GRP DAILY GRIND

new brochure!!

GRP IN
PIPE, TANK & PLANT ENGINEERING

Best practice examples from industry

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Image credits: Amiantit, Ashland

CONTENTS

1. Introduction

Fibre-reinforced plastics, also known as composites, have recently found their way into a wide range of applications. These include sports and leisure, racing, medical engineering, aerospace and construction. Some sectors would now be unthinkable without composites.

These extraordinary materials are often used because of their beneficial qualities compared with other options. For instance, composites have enormous potential in lightweight construction, allow considerable freedom of design and have material properties which can be modified to suit requirements. Because of these qualities and outstanding corrosion resistance, GRPs (glass fibre-reinforced plastics) have also been used in pipe, tank and plant engineering for many years now.

Below we have compiled a few examples to illustrate the amazing potential contained in this group of materials.

Should you have any questions, either about the applications or about the materials themselves, do please contact us. We hope you will enjoy reading this brochure.

2. Success stories from GRP pipe engineering

2.1. Cooling water line in Turkey

Details of the following project have been provided by

⇨ Fiberpipe [www.fiberpipe.de]

From: *energiespektrum*, issue: August 2012

Cooling water pipeline – The engineers used fibreglass pipes to build a CCGT (combined cycle gas turbine) power station in Bandirma, Turkey. The benefit of such pipes is that their wall thickness can be customised to suit specific requirements.

Time was beginning to run out in January 2008 when Fiberpipe was asked by the formerly Austrian company A-Tec Power Plant Systems to construct the pipelines for a gas-fired combined cycle power plant with low-pressure steam turbines and 920 MW output. Construction was to start within three months.

Bandirma, a town with a population of 210,000 on the coast of the Marmara Sea, was to be given a new power supply. Yet the focus was not on expanding its existing facilities, but on building a completely new power plant – on a greenfield site, right on the coast. The company EnerjiSA, owned in equal parts by the wider Group and by Sabanci Holding, had decided to build and complete the gas-fired power station by autumn 2010. By 2015 the Turkish energy utility is planning to provide an installed output of 5,000 MW, catering for 10% of the Turkish electricity market.

Resistant to corrosion

The full scope of services and products delivered by A-Tec Power Plant Systems included delivering the engineering , the heat recovery steam generator, the controls and mechanical and electrical auxiliary facilities as well as setting up and commissioning the actual power station itself. The consortium partner Mitsubishi Heavy Industries supplied two F-Technology gas turbines and the steam turbine system.

Fiberpipe delivered, among other things, the primary and auxiliary cooling water pipes DN

25-2400, made from glass fibre reinforced plastic (GRP) – a material which is very much state-of-the-art in plant engineering and in the energy industry: "The simplest evidence for this development is that our sales figures increased by 20 to 40 per cent each year from 2005 to 2010," says Alexander Bamberger, owner and managing director of the fibreglass pipe company.

The lifetime of such a pipe is between 25 and 50 years, and installation is about 35% less expensive than for stainless steel pipes, he adds. "The main applications can be found wherever corrosion is caused by chlorides or other chemicals. It has a far longer lifetime than rubber lining and a much lower risk of failure." Steel pipes are apparently indispensable in power plant engineering "where temperatures are clearly above 100 or even 120°C and where corrosion resistance or maintenance costs are not an issue."

"No off-the-peg products"

In a CCGT plant (combined cycle glass turbine plant) steam is produced by the hot waste gases of the gas turbines in a waste heat steam boiler. Next, the pressure of the steam is reduced in a conventional process, using steam turbines. The waste steam from the turbines is then cooled in a condenser. Any cooling water that does not flow directly into the condenser is known as secondary cooling water. This is because, apart from the condenser, all the available machinery, equipment and systems need to be supplied with cooling water.

The requirements on the pipeline systems in Bandirma were quite substantial, as they had to be resistant to the water of the Marmara Sea, to corrosion from steam and to extreme pressure fluctuations and temperatures. So the external conditions were a major challenge. A plateau island was created in the open sea, to accommodate the pump house. The cooling water is now pumped directly from the pump house up into the power station, situated 30 metres above sea level.

