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Industrial Corrosion Protection
KERAVERIN / KERAPOLIN

Surface Protective Systems
Refractory Systems
Plastics Engineering

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Product portfolio

Appliances

(max. diameter 5,5 m, length 16 m)

- Vessels
- Towers
- Columns
- Absorption appliances
- Gratings
- Special designs
- Pickling vessels

Pipework construction

Complete programme

→ acc. DIN standard

→ acc. customer standards

- Bayer, DOW, BASF, Formosa Plastics
- Engineering companies

Fan construction

Axial and radial fans made of thermoplastic or GRP

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Applications of plastics in corrosive environments

- ✓ Chemical industry
- ✓ Pickling and regeneration
- ✓ Environmental engineering
- ✓ Power stations (FGD plants)
- ✓ Waste incinerating plants (flue gas cleaning)
- ✓ Pulp and paper industry

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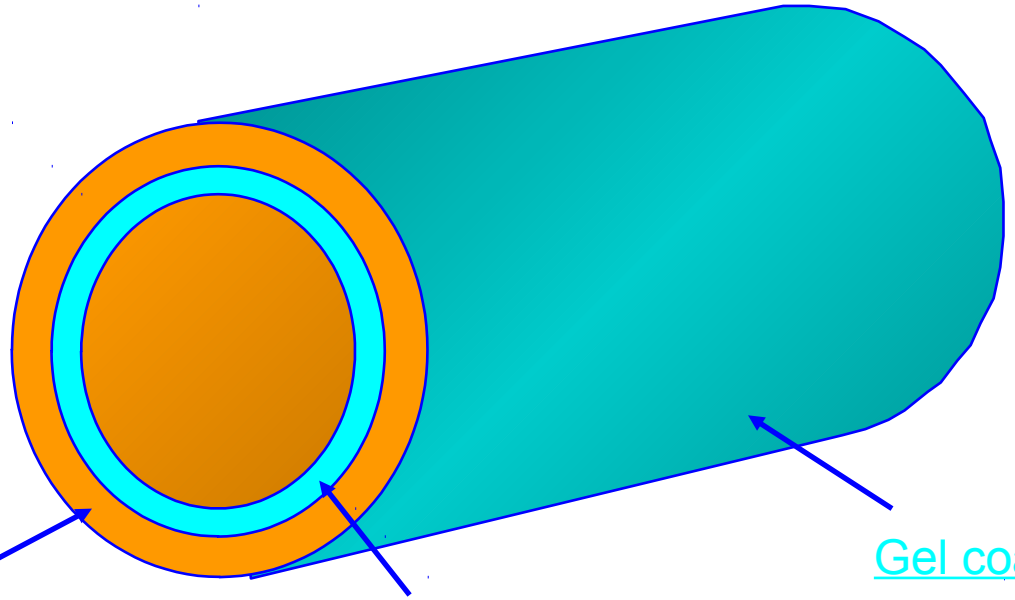
Composite construction:



Gel coat

FRP - reinforcement

Functional layer (lining)

- Thermoplastic liner
- Chemical resistant layer
- Wear & tear layer

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®KERAVERIN and ®KERAPOLIN Pipes / Types and Applications

KERAVERIN

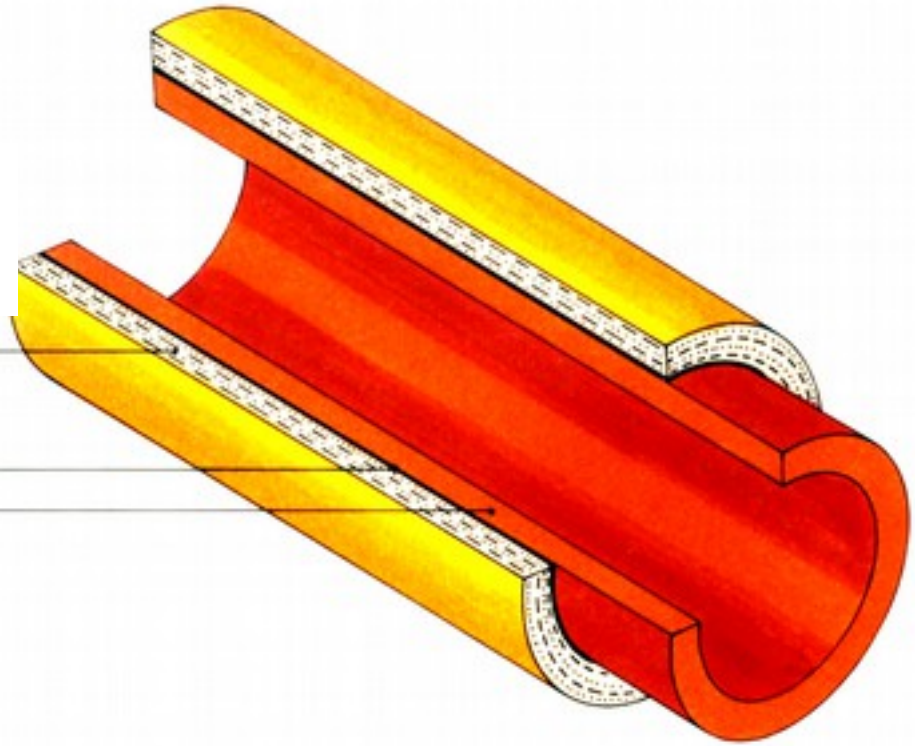
Pipe type B

Composite product made of thermoplastic as a liner and a glass fiber-reinforced laminate with a glass content of about 60%

Bearing laminate with textile rovings, glass mats and glass fibers

Adhesion layer max. 1 mm

Thermoplastic liner made of:
C-PVC, PP, PE, PVDF
E-CTFE, FEP, PFA and PTFE



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®KERAVERIN and ®KERAPOLIN Pipes / Types and Applications

