

Silicon Carbide SiC Direct Sintered Silicon Carbide SSiC

Material Information (W-1)

Silicon Carbide

- Silicon carbide is a very solid, hard and temperature resistant material. Thanks to its excellent chemical resistance and thermal conductivity, it is ideal for the construction of heat exchangers
- Processing the material differs completely from any metallic materials in heat exchanger manufacturing
- The form of the ceramic component is created in the so-called „green“ state, followed by a high temperature sintering process

Best strength

Latest manufacturing technologies

100 % process reliability

Material Characteristic	Units	Sic (SSiC)
Density (20°C)	kg/m ³	3,1
Bending strength (4-Pkt. 20°C)	MPa	460
Compression strength (20°C)	MPa	2900
Elasticity modulus (20°C)	GPa	410
Weibull-module		>12
Thermal dilatation coefficient. (20°C/200°C)	K ⁻¹	2,9 x 10 ⁻⁰
Thermal conductivity (20°C/200°C)	W/mK	115
Free porosity	%	0

Direct Sintered Silicon Carbide (SSiC)

- SSiC is the pressureless sintered modification of silicon carbide without any free silicon in the material structure
- In contrast to silicon infiltrated SiC (SiSiC) this material shows excellent chemical resistance in combination with very high abrasion resistance
- In this respect SSiC is by far superior to most other heat exchanger materials

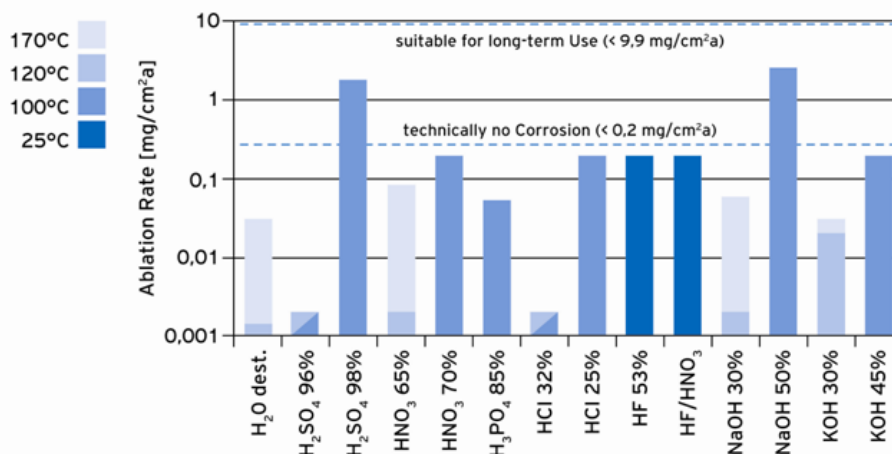
Universal corrosion resistance

Acids, leaches, halogen compounds and oxidising media

Application with all organic solvents

Best abrasion resistance

100% FDA / GMP compliance

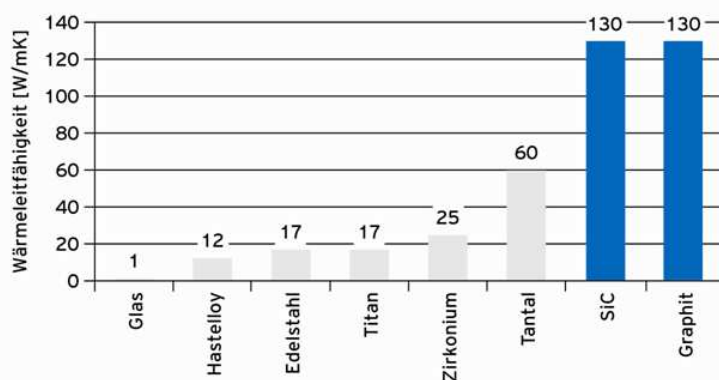


Direct Sintered Silicon Carbide (SSiC)

- SSiC shows very high purity not causing any product contamination
- For use in the highly pure manufacturing of electronic chemicals, SSiC is washed in a defined chemical mixture to achieve manufacturing particle removal
- So the material is enabled for the use in ppt grade clean areas