The amount of cooling water that is required depends on the load at which the power plant is run. Should the pumps fail or be turned off and also during start-up, the water hammer (i.e. the pressure surge) is minimised by butterfly valves which are hydraulically controlled by opening and closure characteristics. Fibreglass pipes could be designed to suit the specific characteristics of Bandirma.

“Fibreglass pipe are never available off-the-peg,” says Bamberger. “Each pipe in this size is manufactured in a way that suits its specific requirements.” He explains that there are always several important design parameters, such as internal pressure, load-bearing capacities and the specifications arising from the water hammer calculations. In Bandirma the entire pipeline network has been designed for and at an absolute pressure of 0.5 bars, and the section after the heat exchanger for a full vacuum.

A virtual journey

“When we set the internal pressure resistance and the vacuum resistance separately, we can almost do so separately” he says. “As we were in a position to vary the wall thickness in increments of about one millimetre, both in production and design, it was possible to find and implement the best possible wall thickness for this application.”

Work was still in progress at the construction site, whereas the detailed planning of the overall system was still unfinished and continued to be an ongoing process. Fiberpipe created design drawings of the tested pipe runs and emailed them to the client, who then put them into an overall 3D model and fed back the updated records to the company in Germany. This enabled the German engineers to move around virtually within the entire power station, analyse all third-party components and their own pipes in 3D, identify potential places for the supports within the system and plan further pipe runs.

50% lighter than steel pipes

“The great benefit of 3D is that if there are any construction issues, you can see them straightaway on your computer monitor. Whenever special parts are required, we notice it at an early stage in the planning,” says Bamberger. “

It is also significantly easier for general planners to check if pipe runs are unimpeded, if there are any danger spots and if perhaps a pipe runs right through open space at waist height."

During the construction stage a drawing was produced, showing 18,000 individual parts for the cooling water pipes alone. Moreover, the engineers had already provided their technical consultancy at the bidding stage. They conducted, among other things computerised stress analyses, calculated flow parameters – and handled the supervision of the construction site in Bandirma. A Turkish assembly team had to be managed on site. An engineering team from Germany inducted local workers and ensured that all connections complied with the strictest safety standards.

As time went on, process inspections and pressure tests were conducted to ensure the safety of the entire system.

GRP can be joined up relatively quickly and conveniently, using glue, lamination, plugs and flanges. Moreover, assembly is made easier by its light weight: GRP has a thickness of about 1,800 kg per m^3, whereas steel has 7,800 kg per m^3. GRP pipes are slightly thicker, says Bamberger, so that the advantage in terms of weight loss is 50%.

"Due to the short project lead time and the structure of A-Tec, we had to conduct the planning while the project was in progress. Many details were therefore only specified shortly before or even during the construction stage," says Bamberger.

"This continuous flexibility and the resulting changes presented ongoing challenges to our assembly operations, in particular." Yet despite the many diverse challenges, all the international partners managed to conclude the project on schedule. The power plant has now been operating since October 2010 and has provided Bandirma with electric power since the end of that year.

2.2 Over 50 kilometres of GRP

Details of the following project have been provided by

- Ingenieurbüro Dr.-Ing. Klaus Westendorff [www.hydrosound.de]

Characteristics:

- Pipe production process: Cross-wound, epoxy resin
- Inner diameter: 433.8 mm
- Outer diameter: 450.0 mm
- Length: 54 km [from Rüdersdorf (federal state of Brandenburg) to Heckelberg (federal state of Brandenburg)]
- Pressure rating: 20 bars
- Construction period: 9 months

- Commissioned in: 2002
- Client: EWE AG
- Planning engineers: Ingenieurbüro Dr.-Ing. Westendorff
- Quality monitoring during construction: Ingenieurbüro Dr.-Ing. Westendorff

2.3 Cooling water pipeline

Details of the following project have been provided by

⇨ Amiantit [www.amiantit.com]

