CORROSION RESISTANCE AND HEAT TRANSFER

GAB neumann

Heat Exchangers and Components in Graphite and Silicon Carbide

GRAPHITE AND SILICON CARBIDE

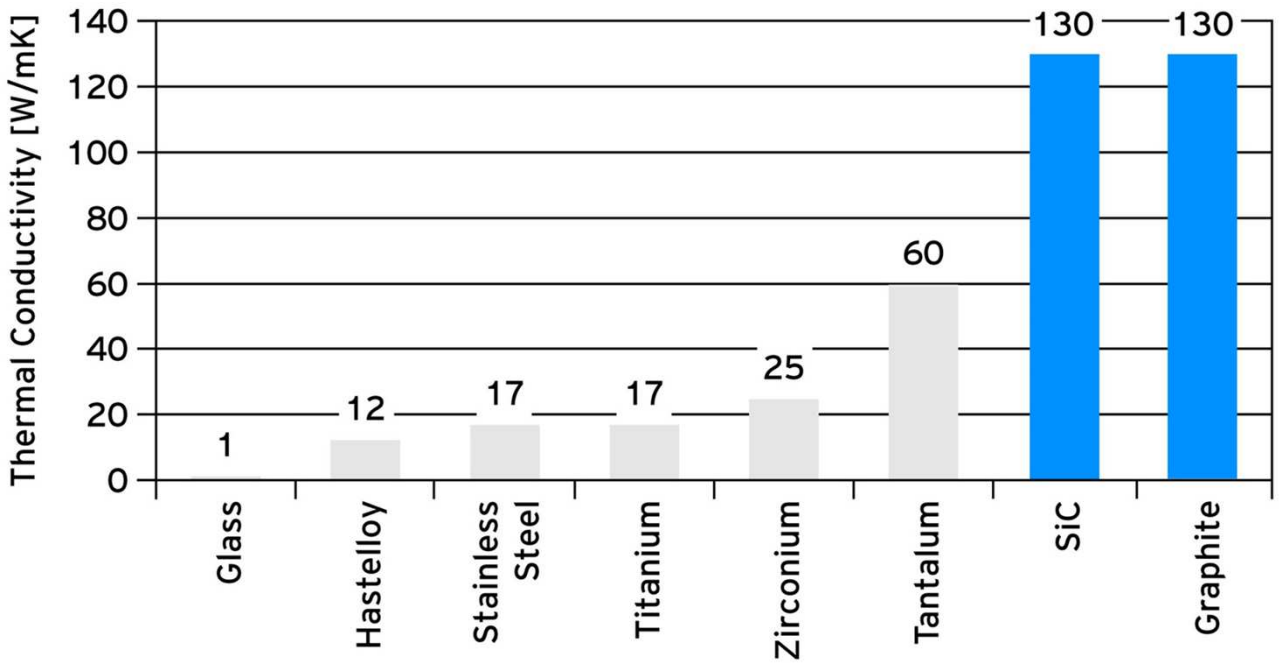
MATERIAL AND DESIGN

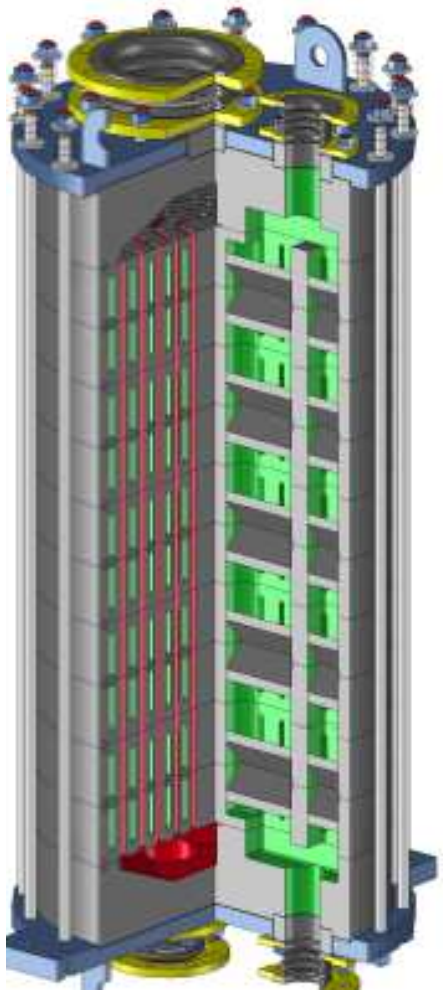
SILICON CARBIDE AND GRAPHITE HEAT EXCHANGERS APPLICATIONS

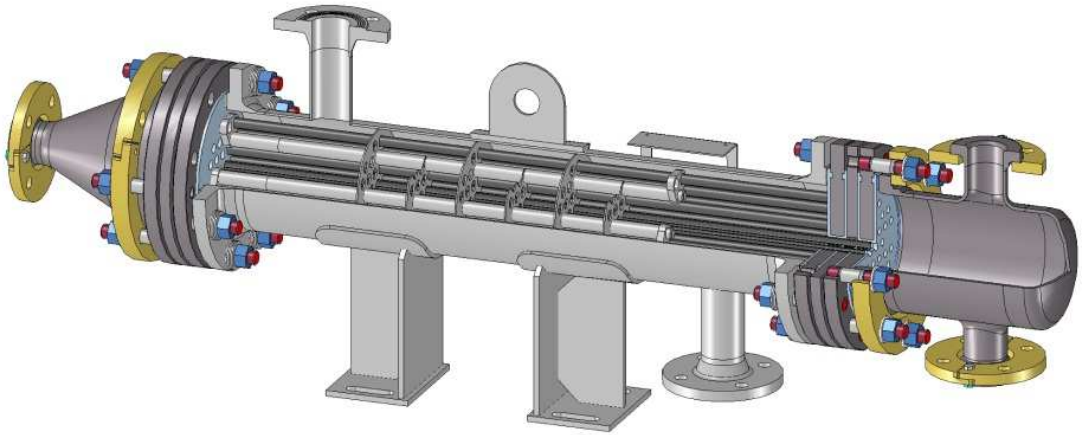
Agrochemicals, Active Pharmaceutical Ingredients, Flavors, Fine Chemicals, Steel Copper Pickling, Automotive Batteries, Advanced Polymers

GAB Neumann GmbH | Alemannenstrasse 29 | 79689 Maulburg
T +49 (7622) 6751-0 | F +49 (7622) 6751-20 | info@gab-neumann.de