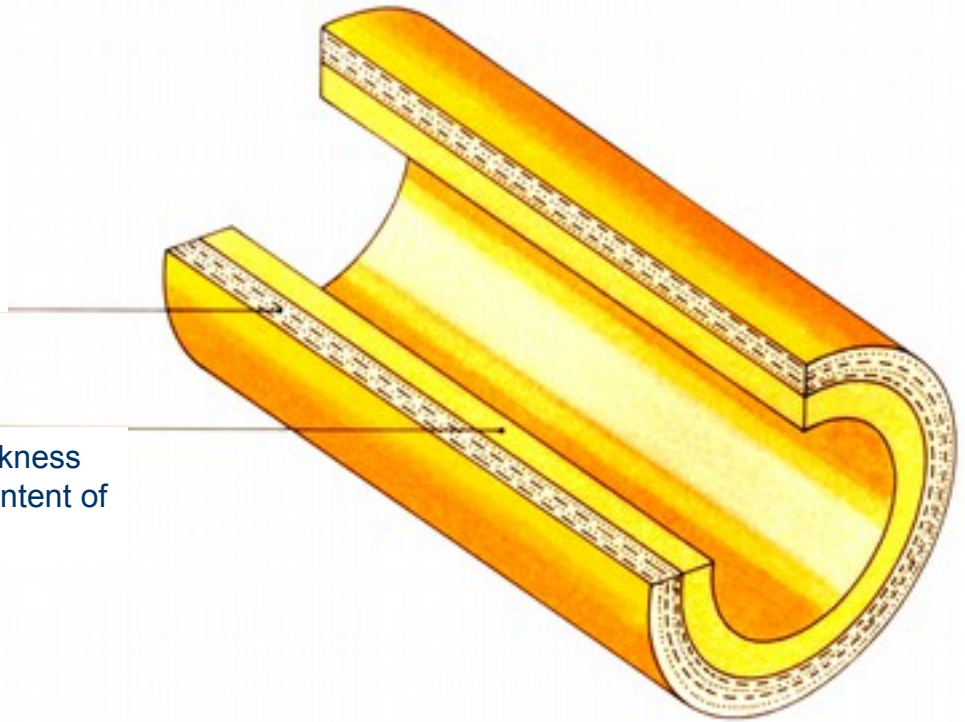
KERAPOLIN

Pipe type D

Characterized by a chemical-resistant layer. The load-bearing laminate with a glass content of about 65%.

Bearing laminate with textile rovings, glass mats and glass fibers

Corrosion barrier layer with a thickness of at least 2.5 mm and a glass content of 25%-30%.



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® KERAVERIN material choice:

Glass fibre reinforced vinylester or unsaturated polyester resin with thermoplastic liner in

PE:	polyethylene
PP:	polypropylene
PVC:	polyvinyl chloride
CPVC:	chlorinated polyvinyl chloride
PVDF:	polyvinylidene fluoride
E-CTFE:	Halar
FEP:	polymer of tetrafluorethylene and perfluorovinylether
PFA:	polymer of tetrafluorethylene and hexafluoropropylene
PTFEm:	modified polytetrafluorethylen

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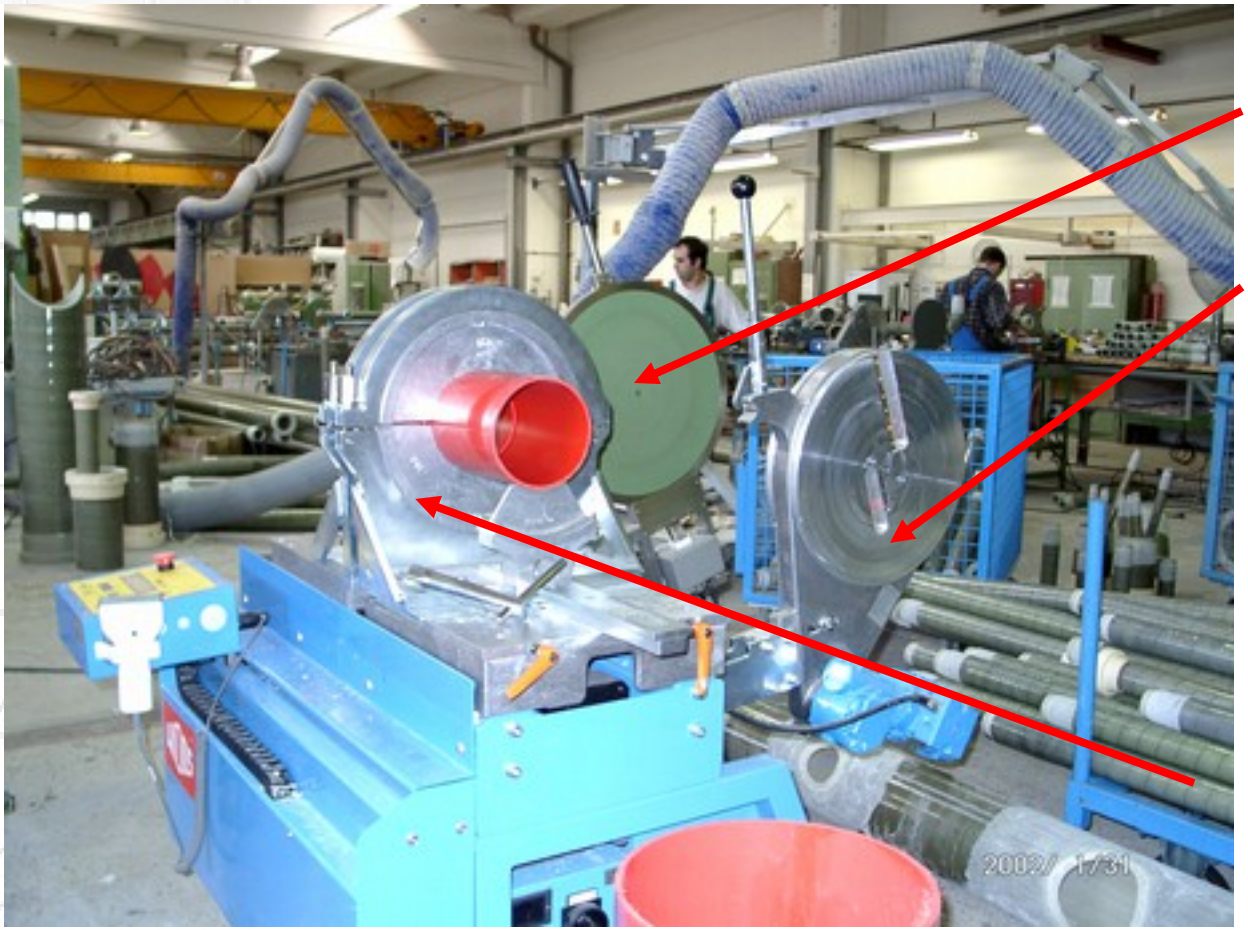
®KERAVERIN and ®KERAPOLIN Piping Systems
Butt-Welding Equipment for Dual Laminate Pipe Connection