- Project name: Salzgitter Cooling Water Pipeline
- Locality and country: Salzgitter, Germany
- Entity: AMITECH Germany GmbH
- Description: installation of cooling water pipes
- Application: Cooling water
- Transported medium: Raw water
- Working pressure: PN6
- Type: new installation
- Choice of pipe system: GRP round filament

- Why GRP product? Light weight
- Owner (name, town): Salzgitter Flachstahl GmbH, Salzgitter
- Consultant / engineer: SKL Engineering & Contracting GmbH, Salzgitter
- Contractor: Finsterwalder Bau Union, Sonnewalde

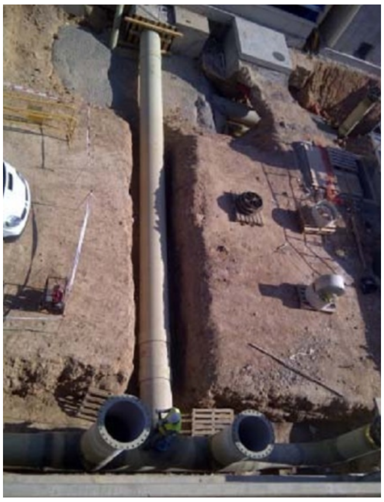
- Pipe details:
  - Total length supplied (m): approx. 400 metres
  - Pipe lengths supplied (m): 12m; 18.5m
  - Diameter DN (mm): DN 1400
  - Pressure PN (bars): PN 6
  - Stiffness SN (N/m²): 10,000

- Installation details:
  - Type: open trench, below

2.4 Hybrid power plant

Details of the following project have been provided by

⇨ Amiantit [www.amiantit.com]



- Project name: Termosolar Borges Hybrid Power Plant
- Locality and country: Les Borges Blanques, Lleida province, Spain
- Entity: AMITECH Spain
- Description: First solar plant in Catalonia; a 58.5 MW hybrid plant that combines parabolic solar thermoelectric technology with biomass.
- Application: cooling system
- Transported medium: Raw water between 30°C and 35°C depending on the pipeline (pumping cool water on return of heat water after passing through the condenser)
- Working pressure: 6 bars
- Type: new installation
- Required standards / specifications / approvals: ANSI/AWWA C950-95 standard for fibre glass pressure pipe BS-7159 for stress analysis
- Choice of pipe system: GRP round filament

- Why GRP product? Corrosion resistance and chemical properties
- Owner: Borges Blanques (Abantia Group + Comsa Emte joint venture)
- Consultant / engineer: IDOM
- Contractor: Constructora Calaf working for Abantia & Comsa

- Pipe details:
  - Total length supplied (m): approx. 120m
  - Pipe lengths supplied (m): 6m, 12m
  - Diameter DN (mm): 250mm - 800mm
  - Pressure PN (bars): 6 bars
  - Stiffness SN (N/m²): 5,000
  - Joint types: Reka, butt-wrap, flanges
  - Fittings used: elbows, flanges, tees

- Installation details:
    - Type: open trench, below
    - Trench dimensions (m): 1.7m wide
    - Laying depth (m): 2m deep
    - Backfill soil type / compaction: similar to SC3
    - Thrust blocks / lock joints: Several thrust blocks, extracted from the stress analysis
    - Quality measures during installation: hydraulic tests

- Completion: 2012
- Summary: There were no special challenges in this installation. It was a mixed installation involving biaxial (FBG) and standard (FPP) pipes. We used two joint systems, depending on the technical requirements: chemical joints and GRP couplings.