GRAPHITE AND SILICON CARBIDE THERMAL CONDUCTIVITY







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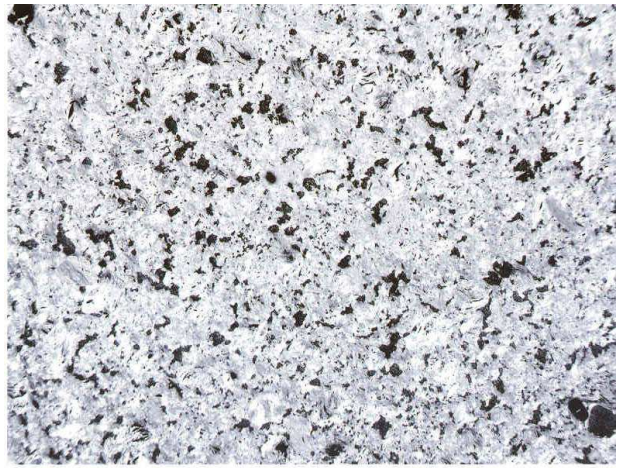
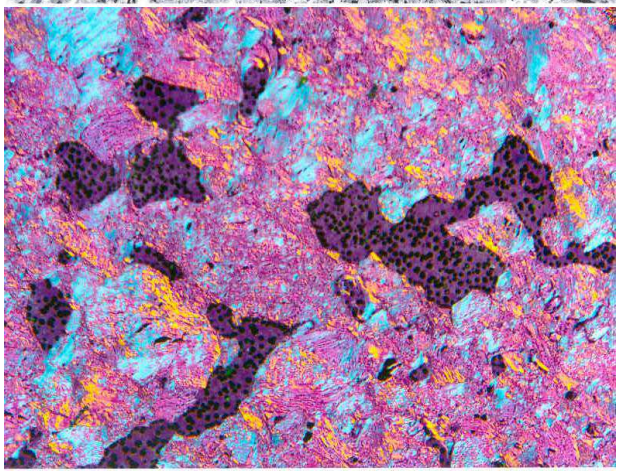
Corrosion Resistant Heat Exchangers and Components

SYNTHETIC RESIN IMPREGNATED GRAPHITE PROPERTIES

		GAB Neumann		
		GPX1	GPX1T	GPX2
Density	g/cm³	1,9±0,02	1,9±0,02	1,9±0,02
Max. grain size	mm	0,8	0,8	0,8
Resin content [1]	%	≤22	≤22	≤15
Permeability	cm²/s	10^{-6}	10^{-6}	10^{-6}
Tensile strength (at 20°C)	N/mm²	≥18	≥18	≥20
Flexural strength (at 20°C)	N/mm²	≥32	≥32	≥35
Compressive strength (at 20°C)	N/mm²	60-80	60-80	60-80
Identification according AD 2000 Merkblatt		G18-0-180 [2]	G18-0-200 [2]	G20-0-200 [2]
GXX-...-... (tensile strength at 20°C)	N/mm²	18	18	20
G...-XX-... (drop in strength per +10K)	‰	0	0	0
G...-...-XX (max. admissible temperature)	°C	180	200	200





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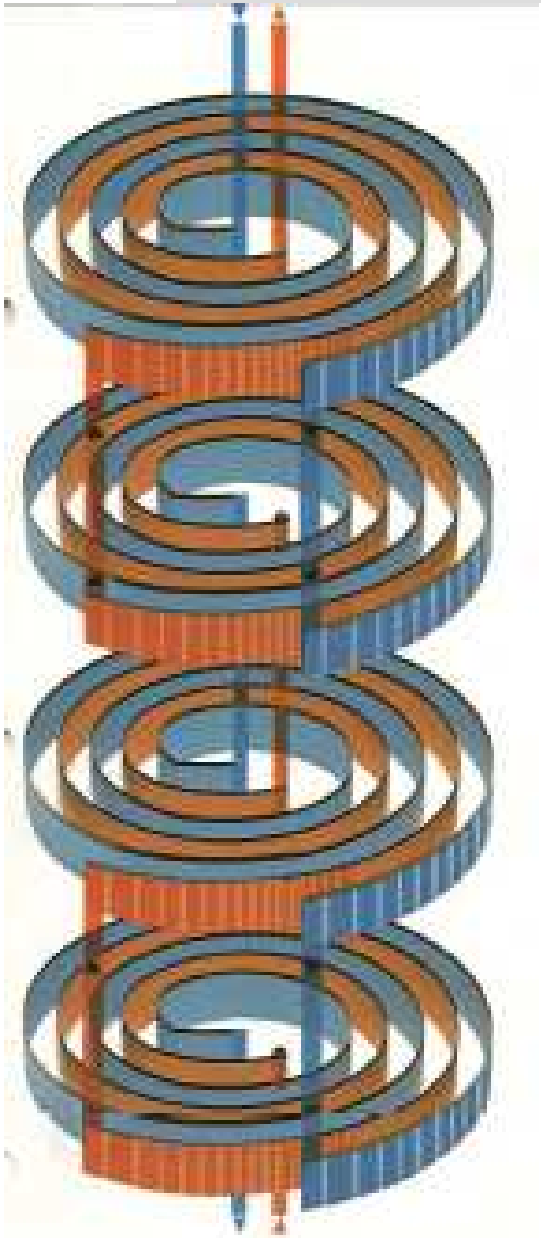
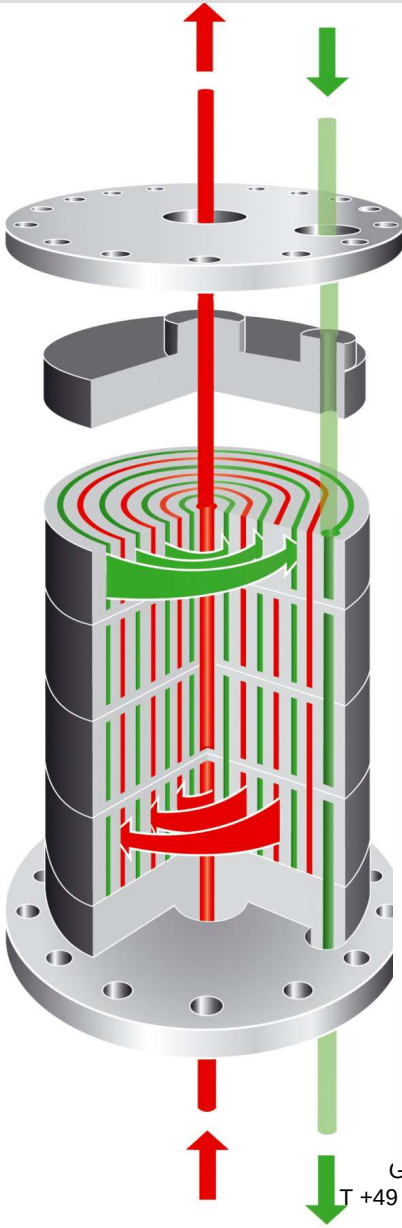
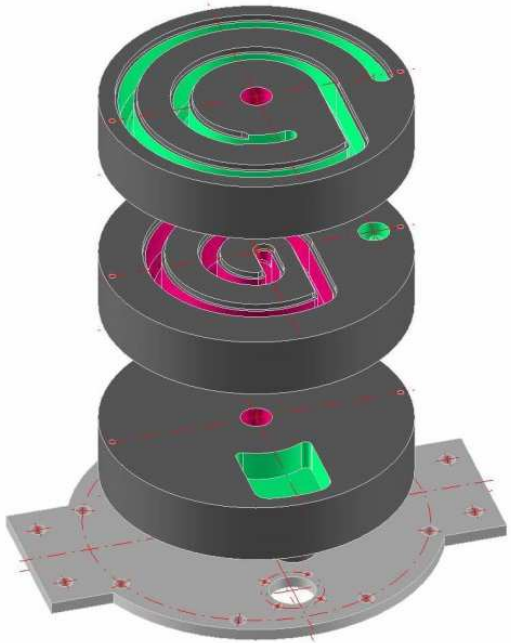
Corrosion Resistant Heat Exchangers and Components