No risk of product contamination

Adequate for ppt grade clean production



- The high heat conductivity is one reason for the excellent thermal shock resistance
- The short-time temperature difference (thermal shock stability parameter R1) is approximately > 200 K
- This ensures high operational safety especially during unsteady start-up or shut-down procedures

Excellent thermal conductivity

High resistance against thermal shock

The CORRESIC® Heat Exchanger Portfolio

- For diverse applications GAB Neumann has developed three different designs:
 - | CORRESIC®-SR shell & tube heat exchangers
 - | CORRESIC®-SE block heat exchangers
 - | CORRESIC®-SB annular-groove heat exchangers
- The specific properties of the different designs result in diverse benefits according the application
- This portfolio ensures best performance in each process

-1 bar to +16 bar max. operating pressure (depending on design)

-60°C to +220°C max. operating temperature (depending on design)

Further Information

- Product information sheets SR-1, SB-1, SE-1 provide further data on our CORRESIC® heat exchangers
- Further amending and complementary information (brochures, corrosion resistance charts, product information, data sheets,...) you may also download at www.gab-neumann.de.



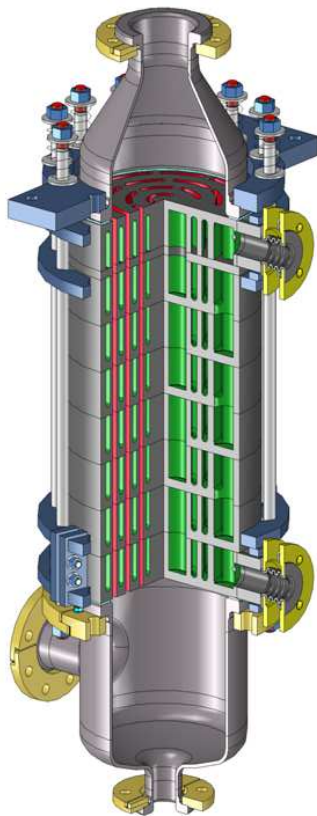
Heat Exchangers and Components in Graphite and Silicon Carbide

Silicon Carbide Annular-groove Heat Exchanger Series CORRESIC®-SB

Product Information (SB-1)

CORRESIC® Silicon Carbide Annular-groove Heat Exchanger

- Universally corrosion resistant disc material silicon carbide (SSiC) with very high thermal conductivity
- Resistant against all brines, acids, solvents and halogens
- Virtually monolithic design with no dead space enabled by TASIC® fusing process for long lifetime and easy maintenance
- Especially applicable in multi-purpose plants, also in cGMP processes
- Various installation modes possible (vertical, horizontal, inclined)



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
- | | |
|----------------------|-------------------------|
| - Heat transfer area | up to 10 m ² |
| - Disc diameter | 320 and 430 mm |

CORRESIC®-SB annular-groove heat exchanger
(cross section)

Applications

- Condensation of organic solvents in active pharmaceutical ingredients manufacturing (API) even under cGMP regulation
- Heat exchanging processes in crop protection chemical synthesis
- Condensation processes in ultra pure electro chemicals manufacturing
- Applications in manufacturing of flavours and fragrances
- Falling film evaporation in organic synthesis
- Liquid/liquid heat exchange at all acids, brines and organic solvents, e.g. mixed acid, sulphuric acid, nitric acid, hydrofluoric acid

Features and Benefits

Highest corrosion resistance against acids, leaches, halogen compounds and oxidising media

Application with all organic solvents

Dead space free design for best cleaning

Completely drainable

Abrasion resistance

No product contamination

100% GMP / FDA compliance

Best thermal conductivity

Excellent thermal shock resistance

Design Parameters

-1 bar to +6 (+10) bar max. operating pressure

-10 (-60) °C to +200 (+220) °C max. operating temperature



Heat Exchangers and Components
in Graphite and Silicon Carbide

Employed Material and Material Options

Discs	Pressureless sintered silicon carbide (SSiC)
Headers	Glass lined steel, PTFE lined steel
Gaskets	TASIC® fusing process based on fluoropolymers GYLON® gaskets
Pressure plates	Carbon steel, stainless steel
Tie rods, bolts, nuts	Stainless steel

Design and Inspection

- CORRESIC® heat exchangers are designed, manufactured, tested and inspected according AD 2000-Merkblatt (in coherence with the European Pressure Equipment Directive PED)
- Other design and manufacturing codes upon request



Disc CORRESIC®-SB with 320 mm diameter

Additional Information

- Data sheet SB-1 includes information on terminology and main dimensions.
- Further amending and complementary information (brochures, corrosion resistance charts, product information, data sheets,...) you may also download at www.gab-neumann.de.