2.5 Installation of 12 siphons

Details of the following project have been provided by

⇨ Amiantit [www.amiantit.com]

- Project name: SIPHONS DE GRAVELINES
- Locality and country: GRAVELINES (59), France
- Entity: AMIANTIT France SAS
- Description: 12 siphons were installed to transfer hot water from the outlet network of the Gravelines nuclear plant to the main cooling system of the new LNG terminal at Gravelines.
- Application: cooling system
- Transported medium: Raw water
- Working pressure: + 1.2 bars, full vacuum (-1 bar)
- Type: new installation
- Special requirements on pipe system: non-corrosive pipes and weight
- Choice of pipe system: GRP round filament

- Why GRP product? Lightweight, corrosion-resistant, flow characteristics
- Owner: EDF France
- Consultant / engineer: ARTELIA, France, Grenoble
- Contractor: EMCC, Le Havre, France

- Pipe details:
  - Total length supplied (m): approx. 700 m
  - Pipe lengths supplied (m): 12 m and less
  - Diameter DN (mm): 1,300
  - Pressure PN (bars): 10
  - Stiffness SN min/max (N/m^2): 5,000 and 10,000
  - Joint types: Flanges, butt strap lamination
  - Fittings used: elbows
  - Stiffness SN min/max (N/m^2): lamination and flanges
  - Joint types: elbows and flanges

- Installation details:
  - above ground
  - Suspended
  - Duration: 2012-2014
- Summary: Light weight and corrosion resistance were the key factors for the installation of GRP pipes at a coastal site.

2.6 Cooling tower pipeline

Details of the following project have been provided by

⇨ Amiantit [www.amiantit.com]

- Project name: Elektrownia Jaworzno
- Locality and country: Poland
- Entity: AMITECH Poland Sp. z o.o.
- Description: Cooling tower pipeline for a new biomass-based power block with 40 MW capacity. Replacement of existing sprinkler system. Installation in winter.
- Application: Cooling water
- Transported medium: Raw water
- Working pressure: 3 bars
- Type: new installation, replacement
- Required standards / specifications / approvals: approval by the Institute of Building Technology
- Special requirements on pipe system: non-corrosive, lightweight, easy to install, resistant to high temperature fluctuations – low thermal expansion
- Choice of pipe system: GRP round filament

- Why GRP product? Lightweight, corrosion-resistant
- Information: GRP used by contractor in more than ten similar investments
- Owner: Tauron Wytwarzanie S.A., Katowice
- Consultant / engineer: ProjChłod, Gliwice

- Contractor: UNISERV S.A., Katowice

- Pipe details:
  - Total length supplied (m): approx. 400 m
  - Pipe lengths supplied (m): 6 m and 12 m
  - Diameter DN (mm): 300 – 700 mm
  - Pressure PN (bars): 1 – 10 bars
  - Stiffness SN (N/m²): 5,000, 10,000
  - Joint types: Double bell couplings
  - Fittings used: flanged fittings

- Installation details:
  - above ground
  - Installation 2011-2012

3. Examples of GRP tanks

3.1 *27-years-old HCL tank – without repairs*

Details of the following project have been provided by

⇨ Ashland [www.ashland.com]

- **Location and year**
  Tank installed in 1971 at DOW, Stade, Germany

- **Manufacturer:**
  Hawodur, Netherlands

- **Manufacturing process**
  The tank was made with DERAKANE 470 epoxy vinyl ester resin.

- **Service conditions**
  Environment: HCl 15 to 30%, pH 0 to 1, operating temperature: 40°C (104°F)

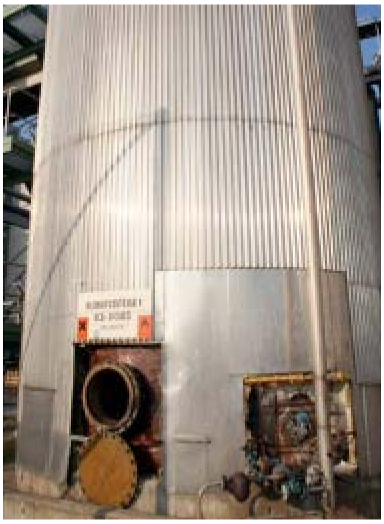
  - **Technical details**
  Volume 44 m³ (11,600 gal).

- **Maintenance**
  After 27 years of service the tank was replaced in 1998 with only minor local chemical attack. There was no need for repairs during the entire service period.