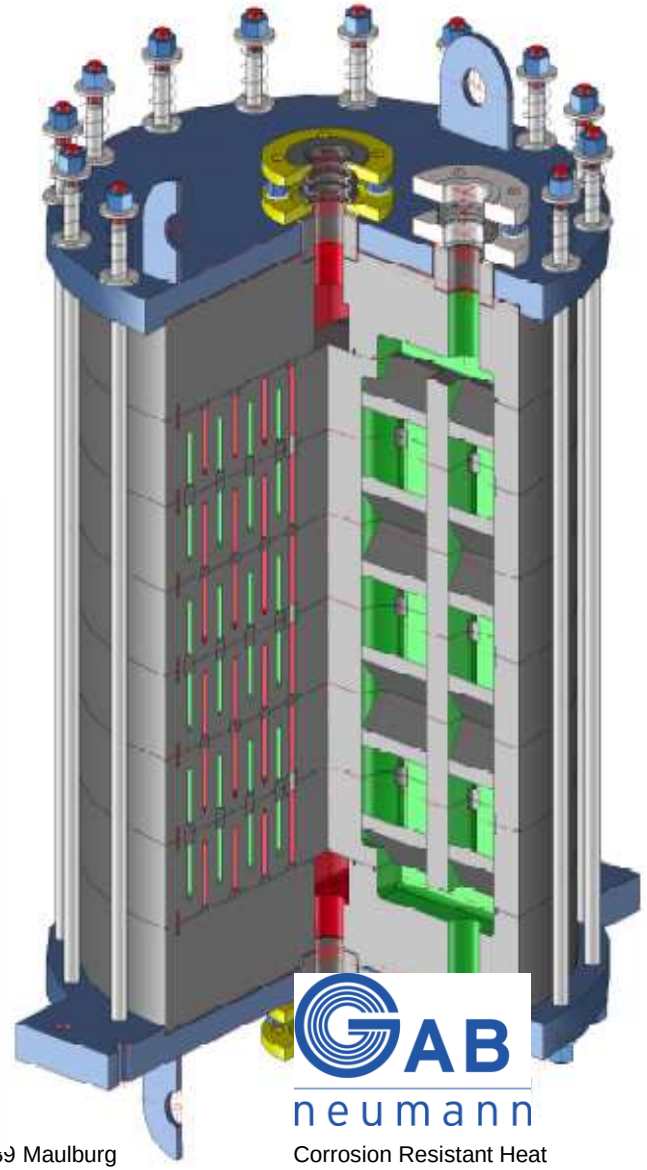
SYNTHETIC RESIN IMPREGNATED GRAPHITE HEAT EXCHANGERS

ANNULAR GROOVE DESIGN PRINCIPLE









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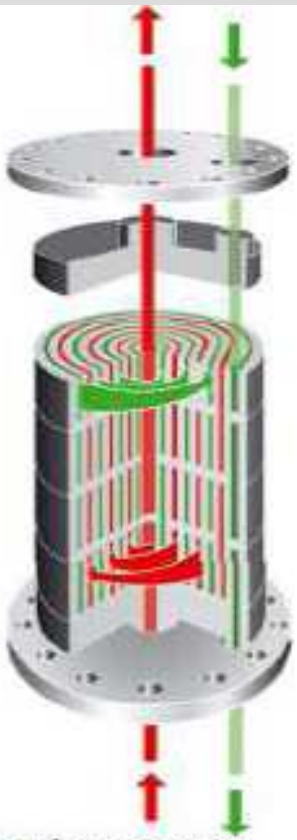
Corrosion Resistant Heat Exchangers and Components

SYNTHETIC RESIN IMPREGNATED GRAPHITE HEAT EXCHANGERS

ANNULAR GROOVE TYPES

Annular-groove condenser

for vertical or horizontal installation
GMP design optionally



Annular-groove heat exchanger

high performance due to optimal flow cross section and real counterflow

Heat exchanger GN type

with large flow cross-section on process side, e.g. as vent condenser or behind dry vacuum pumps

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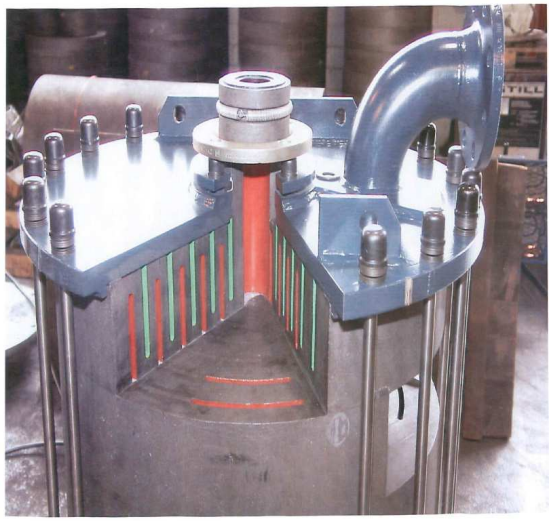
SYNTHETIC RESIN IMPREGNATED GRAPHITE HEAT EXCHANGERS

ANNULAR GROOVE MANUFACTURING



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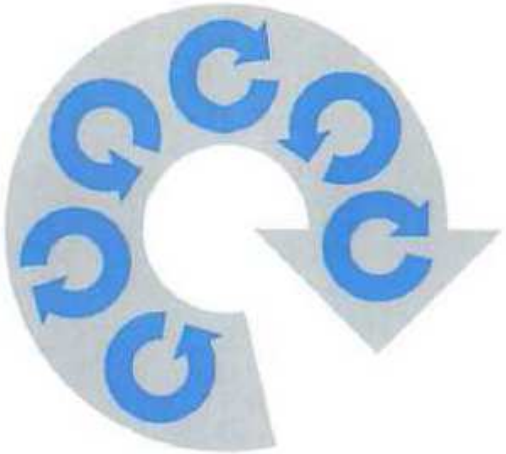
Exchangers and Components