Benefits of Annular-groove Design

- High thermal performance by turbulent flow conditions
- No batch contamination
- No cross contamination
- Easy cleaning

Technically Perfect

- Application in single purpose and multi-purpose plants
- Best thermal performance at compact dimensions
- Small overall size
- Long lifetime

Economically Outstanding

- Best price level
- Standardisation
- Focus on major sizes and material combinations
- Short lead times
- Low operation and maintenance cost

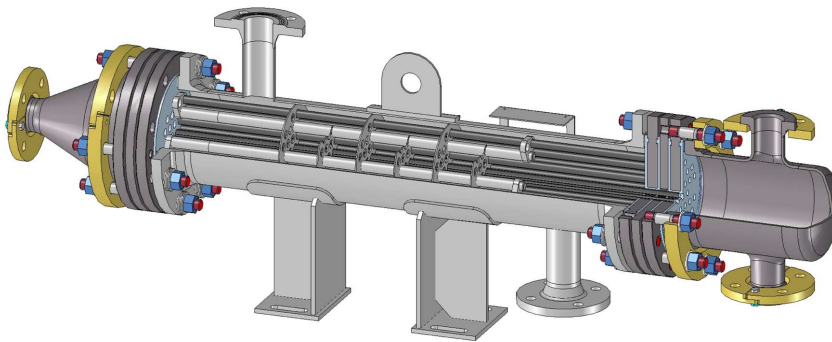


Silicon Carbide Shell & Tube Heat Exchanger Series CORRESIC®-SR

Product Information (SR-1)

CORRESIC® - Silicon Carbide Shell & Tube Heat Exchanger

- Universally corrosion resistant tube material silicon carbide (SSiC) with very high heat conductivity
- Resistant against all leaches, acids, solvents and halogens
- Non-leaking tube sheet sealing system resulting from vast and long operational experience
- Materials of construction as per application (carbon steel, stainless steel, glass-lined, PTFE-lined)



CORRESIC®-SR Shell & tube heat exchanger DN 200 with 1.5 m bundle length

Setup and Design

- HEXOLOY SE®-SSiC tubes Ø14 x 1.5 mm (Ø19 x 2.2 mm)
 - Tube sealing by patented compact sealing system
 - Double sealing FFKM/FFKM resp. FFKM/FKM as standard
 - No threaded connections of the tube sheets in corrosive areas
- | | |
|----------------------|---|
| - Heat transfer area | 0.5 m ² to 26 m ² |
| - Shell diameter | DN 100 bis DN 300 |
| - Bundle length | 1.0 m bis 4.5 m |

Applications

- Liquid/liquid heat transfer at acids, caustic media and all kind of organics, e.g. acid mixtures, sulphuric acid, nitric acid
- Condensation processes
- Condenser units including main and trap condenser and condensate cooler
- Cooling of gases even with elementary halogen compounds (dry and moist)
- High purity chemical processes and API manufacturing in final stages
- Acid concentration

Features and Benefits

- Highest corrosion resistance against acids, leaches, halogen compounds and oxidising media
- Excellent thermal conductivity
- Best abrasion resistance
- High resistance against thermal shocks
- Highest purity, no contamination
- Condensation on both, shell and tube side
- Optimised tube sheet enables low cost and compact design
- Improved relation transfer area to shell volume
- Best available sealing system (double sealing FFKM resp. FKM)
- No corrosion and leakage risk
- Completely drainable

Design Parameters

- 1 bar to +6 (+10) bar
max. operational pressure
- 10 (-30) °C to +180 (+220) °C
max. operational temperature



Employed Material and Material Options

Tubes:	HEXOLOY SE [®] SSiC tubes Ø14 x 1.5 mm (Ø19 x 2.2 mm)
Sealing system tube / tubesheet:	Double sealing FFKM/FFKM resp. FFKM/FKM
Tubesheet:	Steel PFA lined
Shell:	Carbon steel, stainless steel, glass lined
Headers:	Carbon steel, stainless steel, glass lined, PTFE lined

Design and Inspection

- CORRESIC[®] heat exchangers are designed, manufactured, tested and inspected according to AD 2000-Merkblatt (in coherence with the European Pressure Equipment Directive PED)
- Other design and manufacturing codes upon request



CORRESIC[®] SR Shell & tube heat exchanger DN 200, 3m²

Additional Information

- Data sheet SR-1 includes information on terminology and main dimensions.
- Further amending and complementary information (brochures, corrosion resistance charts, product information, data sheets,...) you may also download at www.gab-neumann.de.