3.2 *30-year-old GRP sodium chlorate tank*

Details of the following project have been provided by

⇨ Ashland [www.ashland.com] - with kind permission from G. Bergman, KIMAB, Sweden



- **Equipment**
  30-year-old GRP sodium chlorate tank, 500–700 g/l at 80–9

- **Manufacturing process**
  DERAKANE® 411-45 epoxy vinyl ester resin

- **Comments**
  Micro-delaminations in the fibre bundles of the CSM layer developed down to a depth of about 1.5 mm. No corrosion effects were observed in the structural laminate.

- **Maintenance**
  The tank is suitable for another 30 years of service.

3.3 25-year-old wastewater reactor

Details of the following project have been provided by

⇨ Ashland [www.ashland.com]

- **Location and year**
  Installed in 1986 at DOW, Stade, Germany.
- **Manufacturer:**
  Kurotec, Germany
- **Equipment**
  25-year-old reactor for wastewater treatment
- **Manufacturing process**
  DERAKANE 470 epoxy vinyl ester resin was used.
- **Service conditions**
  Slurry 0.5% (50% organic / 50% inorganic), FeClSO4 50 ppm, NaCl 1.5%, pH 11, temperature 20-40°C (70-104°F).
- **Technical details**
  Reactor for wastewater treatment
- **Comments**
  pH changes regularly from 11 to 1.5 for a short time.
- **Maintenance**
  In 2011 the tank was still in service and in perfect condition.

3.4 Chlorine abatement scrubber tank

Details of the following project have been provided by

⇨ Ashland [www.ashland.com]

- **Location and year**
  Installed in 1967 at the Dow Chemical Company, Freeport, Texas
- **Manufacturer:**
  Beetle Plastics, Inc., Ardmore, Oklahoma
- **Manufacturing process**
  The tank was filamented with DERAKANE 411 epoxy vinyl ester resin.
- **Service conditions**
  Storage of 25% ferric chloride at ambient temperatures
- **Technical details**
  Storage tank 4.5 m high x 3.7 m diameter (15 ft high x 12 ft diameter)

- **Design, comments**
  The fibreglass reinforced plastic tank replaced a rubber-lined steel vessel. As well as internal corrosion, the tank had to be protected from severe atmospheric corrosion.

- **Maintenance**
  The tank was reported in good condition in January 1996, after 29 years.

3.5 Chlorine abatement scrubber tank

Details of the following project have been provided by

⇨ Ashland [www.ashland.com]

- **Location and year**
  Installed in 1989 at DOW, Stade, Germany. The former scrubber tank of the same design and same resin had lasted 16 years.

- **Manufacturer:**
  Christen & Laudon (formerly Vanck), Germany.

- **Manufacturing process**
  Made with DERAKANE 470 epoxy vinyl ester resin, the tank is a part of a chlorine abatement / scrubber system. Volume: 21 m³ (5,550 gal).

- **Service conditions**
  Environment: continuous contact with 10% NaOH
  In case of start-up / shut-down / problems: NaOH 10% with NaClO 5%, pH 11 to 14 at 70°C (160°F)

- **Maintenance**
  The tank was still in service in 2011, after 22 years.

- **Comments**
  This tank / scrubber serves to abate chlorine precipitated upon start-up and shut-down and in the event of production problems of the electrolysis plant (a few days per year). As no continuous operation is required, a cobalt curing system and C-veil were used, despite the presence of NaOCl with 5% concentration.

3.6 Spherical tanks made from GRP

Details have been provided by

⇨ Haase GFK-Technik GmbH [http://www.ichbin2.de]

- **Highly stable and resistant to ageing: spherical tanks made from GRP**

- Double-walled GRP tanks for underground storage have proved their worth for this client for over 35 years, as they are dimensionally extremely stable, resistant to ageing and 100% corrosion-free. These material characteristics ensure a long service life, but also an excellent load-bearing capacity. Situated between the inner tank and the outer tank, both made from glass fibre-reinforced plastic, there is a load-bearing wall, made from resin-bonded gravel – so-called polymer concrete.
  - This adds extreme stability to the underground tank, and load-bearing tests have shown that it can withstand weights of up to 100 metric tonnes.
  - However the benefits of GRP are not just evident in fuel oil tanks. The material is also suitable for the safe storage of numerous chemicals and wastewater in tanks.

