mm,
- Solid rods with a diameter of 6 to 800 mm,
- Hollow rods with a diameter of 125 to 450 mm,
- Profiles and welding rods,
- Electrofusion fittings,
- Valves.

The materials processed by SIMONA include PE, PP, PVC-U, PVC-U foamed, PETG, PVDF and E-CTFE, as well as specialist materials, e. g. for applications within the field of orthopaedics.



SIMONA AG's quality and environmental management system is certified in accordance with DIN EN ISO 9001 : 2000 and DIN EN ISO 14001 : 1996.

SIMONA AG is based in Kirn, a town located in the German state of Rhineland-Palatinate. Sheets, rods, profiles, and welding rods are manufactured at this location, in Plants I and II. Plant III for pipes and fittings is located in Ringsheim, in the German state of Baden-Württemberg. In addition, the company has established a global network of subsidiaries and sales partners, thus guaranteeing a professional, customer-oriented service on all continents.

Product and service quality is of paramount importance. Committed to providing superior solutions, we therefore set great store by continuous quality management. Indeed, at SIMONA quality management is a never-ending process which encompasses regular audits and system enhancements.

Our commitment to excellence is by no means restricted to our manufacturing processes and products. At SIMONA, the customer always takes centre stage. We are well aware of the fact that the quality of all services associated with our product portfolio is an essential prerequisite for success.

That is why our entire value chain is geared towards best-in-class results, from project planning and raw-material procurement through to manufacturing, shipping, on-site consulting and customer relationship management.

Therefore, it comes as no surprise that we were the first company within our area of expertise to have been granted certification in accordance with DIN EN ISO 9001 : 2001 and DIN EN ISO 14001 : 1996. Moreover, our quality management system is subject to continuous improvement as part of internal and external audits.

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