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New development of fibre-reinforced plastic piping for the chloralkali electrolysis

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ALPHARESIST

NEW GENERATION plastic piping with fibre free CRB for the chloralkali electrolysis

Content:

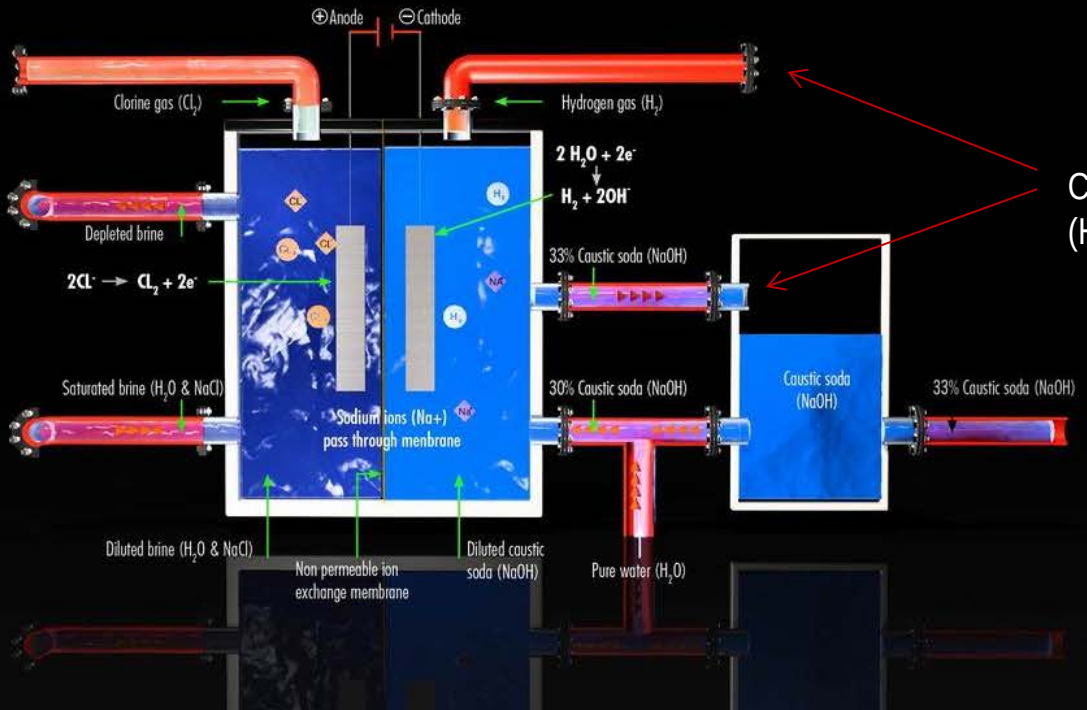
- Motivation
- Idea
- System
- Lab-testing
- Field-testing
- Summary

ALPHARESIST is made by ALPHAPLAST, S.L., a member of the STEULER group

Motivation | Chlor-alkali-electrolysis

The membrane cell process with high-maintenance piping

Anolyte piping
(Depleted brine)



Catholyte piping
(Hydrogen gas)

Motivation | Anolyte piping

Medium	≈ 17 % NaCl, ≤ 1 % Na_2SO_4,≤ 1 % $NaClO_3$, Cl_2 saturated
Temperature	≈ 85 – 95 °C
Working pressure	PS ≈ 0.2 barg – 3 barg
pH-value	1.5 – 5 (max. 12)

Motivation | Anolyte piping

Material system CPVC/FRP
Chemical resistance extremely dependent on pH-value
(pH ≥ 3 -> HOCl -> fast destruction)

Material system FRP with corrosion resistance barrier (CRB)
(Glass content CRB ≤ 30%) or FRP with overall low glass content

Chemical attack dependent on load and:

- Resin type (VIAPAL UP 797, DERAKANE MOMENTUM 470, DERAKANE 510 N etc.)
- curing agents
- glass content -> glass is not resistant