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Recommendation of Material to be used in Membrane Technology

	Material	Temperature
Saturated Brine Ultrapure Brine	PP2222/FRP	95 °C
Repleted Brine	CPVC/FRP	95 °C
Recycled Brine with traces of Cl2	CPVC/FRP	70 °C
Feed Brine	PVC/FRP	70 °C
Caustic Soda 32 %	PP2222/FRP	95 °C 70 – 85 °C
Catholyte	PP2222/FRP	95 °C
Anolyte	CPVC/FRP	95 °C
Sodium Hypochlorite	PVC/CPVC FRP	50 °C
Hydrochloric Acid 32 %	PP2222/FRP	50 °C

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Cell Room Picture Chloralkali-Plant

Membrane Technology

Chlorine Headers CPVC/FRP

Alkali Headers PP2222/FRP

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CL2 DRYING & COOLING
Chloralkali-Plant

Membrane Technology

Chloring header
PVCC/FRP

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Our Products

KERAVERIN Equipments

Vessels, Scrubbers, Ductings, Absorption Towers, Separators

Max. Diameter ⇨ 5.500 mm

Max. Length ⇨ 15.000 mm

Temperature Range ⇨ -20 °C to +180 °C (-4 F to 356 F)

Dual Laminate Construction

KERA thermosetting equipment

Not available:
FRP with corrosion barrier due to local manufacturer all over the world

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KERAVERIN Equipments

Evaporator

PFA/FRP

Sulphuric Acid 75 % / 120 °C

Dimensions:

Diameter : 3 m

Length : 6,5 m

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KERAVERIN Equipments

Washing Towers TiO2-Plant

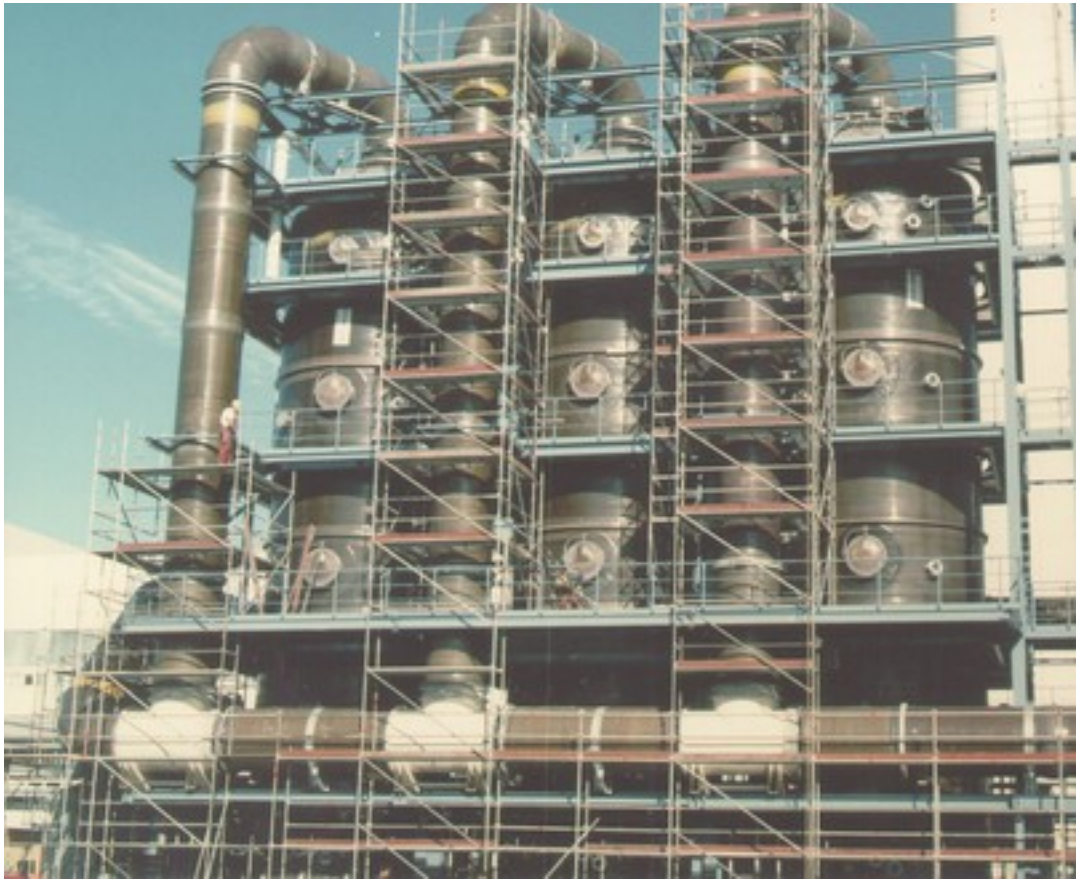
PP/FRP

SO2-Gas 80 °C / -0,2 bar

Dimensions:

Diameter : 5,2 m

Height : 20 m



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KERAVERIN Equipments

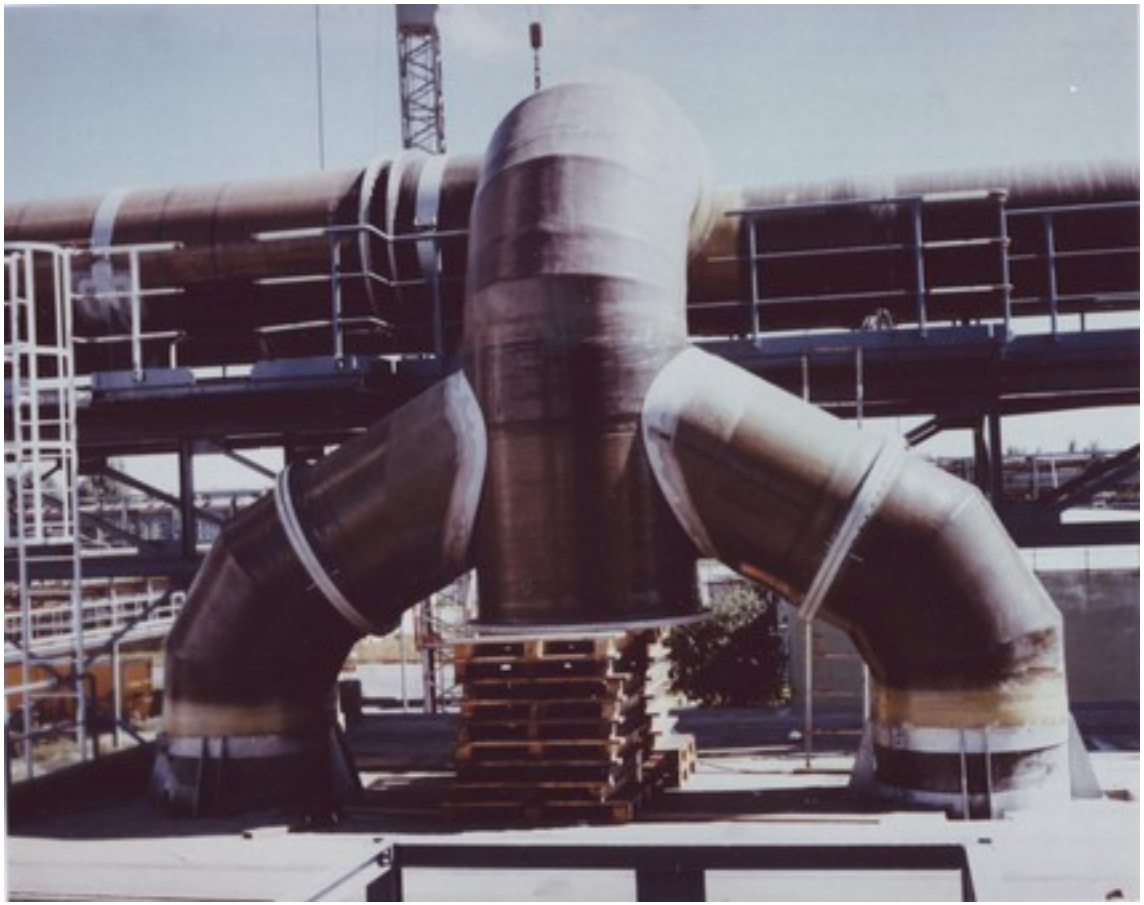
Ducting TiO2-Plant

PP/FRP

SO2-Gas 80 °C / 0,25 bar

Dimensions:

Diameter : 1,5 m



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®KERA

Thermosetting Resin Phenolic Based Columns and Internals

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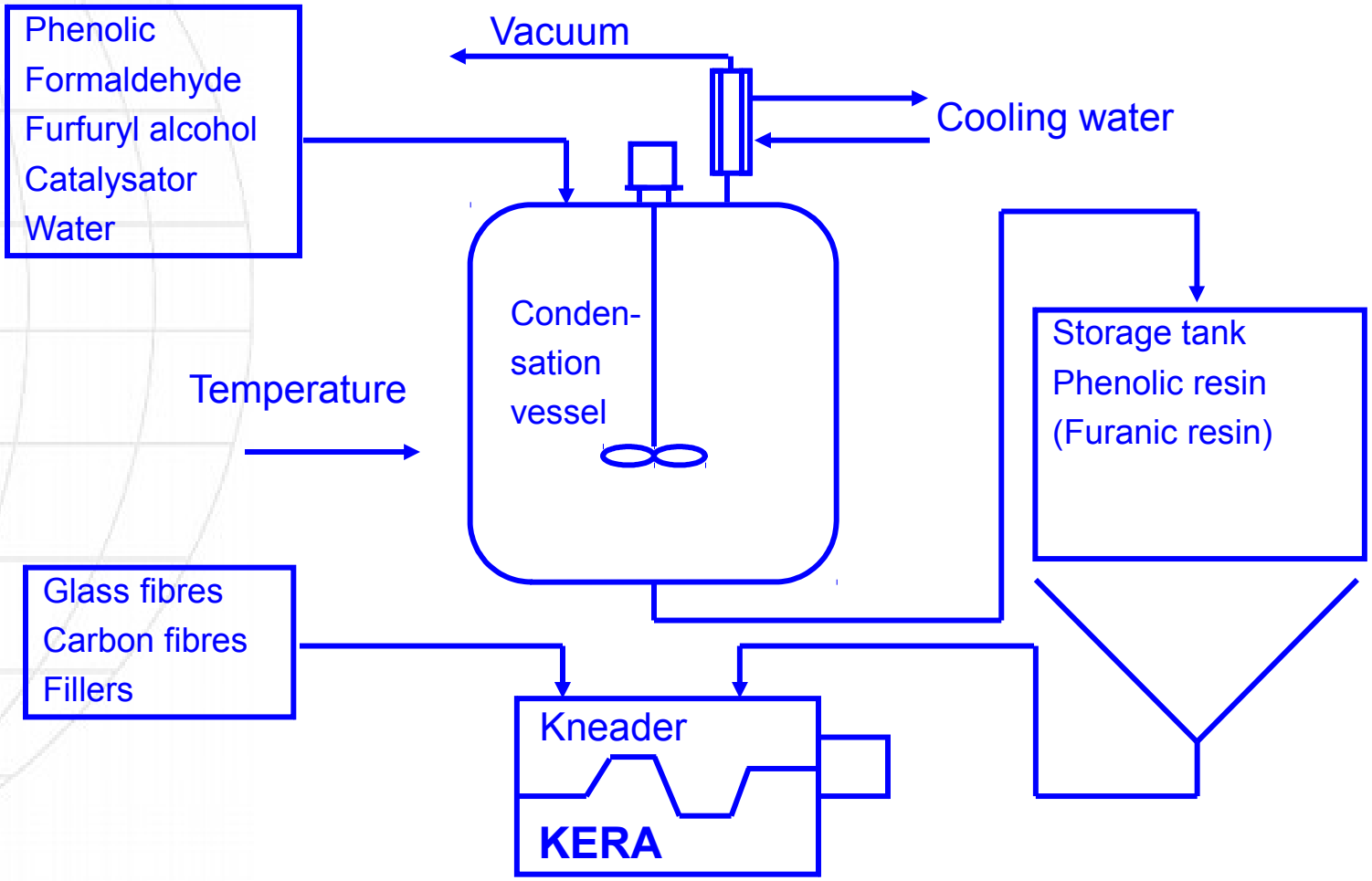
Production of Thermosetting Resin