SYNTHETIC RESIN IMPREGNATED GRAPHITE HEAT EXCHANGERS
ANNULAR GROOVE DESIGN BENEFITS

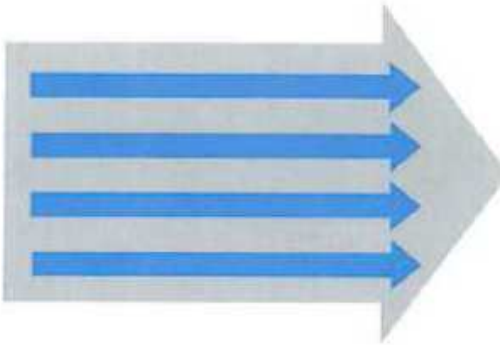
Annular-groove design



"Spiral" groove arrangement means

- High turbulent flow
- No fouling, no sedimentation
- High heat transfer
- Full counter flow

Block design



Linear flow arrangement means

- Laminar flow
- Tendency to fouling and sedimentation
- Lower heat transfer
- Only cross flow

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SYNTHETIC RESIN IMPREGNATED GRAPHITE HEAT EXCHANGERS

ANNULAR GROOVE DESIGN BENEFITS

Overall heat transfer value (W/m² K)

	Block	*Annular-groove*	*Increase*
Two acqueous liquids	500-1.000	1.100-1.600	+ 60-120%
Water and organic solvents	400-700	600-1.200	+ 50-70%
Water and acid	400-700	600-1.400	+ 50-100%
Water and condensing steam	600-1.100	1.300-1.800	+ 60-130%
Water and condensing solvents	400-700	700-1.300	+ 75-90%
Heating steam and evaporating water	800-1.100	1.400-1.800	+ 65-75%
Heating steam and organic solvent	600-900	800-1.400	+ 35-55%
Heating steam and acid	500-900	700-1.400	+ 40-55%

Average heat transfer value indicating the thermal performance annular-groove heat exchanger vs. block heat exchanger

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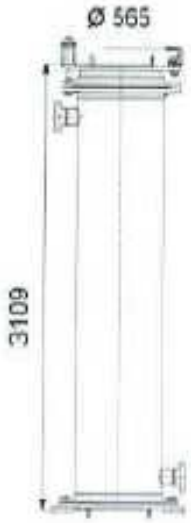
SYNTHETIC RESIN IMPREGNATED GRAPHITE HEAT EXCHANGERS
ANNULAR GROOVE DESIGN BENEFITS

Block and Annular-groove h.e. sizes (at comparable heat load)



Block
18,2 m² transfer area

Annular-groove
13,8 m² transfer area

Block (Lecarbone Lorraine) vs. Annular-groove GAB
Acid heating with steam
(Jordan Phosphate Mines)

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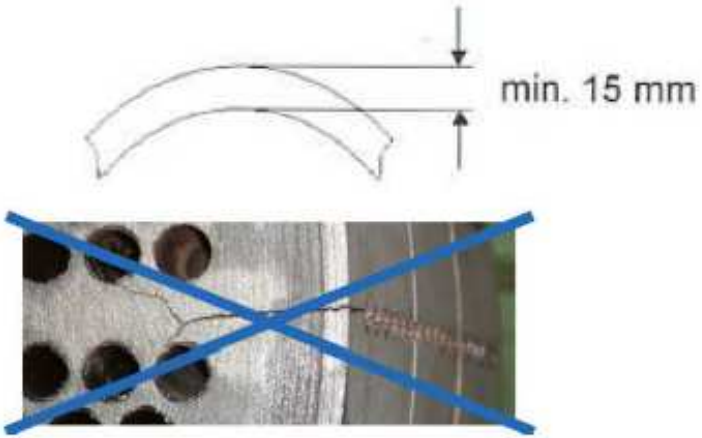
Graphite Heat Exchangers and Components

SYNTHETIC RESIN IMPREGNATED GRAPHITE HEAT EXCHANGERS

ANNULAR GROOVE BENEFITS

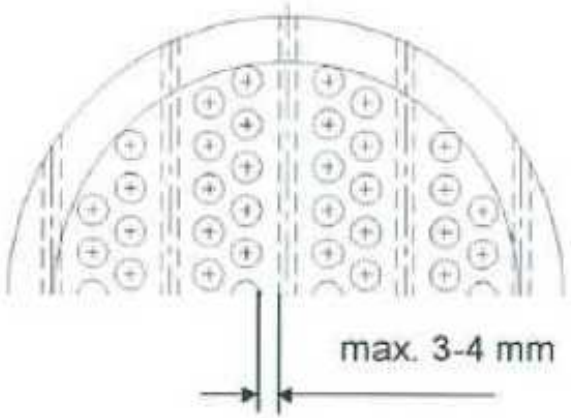
Annular-groove design



High wall thickness means

- No leakage
- No cracks
- Stress is very unlikely to exceed the maximum allowed

Block design



Small wall thickness (3-4 times smaller than Annular-groove)

- Risk of leakage
- Risk of cracks
- Stress exceeds the maximum allowed easily

SYNTHETIC RESIN IMPREGNATED GRAPHITE HEAT EXCHANGERS

ANNULAR GROOVE CONDENSER

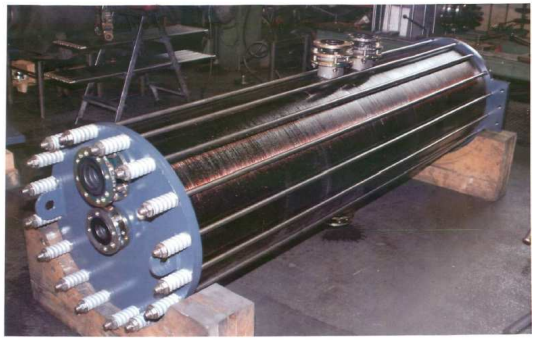
Reactor			Required transfer area (m²) at condensating temperature of…							
Type	Area m²	Heat load kW	> 100 °C Toluol, Water		> 75 °C Benzene, Ethanol		> 65 °C Methanol		> 55 °C Acetone	
AE 63	0.56	10	0.2	1)	0.3	1)	0.37	1)	0.6	1)
AE 100	0.88	16	0.27	1)	0.45	1)	0.59	1)	1.0	1)
AE 160	1.25	23	0.38	1)	0.65	1)	0.85	1)	1.4	2)
AE 250	1.7	31	0.52	1)	0.88	1)	1.14	1)	1.9	2)
AE 400	2.5	45	0.75	1)	1.3	2)	1.7	2)	2.1	2)
AE 630	3.1	56	0.93	1)	1.6	2)	2.1	2)	2.6	3)
AE 1000	4.6	83	1.4	2)	2.4	2)	3.1	3)	3.8	3)
BE 1600	7.3	131	2.2	2)	3.7	3)	4.8	4)	6.1	4)
BE 2500	9.7	175	2.9	3)	5.0	4)	6.4	4)	8.1	5)
BE 4000	13.4	241	4.0	3)	6.8	4)	8.9	5)	11.2	5)
BE 6300	18.1	326	5.4	4)	9.3	5)	12.0	5)	15.1	6)
BE 8000	18.0	324	5.4	4)	9.2	5)	11.9	5)	15.0	6)
BE 10000	20.7	373	6.2	4)	10.6	5)	13.7	6)	17.3	7)
BE 12500	25.2	454	7.6	5)	12.9	6)	16.7	6)	21.0	7)
BE 16000	29.5	531	8.9	5)	15.1	6)	19.5	7)	24.6	8)
BE 20000	34.0	619	10.2	5)	17.4	7)	22.5	8)	28.3	8)