Quantity of attack ≈ 0.3 to 1 mm/a

Obstruction of the cell membrane and the piping with worn out glass fibres

Motivation | Anolyte piping

Nominal diameter	Surface	Removal volume	FRP	glass
DN 50	7.85 m^2	3.93 dm^3	6283 g	1885 g
DN 80	12.57 m^2	6.28 dm^3	10053 g	3016 g
DN 100	15.71 m^2	7.85 dm^3	12566 g	3770 g
DN 150	23.56 m^2	11.78 dm^3	18850 g	5655 g
DN 200	31.42 m^2	15.71 dm^3	25133 g	7540 g
DN 400	62.83 m^2	31.42 dm^3	50265 g	15080 g

Examples of annually attack:

- Length of Pipe: 50 m
- Glass content of CRB: 30 %
- Annual chemical abrasion: 0.5 mm/a
- Density of CRB: 1.6 kg/dm^3

Motivation | Catholyte piping

Medium	≈ 32 % NaOH , ≤ 20 ppm $NaClO_3$
Temperature	≈ 85 – 95 °C
Working pressure	< 1.5 barg

Material systems:

PP-B (PPH 2222/36)/FRP

PP-R (RA130E-8427)/FRP

PVC (DEKADUR Plus)/FRP (only in exeptional cases)