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®KERA - the outstanding

- Duroplast on phenol-resin-basis, reinforced with glasfibers and/or carbonfibers as well as specific filler materials
- Outstanding resistance against non oxidizing acids and many solvents
- Applicable up to permanent operating temperatures of 140°C shorttime temperature peaks up to 170°C possible

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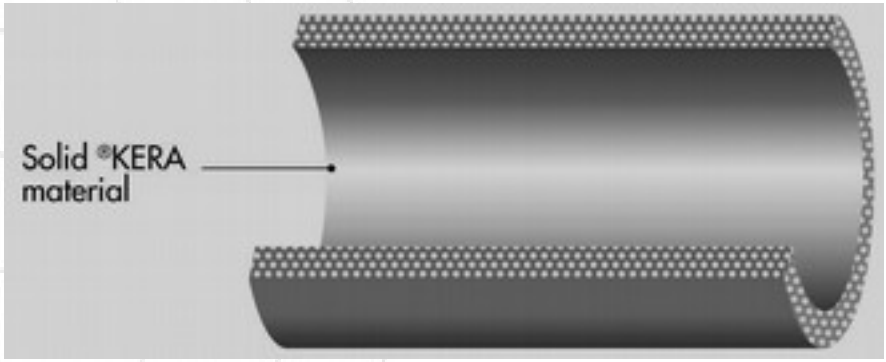
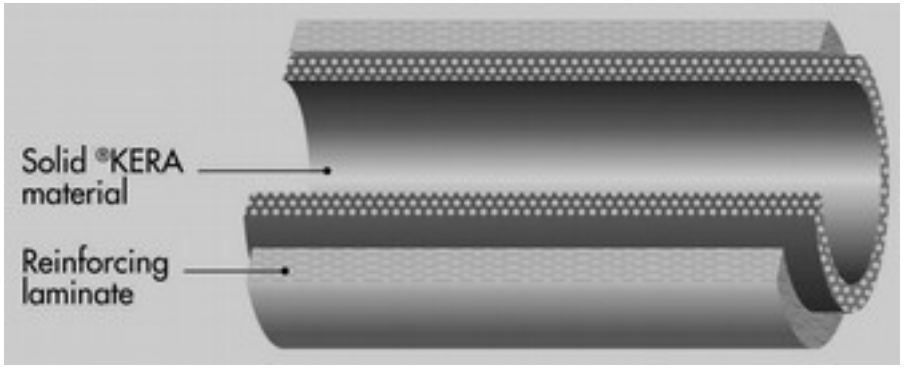
®KERA - the remarkable





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Our Materials

®KERA - at a glance

Media	SP 20	SP 21	SP 23	SP 30	FU 23
Non oxidizing acids	+	+	+	+	+
Oxidizing acids	-	-	-	-	-
SiO_2-dissolving acids	-	+	+	-	+
Salts	+	+	+	+	+
Water	+	+	+	+	+
Non oxitizing alkalies	-	-	-	-	o
Oxidizing alkalies	-	-	-	-	-
Aliphatic hydrocarbons	+	+	+	+	+
Aromatic hydrocarbons	+	+	+	+	+
Chlorhydrocarbons	+	+	+	+	+
Alcohol	O	O	O	O	O
Ester	O	O	O	O	O
Ketones	O	O	O	O	O
Oil and Fat	+	+	+	+	+

+ resistant **o limited resistance** **- not resistant**

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VC-Plant

HCl Tower

Diameter 2.2 m
Height: 15 m
Temperature 120 °C

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®KERAVERIN PTFE

PTFE/FRP Dual Laminate System For Corrosion Resistant Pipes And Vessels At High Temperatures

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Performance of fluorinated plastics

Material	Chemical resistance	Perm. operating temperature [°C]	Price	Availability sheet	Availability pipe	Weldability
PP **Polypropylene**	o	-15 up to 100	++++	++	++	+
PVDF Polyvinylidene fluoride	+	- 40 up to 150	+++	+	+	+
ECTFE Ethylene chlorotrifluoroethylene	++	- 76 up to 160	++	+	o	+
FEP Fluorienated ethylene propylene	+++	- 190 up to 205	o	+	o	+
MFA Tetrafluoroethylene perfluoromethylvinylether	+++	- 190 up to 250	-	+	--	+
PFA Perfluorated Vinylether	+++	- 190 up to 260	-	+	-	+
PTFE Polytetrafluoroethylene	+++	- 200 up to 260	++	+	+	-
PTFE **Modified Polytetrafluroethylene**	+++	**- 200 up to 260**	+	+	+	+

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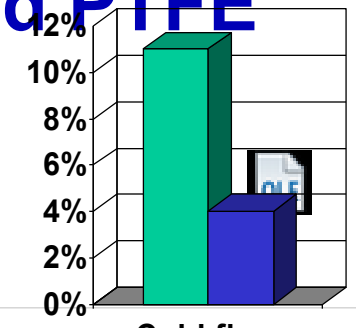
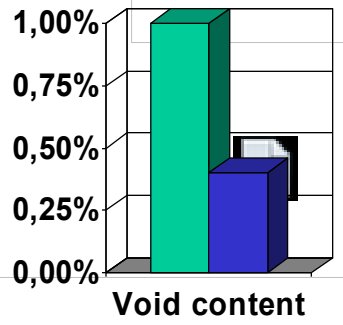
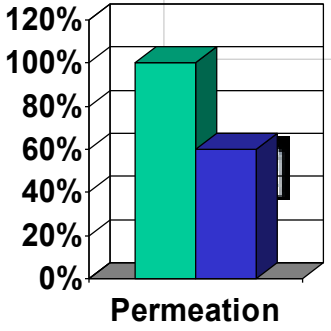
Property profile of modified PTFE