(see also Work Standard 1562)

Standardised Condensators (recommendation)

1) GN1-06-9 (1,08 m²)
2) NB5-05 (2,5 m²)
3) NB5-08 (4,0 m²)
4) NB6-08 (6,4 m²)
5) NB7-10 (11,5 m²)
6) NB7-14 (16,1 m²)
7) NB7-18 (20,7 m²)
8) NB7-26 (29,9 m²)

see also Product Info RN-11 resp. RN-9 (GMP), RN-18 resp. RN-10 (GMP) GN-1



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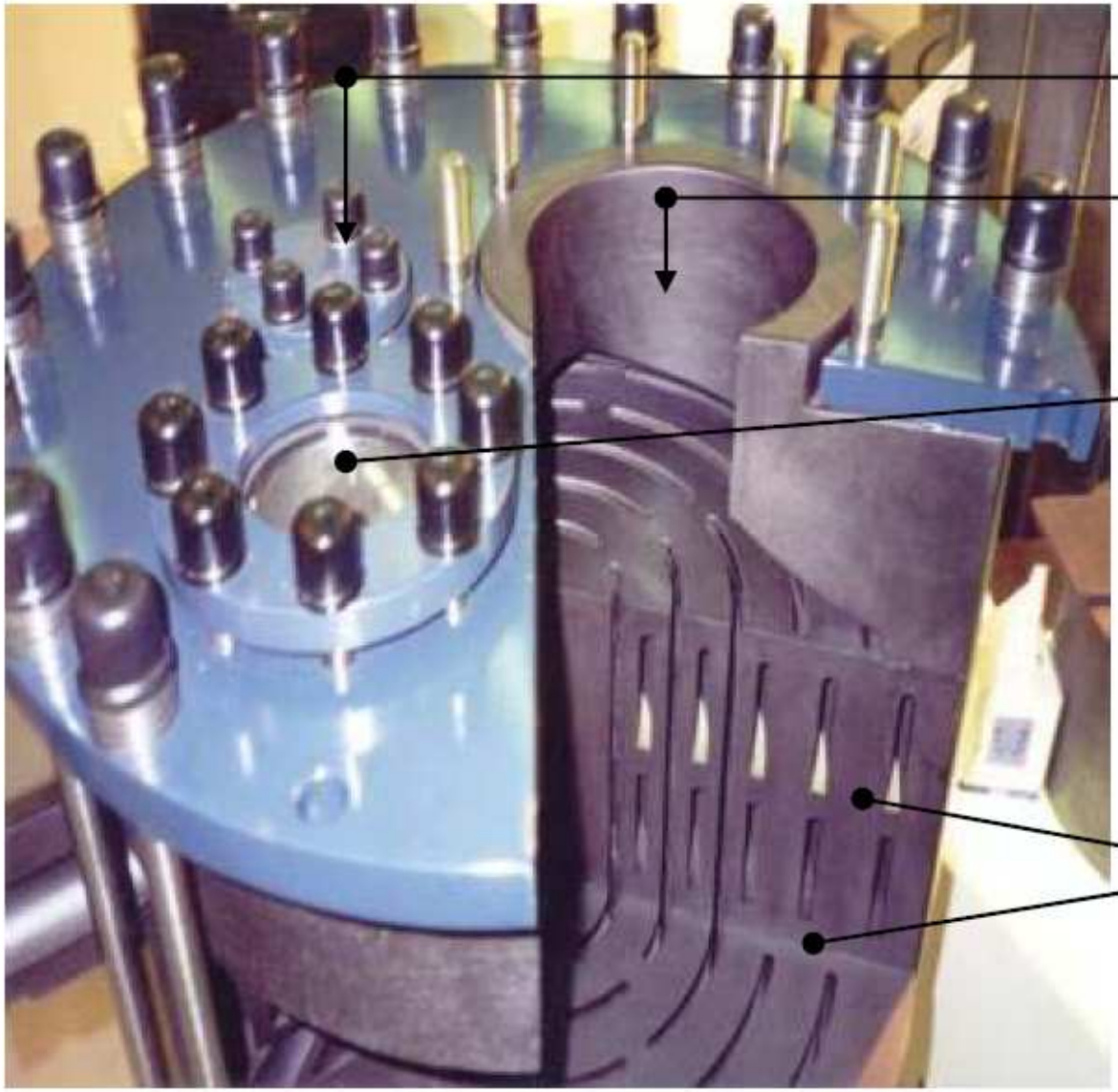
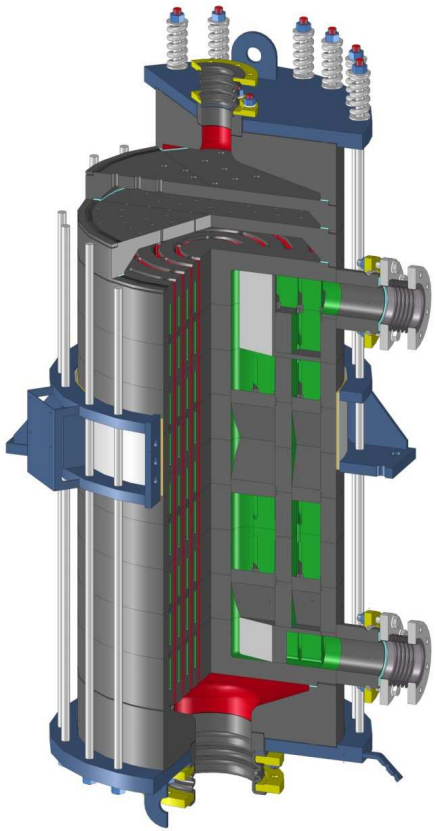
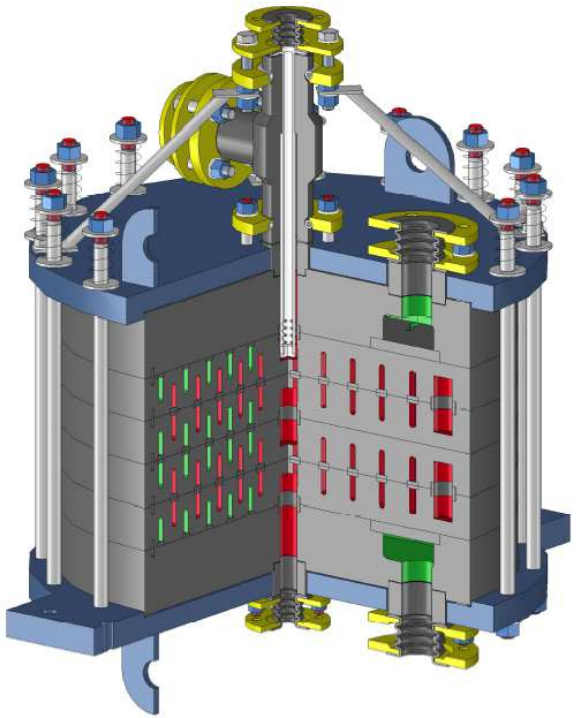
Graphite Heat Exchangers and Components