3.7 Flat-bottom tanks made from GRP

Details have been provided by

⇨ Haase GFK-Technik GmbH [http://www.ichbin2.de]

- **Flexible size and fittings: GRP flat-bottom tanks**
- GRP tanks and heat storage units make good use of the media and temperature resistance of this material and also its light weight and its excellent load-bearing capacity. It is possible to set up containers that are over 10 metres high and 4 metres in diameter.
- Thanks to on-site assembly engineering and the excellent properties of fibreglass-reinforced plastic, such containers can be installed quickly and conveniently even under difficult access and setup conditions.

4. GRP plant engineering projects

4.1 GRP gas cleaning vessel and ducting.

Details of the following project have been provided by

⇨ Ashland [www.ashland.com]

- **Location and year**
  Installed in 1984 at Tin Smelting Plant of Capper Pass Ltd., Humberside, UK
- **Designer and manufacturer**
  Garlway Ltd, UK According to B.S. 4994
- **Manufacturing process**
  Manual lay-up with DERAKANE 470 (corrosion barrier with Nexus double synthetic veil, structural laminates with CSM / woven roving reinforcement). External layer of DERAKANE 510A (with 5% antimony trioxide for Class 1 fire retardance according to B.S. 476).
- **Area of application**
  GRP gas cleaning vessel and ducting. For removal of exhaust gases from sinter machine processing. Tin containing scraps in preparation for blast furnace, as part of tin recovery process.
- **Service conditions**
  Gases spray-cleaned with re-circulated water (pH of liquid limited by corrosion resistance of metal pumps / valves).

  Gas stream contains: steam 12-15 vol%; SO_2 1-3%; SO_3 0.1-1.15%; CO_2 1-3%, fluorides <0.1%, chlorides <0.05%, arsenic 0.5 mg/Nm³.

  Temperature : inlet gas up to 100°C (210°F), gas in scrubber at 80-100°C (180-210°F), gas in exit ducts at 70-80°C (160-180°F) (all in continuous operation).
- **Technical details**
  Gas flow rate < 100,000 m³/h (26,417,200 gal/h). Height 11 m (36 ft), diameter 5 m (16 ft). Average wall thickness, total, 12 mm (0.4 in).
- **Maintenance**
  Dismantled in 1992. No maintenance required for the GRP structure, except for minor repairs to the inlet duct, following internal fire damage inside the ducting due to the presence of pyrophoric dust in the gas stream. This occurred 2 or 3 times during the lifetime of the vessel. High temperature excursions from these duct fires may have contributed to the cracking of the internal NEXUS™ veil surface layer of the corrosion barrier. The low thermal conductivity of GRP and the high thermal capability of the DERAKANE 470 resin meant that no significant damage occurred to the vessel as a result of these fires.

- **Inspection**
  An inspection at 3 to 6 months after start-up showed small blister formation behind the NEXUS™ surface veil layer on the inside wall. It was decided by Dow, Garlway and Capper Pass that this presented no great problems and was left to continue in service with no further deterioration. After almost 9 years in service, the laminate was examined and tested and showed only a localised surface chemical attack, with the structural laminate still in perfect condition and exceeding the design strength and stiffness criteria.

- **Comments**
  The corrosive nature and composition of the gas stream is very similar to those now found in modern flue gas desulfurisation (FGD) and waste incineration (WI) gas cleaning systems.

  The presence of fluorides in combination with sulfuric acid results in the formation of some hydrofluoric acid.

  Last update in 1993.

4.2 *Chlorine cooling tower*

Details of the following project have been provided by

⇨ Ashland [www.ashland.com]

- **Location and year**

  Installed in 1971 at DOW, Stade, Germany.

- **Manufacturer:**

  Hawodur, Netherlands

- **Manufacturing process**

  Made with DERAKANE 470 epoxy vinyl ester resin.