Benefits of Shell & Tube Design

- Modular setup
- Application focussed material mix
- Best cleaning possibilities

Technically Perfect

- Application in single-purpose and multi-purpose plants
- Best thermal performance at compact dimensions
- Long lifetime

Economically Outstanding

- Best price level
- Standardisation and focus on major sizes and material combinations
- Short lead times
- Low operation and maintenance cost



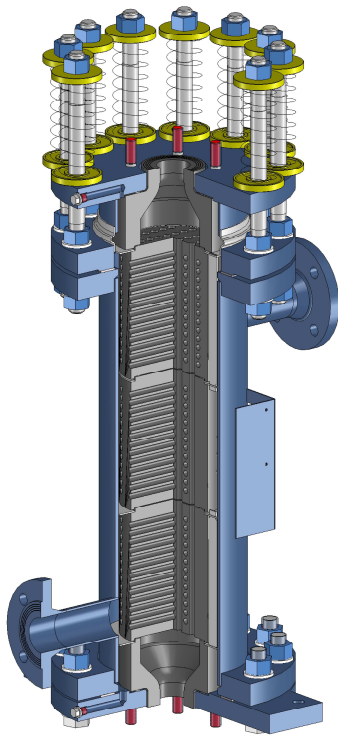
Heat Exchangers and Components
in Graphite and Silicon Carbide

Silicon Carbide Block Heat Exchanger Series CORRESIC®-SE

Product Information (SE-1)

CORRESIC®-Silicon Carbide Block Heat Exchanger

- Universally corrosion resistant block material silicon carbide (SSiC) with very high thermal conductivity
- Resistant against all leaches, acids, solvents and halogens
- Robust, modular design ensuring long lifetime and low cost maintenance
- Especially applicable for steam heated evaporation or heating processes
- Various installation modes possible (vertical, horizontal, inclined)



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
- Heat transfer area: 0,3 m² to 20 m²
- Block diameter: 160, 260 and 350 mm

CORRESIC®-SE block heat exchanger (cross section)

Applications

- Liquid/liquid heat exchange at all acids, leaches 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

Features and Benefits

Highest corrosion resistance

Excellent thermal shock resistance

Robust and modular design

Abrasion resistance

Especially applicable in steam heated processes

No product contamination

Low maintenance need

High operational reliability in robust applications

Design Parameters

-1 bar to +10 (+16) bar max. operational pressure

-10 (-60) °C to +200 (+220) °C max. operational temperature



Heat Exchangers and Components
in Graphite and Silicon Carbide

Employed Material an Material Options

Blocks: Pressureless sintered silicon carbide (SSiC)

Headers: Pressureless sintered silicon carbide (SSiC)

Gaskets: PTFE

Baffles: PTFE, stainless steel

Shell: Carbon steel, stainless steel

Design and Inspection

- CORRESIC[®] heat exchangers are designed, manufactured, tested and inspected according AD 2000-Merkblatt (in coherence with the European Pressure Equipment Directive PED)
- Other design and manufacturing codes upon request



Block CORRESIC[®] SE with 160 mm diameter

Additional Information

- Data sheet SB-1 includes information on terminology and main dimensions.
- Further amending and complementary information (brochures, corrosion resistance charts, product information, data sheets,...) you may also download at www.gab-neumann.de.

Benefits of Block Design

Modular setup

Robust design

Easy cleaning

Low cost maintenance

Technically Perfect

Application in single-purpose and multi-purpose plants

Best thermal performance at compact dimensions

Small overall size

Long lifetime

Economically Outstanding

Best price level

Standardisation

Focus on major sizes and material combinations

Short lead times

Low operation and maintenance cost