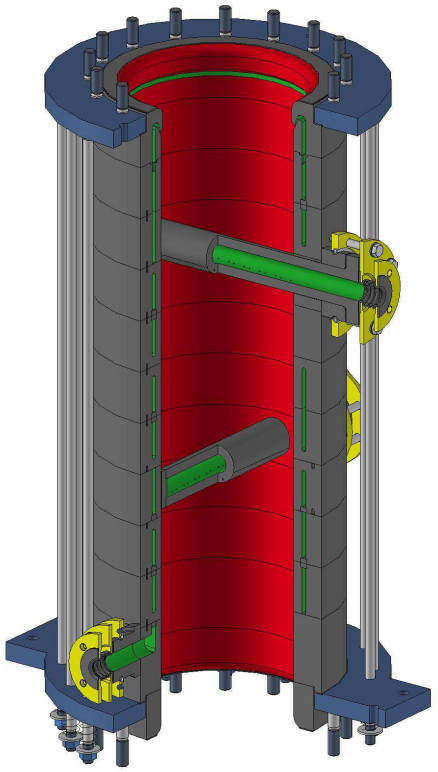
SYNTHETIC RESIN IMPREGNATED GRAPHITE HEAT EXCHANGERS
ANNULAR GROOVE GMP DESIGN TYPE

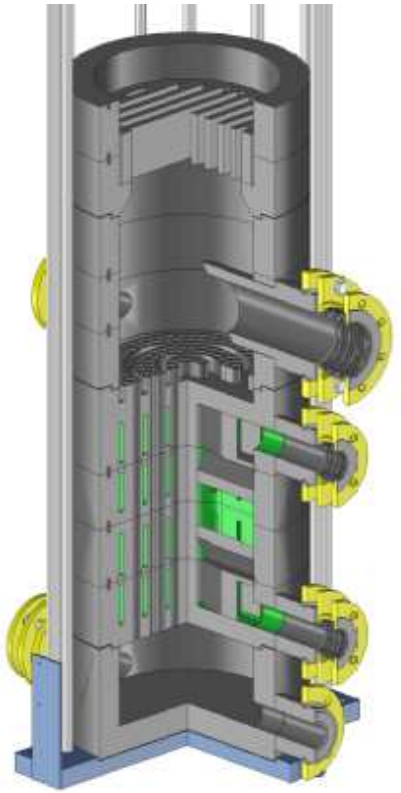


ANNULAR GROOVE PROCESS EQUIPMENT



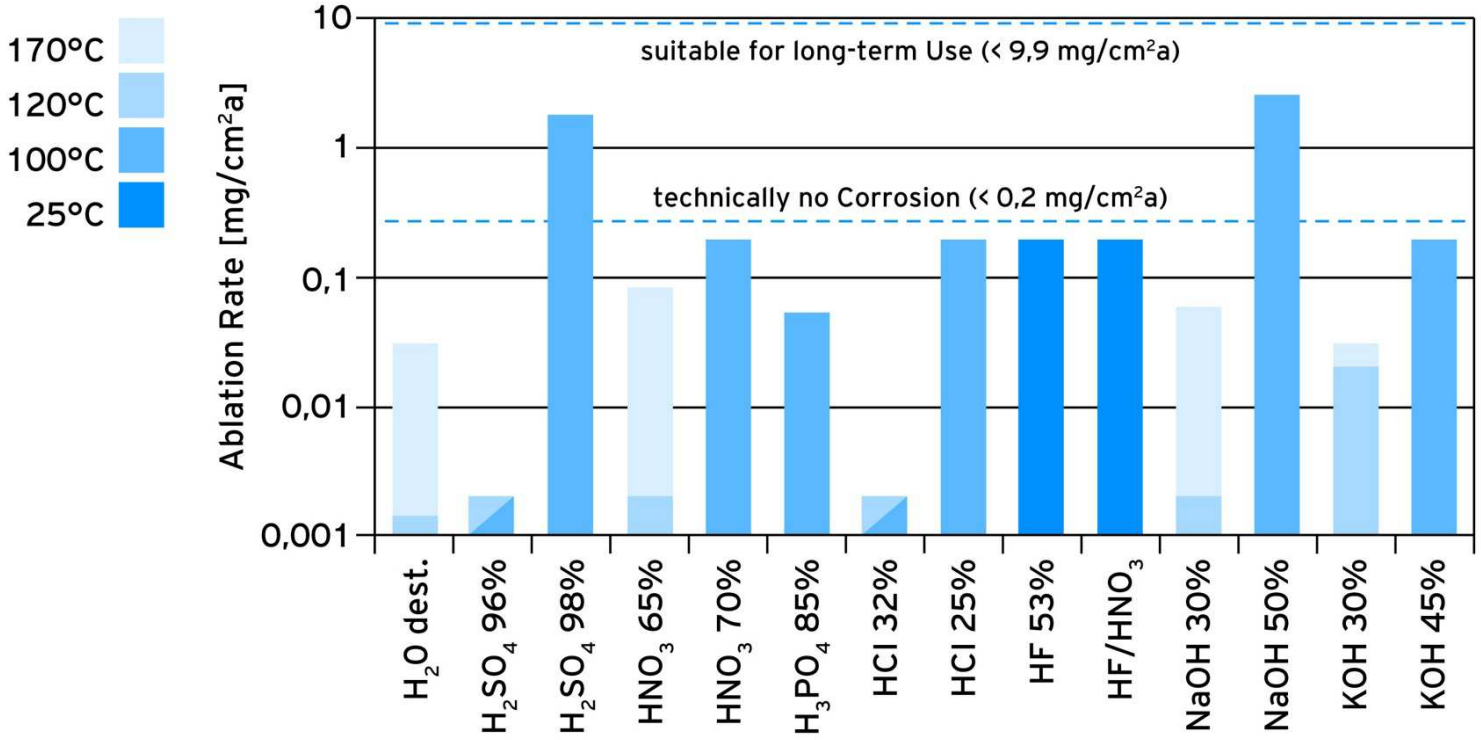






SYNTHETIC RESIN IMPREGNATED GRAPHITE COLUMN INTERNALS

SILICON CARBIDE
CORROSION RESISTANCE



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Corrosion Resistant Heat Exchangers and Components

SILICON CARBIDE PROPERTIES

Density (20°C)	kg/m³	3,1
Flexural strength (20°C)	N/mm2	460
Comprressive strength (20°C)	N/mm2	2900
Elasticity modulus (20°C)	Gpa	410
Weibull-module		>12
Thermal conductivity	W/mK	130
Free porosity	%	0