- Substantially
  lower deformation under load
- Higher density
  of polymer structure
- Lower permeation





Standard PTFE



Modified PTFE

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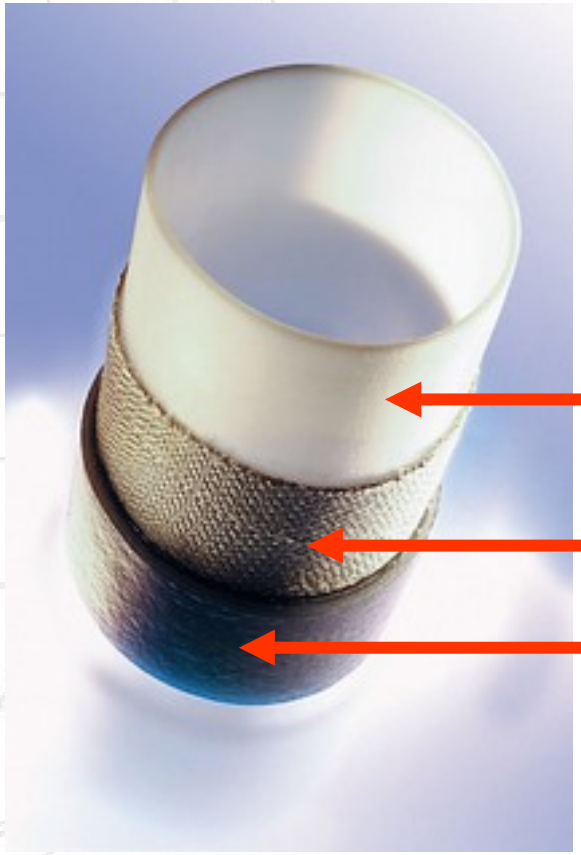
Wall construction



PTFE liner

Bonding layer

FRP reinforcement

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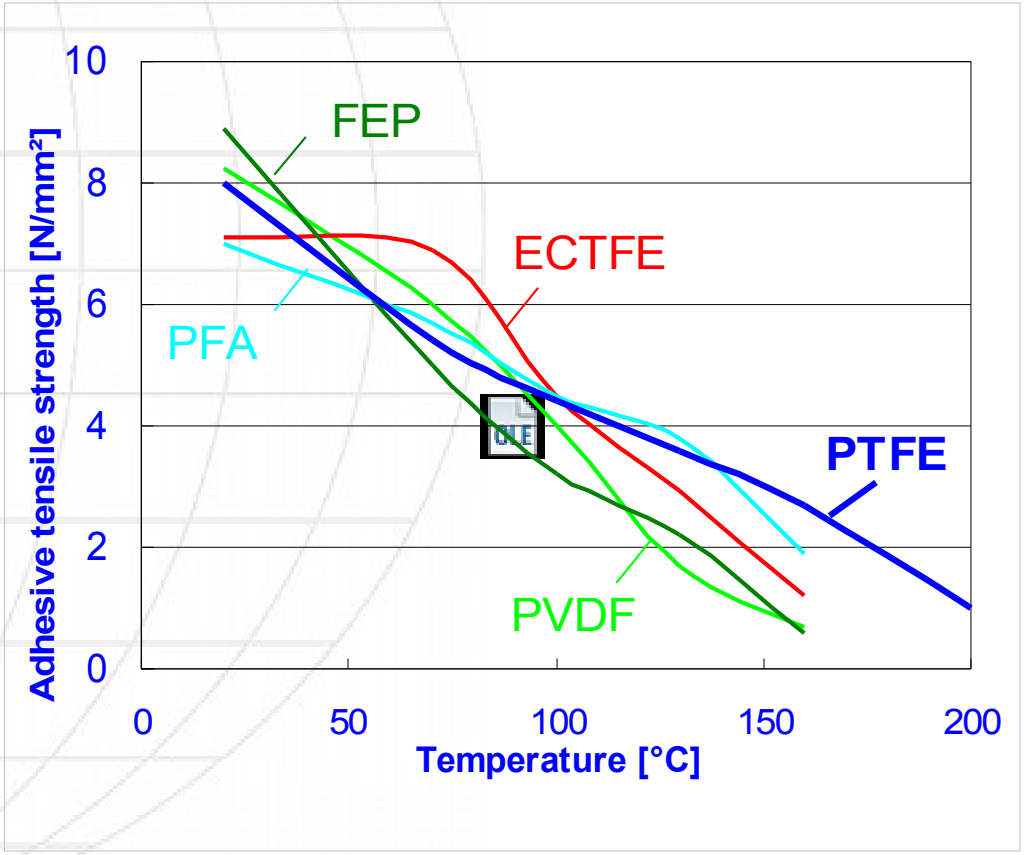
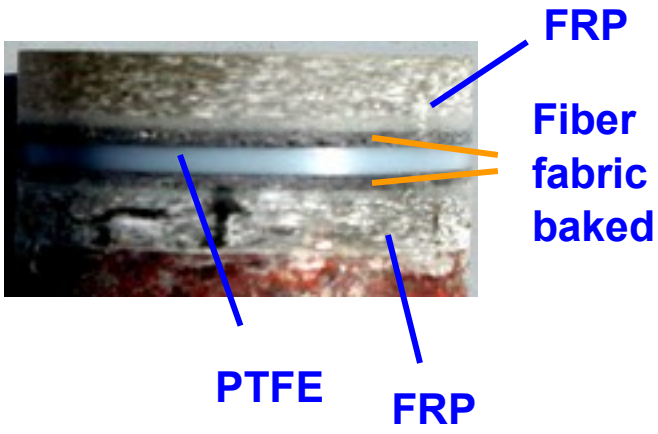
Thermo-mechanical properties of PTFE/FRP dual laminate