Motivation | Catholyte piping

Hot caustic

Decomposition of PP-stabilisers

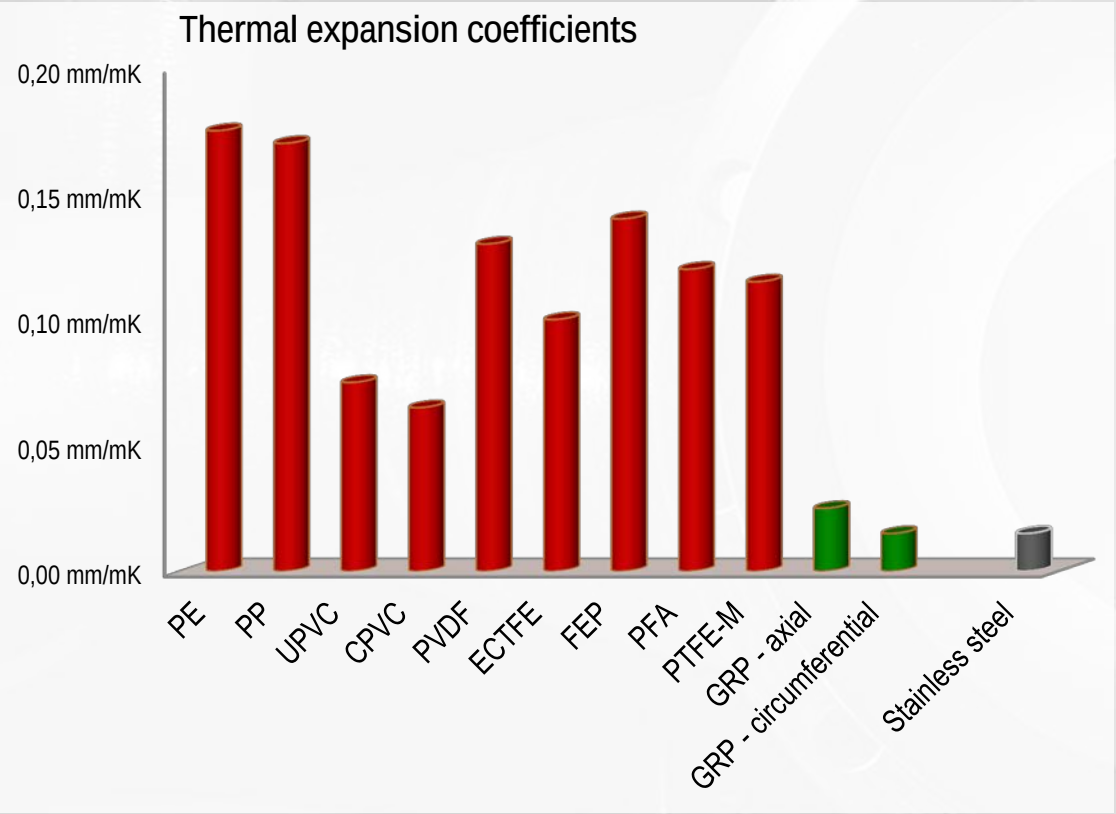
Result

- Stress cracking in welds
- Caustic glass corrosion!

Motivation | Catholyte piping

Different coefficients of thermal expansion

Increase of starts and shutdowns results in debonding of lining



Motivation | Catholyte piping

Temperature changes generate high shear stresses between FRP and lining

Debonding of PP-lining

Idea | System for Anolyte piping

Development of an adapted FRP system without glass fibres in the CRB and reduced attack to the piping

CRB	Resin	VE-NK- or UP-HET-type
	“Reinforcement”	Instead of glass fibres use of inert mineral powder
Structural laminate	Resin	VE-NK- or UP-HET-type
	Reinforcement	Glass fibre
Type name		ALPHARESIST-A

Idea | System for Catholyte piping

Development of an adapted FRP system without glass fibres in the CRB and reduced attack to the piping

CRB	Resin	Epoxy-type
	“Reinforcement”	Instead of glass fibres use of inert mineral powder
Structural laminate	Resin	Epoxy-type
	Reinforcement	Glass fibre
Type name		ALPHARESIST-K

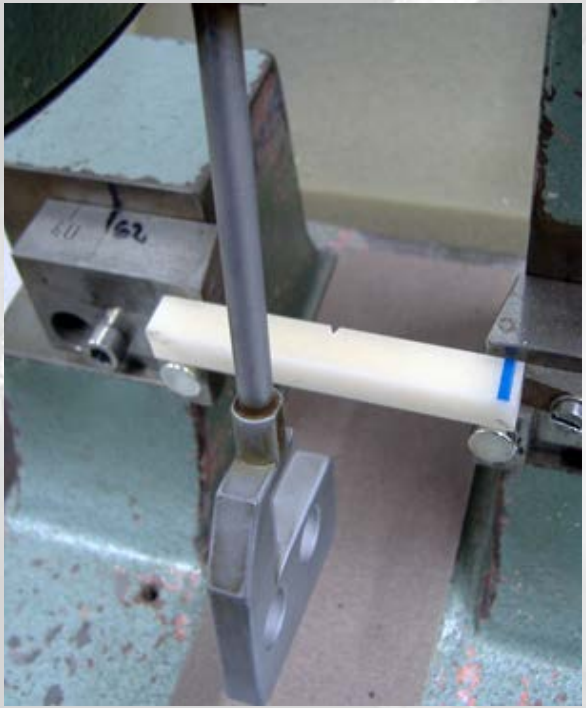
Lab-testing | at Alphaplast, Spain

Specimen preparation:

- Sheet
- Pipe

With different:

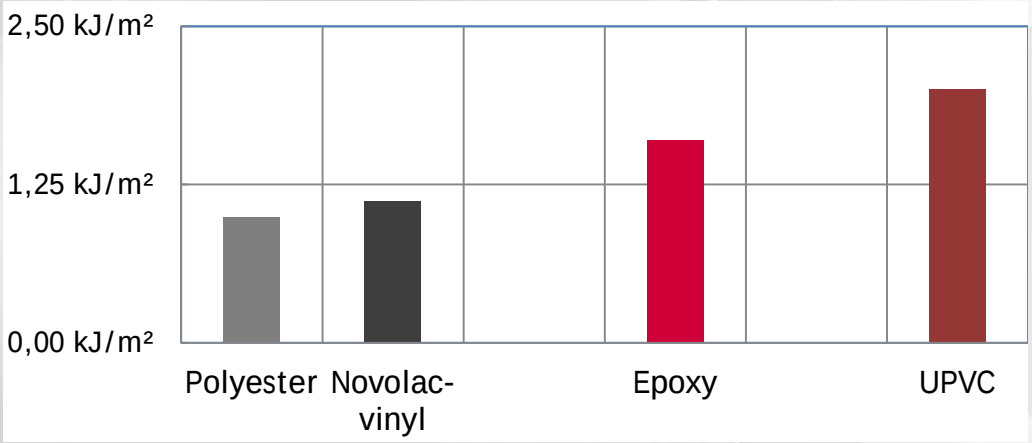
- Resins
- Curing systems / hardener
- Fillers (type,content)



Lab-testing | Impact properties

CHARPY impact strength according to DIN EN 179-1

Lab-testing | Impact properties



ALPHARESIST for anolyte

ALPHARESIST for catholyte

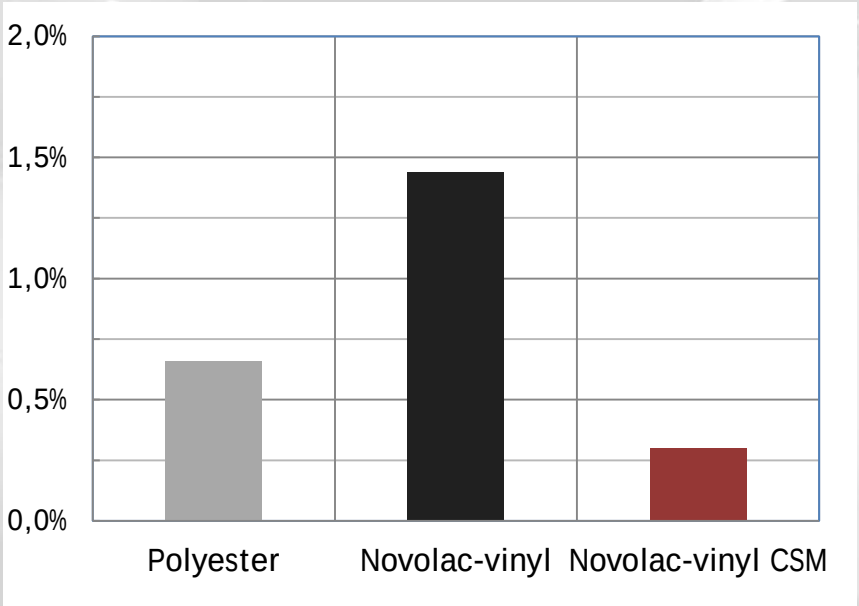
PVC Lining

CHARPY impact strength according to DIN EN 179-1

Impact strength of ALPHARESIST CRB with a filler content of 30 % is slightly lower than that of PVC

Check of ultimate elongation

Lab-testing | Ultimate elongation



ALPHARESIST
anolyte piping
CRB with 30 % mineral filler

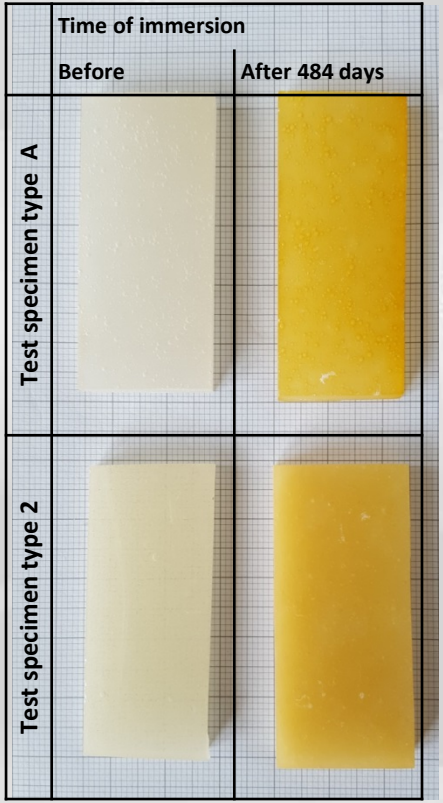
Traditional CRB
min. requirement
according to
DIN EN 13121-3