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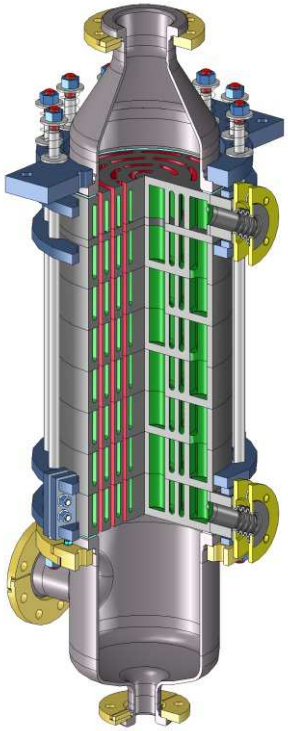
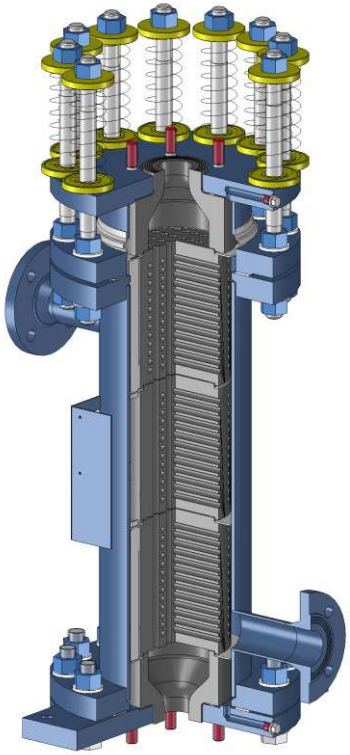
Corrosion Resistant Heat Exchangers and Components

CORRESIC® HEAT EXCHANGERS DESIGN

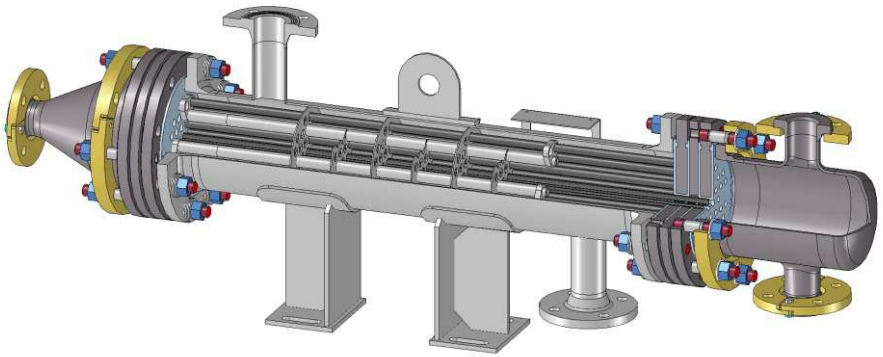
- Extend product range by SiC products (intended annular-groove, shell & tube (and block)



CORRESIC® annular-groove heat exchanger



CORRESIC® Block heat exchanger



CORRESIC® Shell & tube heat exchanger

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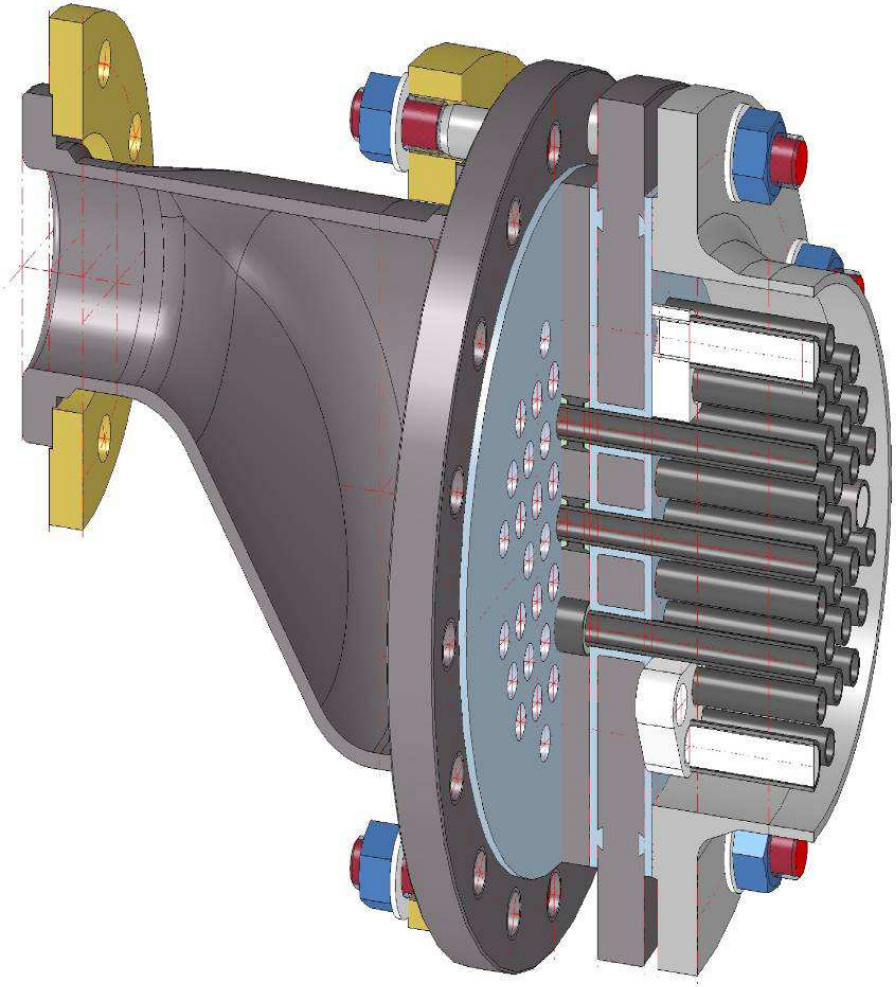
CORRESIC® Compact Sealing System



- Compact sealing system with double sealing as standard > minimised risk of cross contamination
- Sealing face in thermally resistant sleeve > no creeping at high temperatures
- No sinkings for sealing in tube sheet > more compact bundling of tubes means up to 35% more transfer area > strengthened steel core for better stability and therefore…
- …fixing of the tube sheets only by outer pitch circle > no corrosion risk by coated screws compressing the tube sheets