Test specimen



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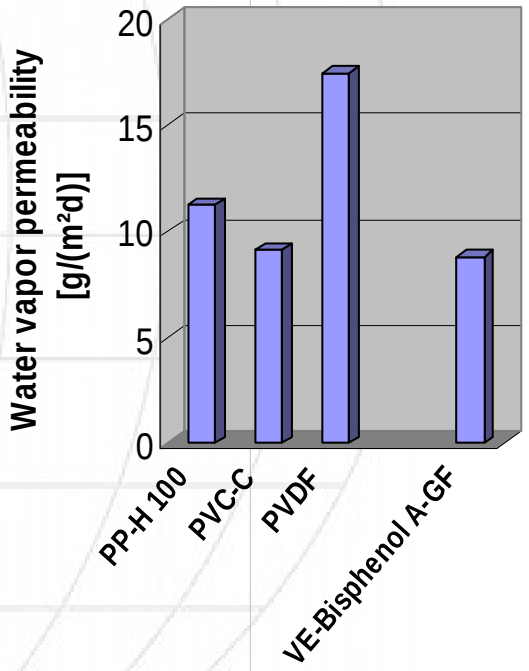
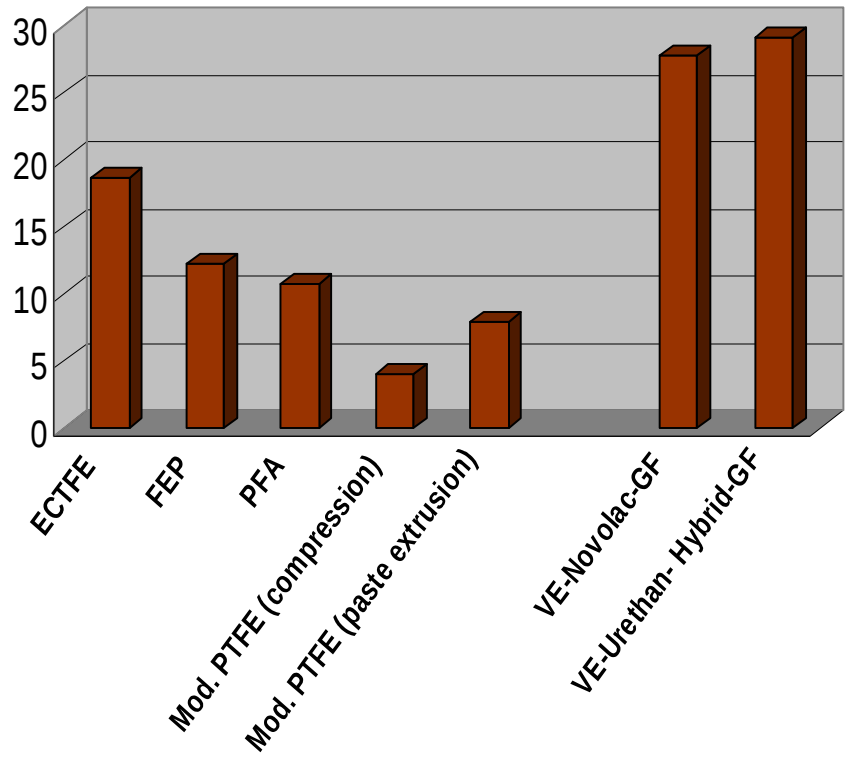
Permeation

- Water vapor permeability according to ISO 15106-3 (specimen thickness = 2 mm)

Temperature = 100 °C (partial pressure = 1 bar)



Temperature = 130 °C (partial pressure = 2,7 bar)



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Summary of KERAVERIN PTFE references

Piping more than 1600 m
Vessels more than 1000 m²

Country	Pressure	Temp.	Medium	Size	Type	Date	Comment
Sweden	2 bar	200 °C	process fluid	DN 100 L = 6 m	jet pipe	Mar 01	
Germany	pressure less	80 °C	process water with dichloroethane, hydrochloric acid 10 %, caustic 10 %	DN 300 DN 500 L = 60 m	pipe system	Jul 01	electrically-conductive
Germany	2 bar	30 °C	HCl gas with cyclic siloxanes	DN 100 L = 0.8 m	flanged pipe, elbow	Apr 02	
Belgium	1 bar	170 °C	phosphoric acid with traces of hydrofluoric acid	DN 80 L = 0.5 m	flanged pipes	May 02	glass + carbon backing
Germany	pressure less	110 °C	TCPP brine	DN 80 L = 0.5 m	flanged pipe	May 02	
Germany	1.4 bar	50 °C	cerium sulfate 18.5 %, sulphuric acid 8 %	DN 80 L = 2.5 m	flanged pipe with elbow	Jun 02	
Germany	pressure less	90 °C	waste gas dichloro benzene production	DN 150 L = 0.5 m L = 4 m	flanged pipe	Jul 02 Dec 02	electrically-conductive

Country	Pressure	Temp.	Medium	Size	Type	Date	Comment
Germany	2 bar	30 °C	paraffin oil with sulphur chlorine parts	DN 50 L = 0.5 m	flanged pipe	Jul 02	electrically-conductive
Germany	unknown	unknown	cyanogen chloride media	DN 200 L = 1 m	flanged pipe	Jul 02	
Germany	PN 16	50 °C	Methanole 10 - 20 %, sulfuric acid, perflouro octane acid and traces of tensides	DN 100	Elbow with Tee	Sep 02	
Germany	4 bar	140 °C	unknown	DN 50	Header	Sep 02	electrically-conductive
Germany	4 bar	140 °C	unknown	DN 25 DN 50	Elbow with Tee	Oct 02	electrically-conductive
Germany	0.49 bar	80 °C	nitogen with HCl fumes, silicone oils	DN 500 L = 4.5 m	Waste gas header	Oct 02	electrically-conductive
Germany	PN 16	50 °C	chlorine drying: sulfuric acid 50 %	DN 100	Tee	Oct 02	

Country	Pressure	Temp.	Medium	Size	Type	Date	Comment
Germany	Vacuum	180 °C	hydrofluoric acid 10 %, sulfuric acid 85 %, water 5 %	DN 80	Flanged pipe, Elbow, Tee	Oct 02	carbon backed liner and reinforcement
Germany	-	150 °C	Chloroacetic acid	DN 50 L =0.5 m	Flanged pipe	Nov 02	
Germany	unknown	70 °C	unknown	DN 50	Flanged pipe	Nov 02	
Germany	2 bar	120 °C	glycerine 20 %, methanole 10 - 20 %, sodium chloride 1 %	DN 40 L = 40 m	Piping system	Nov 02	
Germany	4 bar 10 bar	160 °C 110 °C	Hydrochloric acid 17 % 30 %	DN 100 L = 5 m	Piping system	Dec 02	carbon backed liner
Germany	-0.96 bar	80 °C (120 °C)	HCl exhaust vapours max. 20 %	DN 150 L = 25 m	Piping system	Dec 02	
Spain	Vacuum resp. 5 bar	150 °C	Sulfuric acid 80 %, solids 1 %	DN 500 L =0.9 m	Flanged pipe	Dec 02	