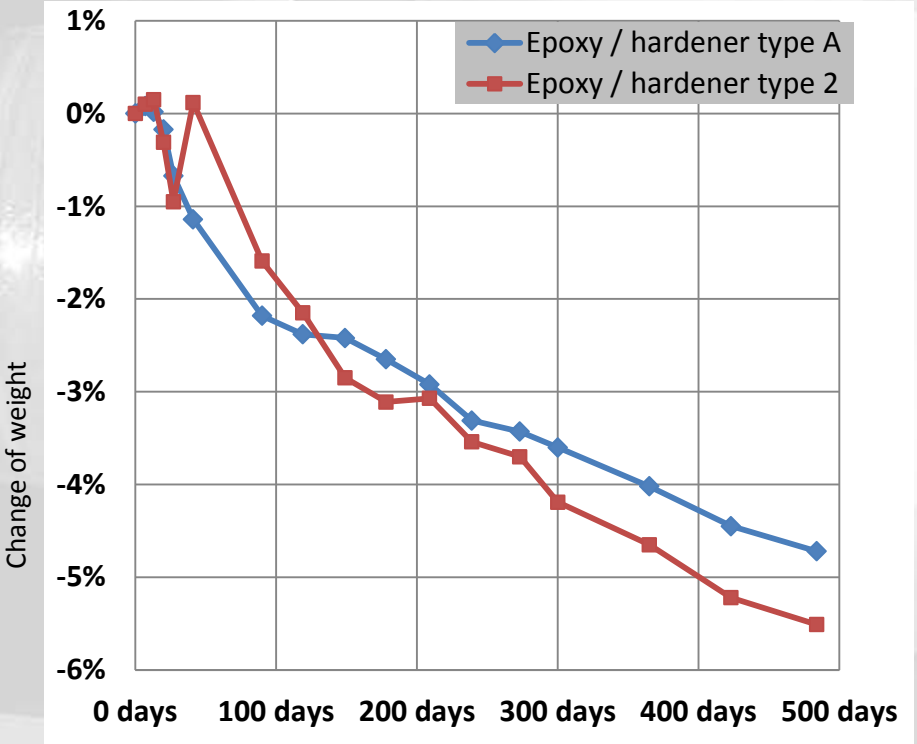
Design strain for ALPHARESIST anolyte piping determined with bending tests