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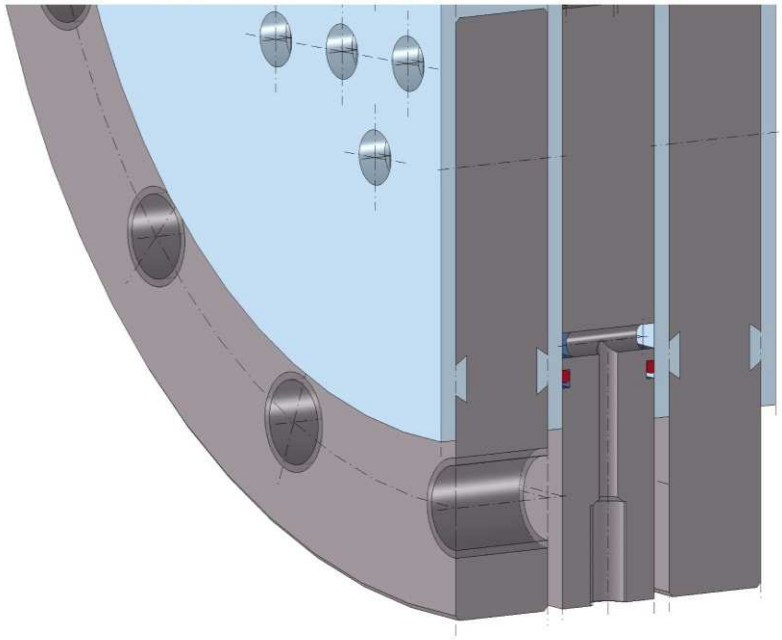
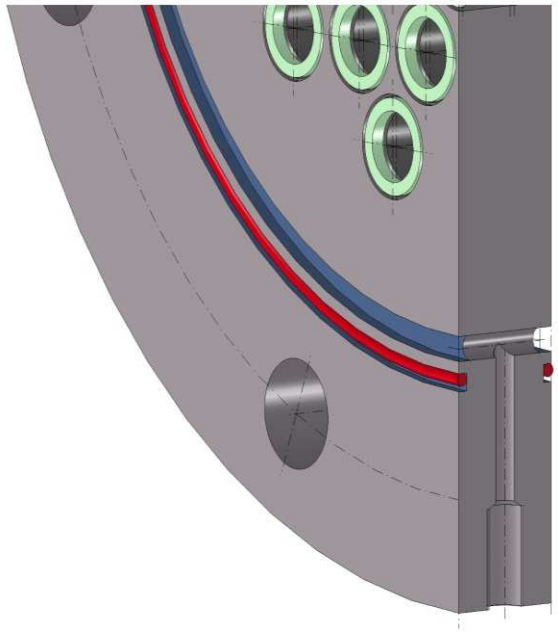
CORRESIC®-SB Leakage detection system



Tube sheet (assembled) with leakage detection system



Spacer disc with draining channels and gasket

- The leakage detection system (optional feature) allows to detect failing gasket in double sealing

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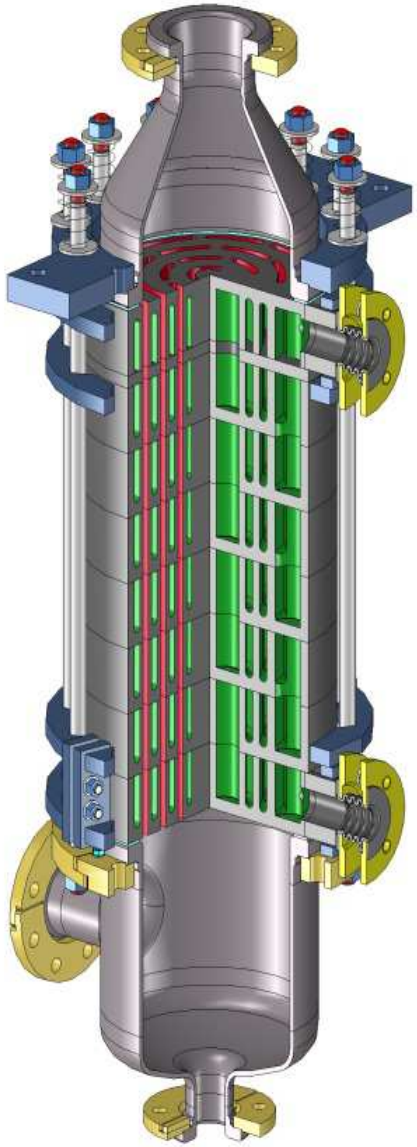
CORRESIC®-SB Design



- Monolithic discs in pressureless sintered SSIC material for best corrosion resistance
- Corrosion and temperature resistant TASIC® fusing based on fluoropolymers
- Dead corner free design enabled by TASIC® fusing process
- Helical springs for sustainable sealing forces throughout the total range of operation
- Main data
  - Heat transfer area up to 10 m²
  - Disc diameter 320 and 430 mm
  - -1 bar to +6 (+10) bar
  - -10 (-60) °C to +200 (+220) °C

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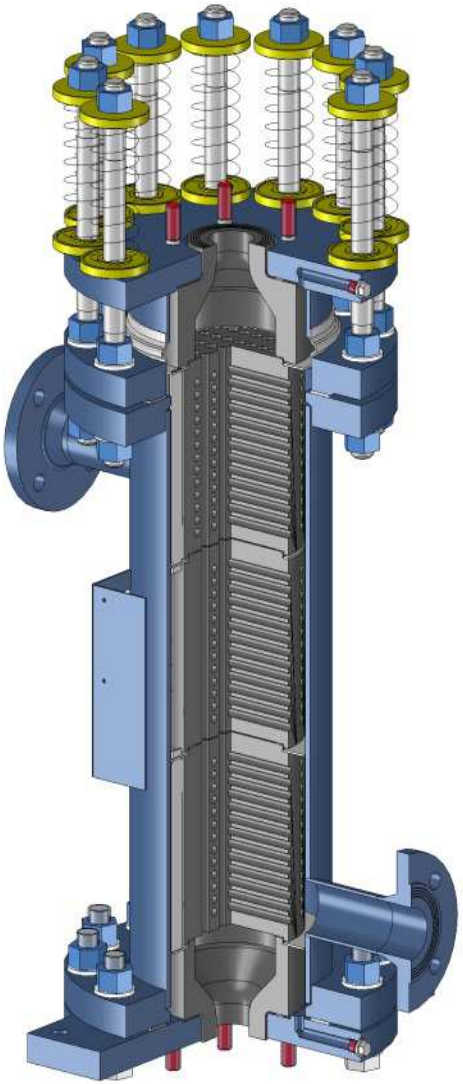
CORRESIC®-SE Design



- Monolithic blocks and headers in pressureless sintered SSiC material for best corrosion resistance
- Modular design with PTFE gaskets and PTFE or stainless steel baffles
- Steel shell with axial compensator for thermal dilatation
- Helical springs for sustainable sealing forces throughout the total range of operation
- Main data
  - Heat transfer area 0,3 m² to 20 m²
  - Block diameter 160, 260 and 350 mm
  - -1 bar to +10 (+16) bar
  - -10 (-60) °C to +200 (+220) °C

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CORRESIC®-SE Applications

- Liquid/liquid heat exchange at all acids, brines and organic solvents, e.g. mixed acid, sulphuric acid, nitric acid
- Reboiler evaporation, especially steam heated
- Condensation processes with special need of robustness
- Pickling applications in steel and galvanic industries (heating, cooling, acid regeneration)
- Acid concentration processes

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