- **Service conditions**

  Environment: Cl_2 gas, 95 vol.-%, NaCl 300 g/litre (4 oz/gal), traces of hypochlorite, brine temperature approx. 0°C (32°F), gas cools down from 40°C to 10°C (104-50°F) during washing process.

- **Maintenance**

  The first sign of attack of the chemical resistance barrier was noticed in 1986, after 15 years of service. As degradation had extended through 1991, the tower was relined with the same resin in 1991. In 1995, after 24 years of service, the 13m (42.6 ft) tower was replaced by a new one with the same design made with DERAKANE 470 resin.

4.3 *Flue gas scrubber with HCL absorber*

Details of the following project have been provided by

⇨ Ashland [www.ashland.com]

- **Location and year**
  Installed in 1989 at DOW, Stade, Germany (thermal oxidiser unit).
- **Manufacturer:**
  CAR GmbH, Germany
- **Equipment**
  Flue gas scrubber / HCl absorber
- **Manufacturing process**
  DERAKANE 470 epoxy vinyl ester resin was used.
- **Service conditions**
  Flue gases, hydrochloric acid, HCl, 14-17%; temperature 70°C (160°F).
- **Maintenance**
  1 mm (40 mils) deep fine cracks were detected in the CR liner in 1991; the surface had the same appearance in 2010 during the last inspection. The cracks did not spread any further. The tank was still in service in 2011, after 22 years.

4.4 *CO_2 scrubber for $Na_2 CO_3$ recovery*

Details of the following project have been provided by

⇨ Ashland [www.ashland.com]

- **Location and year**
  Installed in 1990 at DOW, Stade, Germany (thermal oxidiser unit)
- **Manufacturer:**
  Kurotec, Germany
- **Manufacturing process**
  DERAKANE 470 epoxy vinyl ester resin was used.
- **Service conditions**
  Environment: CO_2 in cleaned flue gas
  NaOH 9%, pH >8, temperature 40°C (104°F)
- **Comments**
  This scrubber produces $Na_2 CO_3$ for use on site
- **Maintenance**
  In 2011, after 21 years, the scrubber was still in service and in perfect condition.

5. Other examples in pipe, tank and plant engineering

5.1 Renovation using GRP lining

Details have been provided by

⇨ Haase GFK-Technik GmbH [http://www.ichbin2.de]

- **The right way to renovate existing systems, using GRP lining**
- Laminate panels made from fibreglass-reinforced plastic are ideally suited for lining existing containers – mainly thanks to the flexibility of this material. As soon as the panels have been produced, they can be rolled up, and their low specific weight makes it easy to transport them to a construction site where they can then be used to line the relevant containers or rooms.
- But Haase's nap laminate has another important and unique advantage over conventional lining, as it allows you to save complex preparatory work and drying times.
- GRP laminate panels are suitable for tanks of all sizes, for separators made from concrete and for steel tanks. Should it be required, Haase can even provide double-walled laminates.

The flexibility, light weight and good processing qualities of GRP are particularly apparent when renovating separators, as the laminate can be rolled up like a carpet and therefore fed quite easily through the manhole of the tank.

Whether a tank is large or small, open or cylindrical, GRP is suitable for the durable panelling of virtually any container.

5.2 Moulded parts made from GRP

Details have been provided by

⇨ Haase GFK-Technik GmbH [http://www.ichbin2.de]

- **Moulded parts made from GRP: there's (almost) no limit to the imagination.**
  - Moulded parts made from GRP clearly illustrate the full range of benefits that characterise this material: light weight, no need for maintenance, corrosion resistance and weather resistance. Moreover, it has a high level of torsional rigidity while being extremely safe and durable. It can come in almost all shapes and sizes, so that there are virtually no limits to its possible variations.
- Also, by using special fibres (e.g. natural fibres), it is possible to have paintable surfaces and achieve high insulation values.

The category of moulded parts comprises a wide range of applications, such as landfill gas pits, covers, sanitary facilities and panelling.