Catholyte piping with epoxy resin shows higher ultimate strain

Requirement of design strain fulfilled by ALPHARESIST

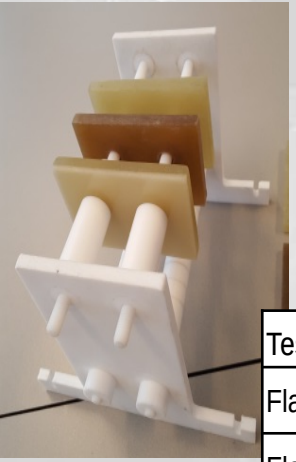
Lab-testing | ALPHARESIST-K





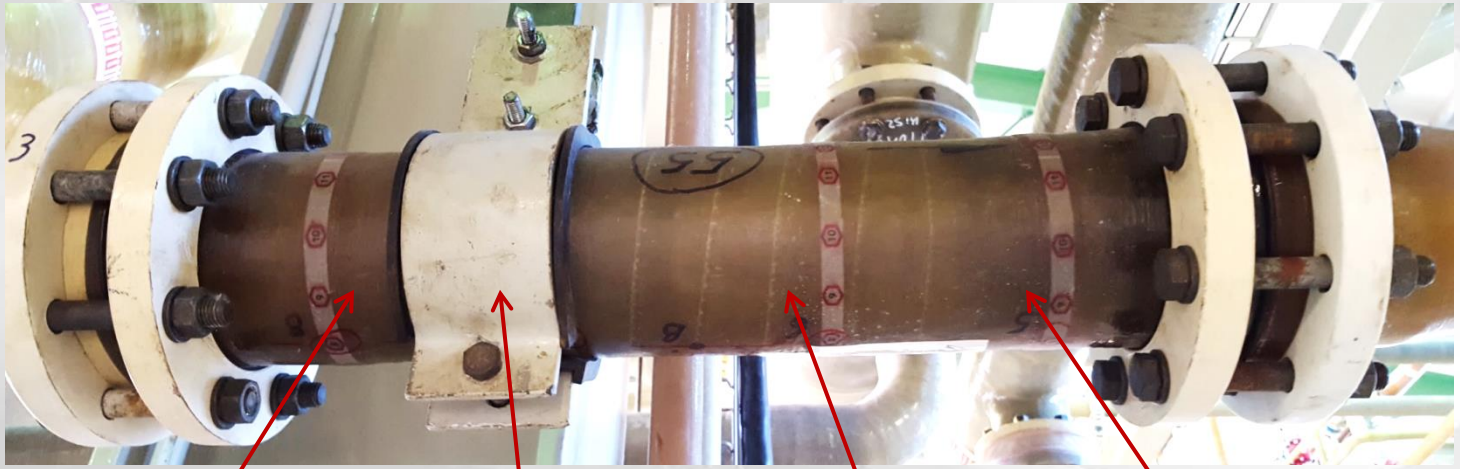
Immersion to
32% NaOH at 100 °C

First field tests | ALPHARESIST



Test piece	Load	Material	Resin	Filler	Location of electrolysis	Duration
Flanged pipe DN 100 x 600	Anolyte	Alpharesist-A	VE-NK, UP-HET	Two different types	Germany	Since April 2016
Flanged pipe DN 150 x 1000	Catholyte	Alpharesist-K	Epoxy	Ceramic	Middle East	Coming soon
Bypass piping DN 150 x 6000	Catholyte	Alpharesist-K	Epoxy	Ceramic	Germany	Since May 2017
Piping isometric DN 80	Anolyte	Alpharesist-A	VE-NK	Ceramic	Middle east	Upcoming
Piping isometric DN 100	Catholyte	Alpharesist-K	EP	Ceramic	Middle east	Upcoming
4 flanged pipes DN 100 x 600	Anolyte	Alpharesist-A	VE-NK UP-HET	Two types	Germany	Since May 2017

Field test | ALPHARESIST-A in a anolyte piping



Pipe	Load	Material	Resin	Filler	Location	Duration	Remarks
DN 100 x 600	Anolyte	ALPHARESIST-A	VE-NK, UP-HET	Two different types	Germany	Since April 2016	No anomalies at inspection May 2017

Field test | ALPHARESIST-K in a catholyte piping

Pipe	Load	Material	Resin	Filler	Location	Duration	Remarks
DN 150 x 6000	Catholyte	ALPHARESIST-K	Epoxy	Ceramic	Germany	Since May 2017	No anomalies

Summery | ALPHARESIST

Anolyte piping

- Glass-fibre free chemical protection layer based on special polyester or vinyl ester resin
- No contamination or blockage from removed glass fibres
- Optimized maintenance intervals

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Summery | ALPHARESIST

Catholyte piping

- Glass-fibre free chemical protection layer based on epoxy resin
- Full fibre-reinforced plastic piping without thermoplastic lining
- Homogenous material system
- Easy erection on-site without welding

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STEULER KCH

ALPHARESIST

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THANK YOU FOR YOUR ATTENTION