Country	Pressure	Temp.	Medium	Size	Type	Date	Comment
Austria	PN 16	50 °C	sulfuric acid 70 %	DN 50 DN	Special elbow Concentric	Mrz 03	

Country	Pressure	Temp.	Medium	Size	Type	Date	Comment
Germany	pressure-less	60 °C	process water with solvents, acid and brine	DN 1300 V = 3 m³	process vessel	Jun 01	electrically conductive
Germany	2.5 bar	100 °C	hydrochloric acid and ortho dichloro benzene	DN 600 L = 1.7 m	process vessel	Apr 02	
Germany	0.1 bar	150 °C	sulfuric acid 15 %	DN 200 L = 6.7 m	column	Apr 02	
Belgium	-0.9 bar	125 °C	phosphoric acid with parts of hydrofluoric acid	DN 2500	column parts	Oct 02	carbon fibre backing and carbon/glass reinforcement
Maroc	min. -0.89 bar	135 °C	phoshoric acid 85 % with hydrofluoric acid 300 ppm and chlorine 200 ppm	DN 2850 L = 2.6 m	column part	Nov 02	carbon fibre backing and carbon/glass reinforcement
Germany	pressure-less	max. 200 °C	oleum 6 % and steam with sulfur trioxide and hydrogen sulfide	DN 4800	upper shell of an exposure vessel	Feb 03	

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Country:	**Germany**	**Temperature:**	**80 °C**
Medium:	**nitrogen with HCl fumes and silicone oils**	**Pressure:**	**0.49 bar**
		Date:	**October 2002**
Resin:	**vinyl ester based on bisphenol A**	**Comment:**	**electrically-conductive (PTFE and FRP)**

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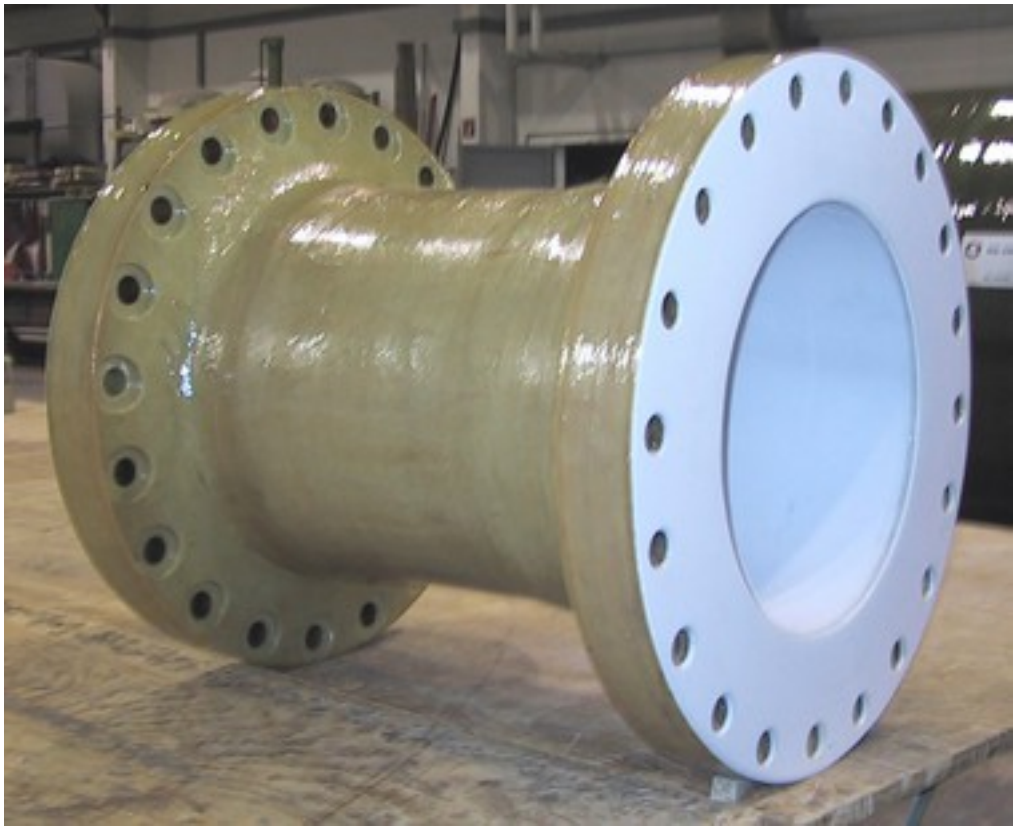
Flanged pipe DN 500; L = 0.9 m

Country:	**Spain**
Medium:	**Sulfuric acid 80 % solids 1 %**
Resin:	**vinyl ester urethane hybrid**
Temperature:	**150 °C**
Pressure:	**vacuum resp. 5 bar**
Date:	**December 2002**



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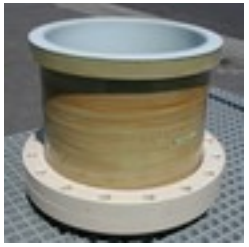
Flanged pipes DN 50, 80, 40

Country:	**Netherlands**
Medium:	**Chloroacetic acid; Process upset: chlorine –40 °C**
Resin:	**vinyl ester urethane hybrid**
Diameter:	**DN 50 DN 80 DN 400**
Temperature:	**160 °C 140 °C 100 °C**
Pressure:	**3 bar 6 bar vacuum**
Date:	**July 2003**
Comment:	**carbon backed lining**



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Upper shell of an exposure vessel DN 4800

Place:	**Germany**
Medium:	**Oleum 6 % and steam with sulphur trioxide and hydrogen sulfide**
Resin:	**vinyl ester urethane hybrid**
Temperature:	**max. 200 °C**
Pressure:	**atmospheric**
Date:	**February 2003**