Italpotec Industries

FLOWSiC®

ITALIANO

FLOWSIC®

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All data and instructions for use contained in the leaflet are based on the most up-to-date knowledge.

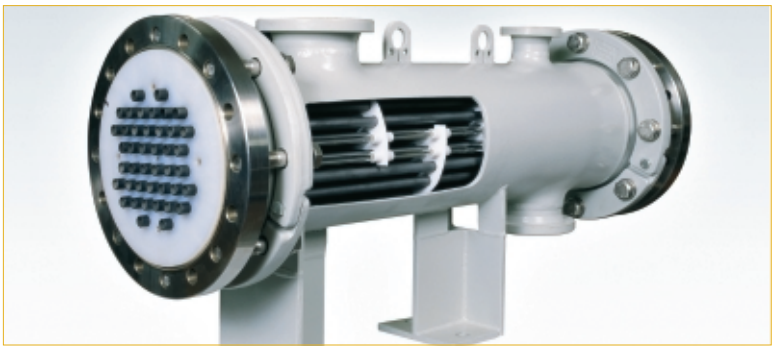
The information herein displayed does not exempt the user from ascertaining the safety and suitability of the products with regards to his/her specific need.

Silicon Carbide Shell and Tube Heat

Exchangers for Corrosive Media

The new Silicon Carbide Shell and Tube Heat Exchanger with triple steel tube-sheet (patent pending) have been designed considering each detail according to hi-tech standards. They are the result of:

- Detailed knowledge of corrosion-resistant materials
- Several years' experience with the engineering of heat exchangers in different acid-resistant materials (graphite, glass, tantalum, glass lined steel, lined carbon steel, stainless steel)
- Expertise on "transfer-moulding" process, which is used to line steel or stainless steel parts in corrosion-resistant polymers (PFA, PP, PVDF)
- Appropriate logistics, skilful personnel and state-of-the-art computer support
- High production capacity thanks to modern equipment
- Compliance with international standards (ISO, DIN, ANSI) and with CE 97/23 PED for pressure piping and equipment
- Co-operation with Research and Standards Institutes



Silicon carbide (sic) features

Chemical resistance

Hexoloy® SA is a pressureless, single-phase, fine-grain sintered alpha product and contains no free silicon.

It is composed of micro-particles of silicon carbide (8 micron), that is inert to all known chemicals up to 205°C (400°F).

Hexoloy® SA tubes are highly resistant to corrosion and have been tested with HF, bromine, concentrated nitric acid, acid and basic mixtures, oxidisers and chlorinated organic products.

Important

FLOWSIC® heat exchangers do not use SiC tubes with free silicon, as it may react with the products it comes into contact with

Chemical	Temperature °C (°F)	Corrosion Rate (mg/cm² YR)
98% H_2SO_4	100 (212)	1,8
85% H_3PO_4	100 (212)	<0,2
53% HF	25 (77)	<0,2
50%NaOH	100 (212)	2,5
45% KOH	100 (212)	<0,2
70% HNO_3	100 (212)	<0,2
37% HCl	86 (187)	<0,2
10% HF + 57% HNO_3	25 (77)	<0,2

Excellent mechanical properties

Each silicon carbide tube is tested at 186 bar (2700 psi) to guarantee its safety and mechanical reliability.

High thermal conductivity

Silicon carbide's thermal conductivity is similar to graphite's and much greater than other corrosion-resistant materials (PTFE, glass, compound special alloys, noble metals).This implies better efficiency, less exchange area and space needed.

High resistance to erosion

Being extremely hard (50% higher than tungsten carbide), silicon carbide is very resistant to erosion, which allows a higher fluid velocity and improves the heat exchange factor.

Purity and resistance to permeation

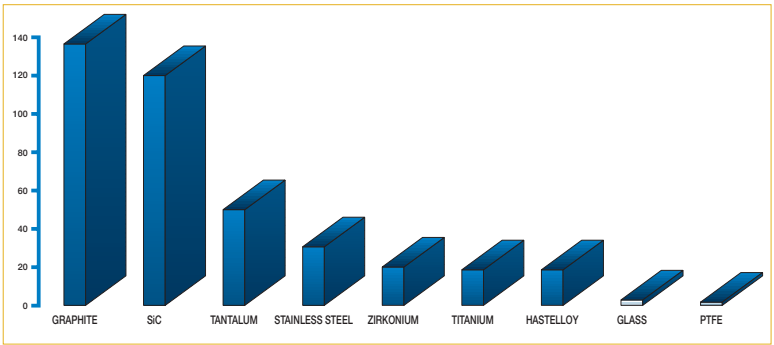
Hexoloy® SA is a basically pure silicon carbide with no free silicon, binders or fillers.

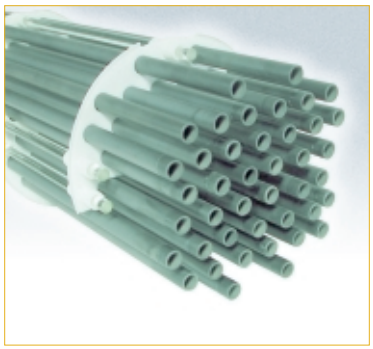
It is totally resistant to all fluids and gases even at high temperature and pressure; it avoids contamination in high purity applications.

Hexoloy® SA is compliant with:

- FDA
  Food & Drug Administration (USA)
- WRC
  Water Bylaws Scheme (U.K.)
- DVGW
  German Society for Gas and Water

Thermal conductivity





Hexoloy® SA SiC tubes physical properties

Properties	Units	SA
Composition		SiC
Density	g/cm^3	3.10
Grain size	micron	4-6
Knoop hardness	Kg/mm^2	2800
Flexural strength (on 4 points at 20°C)	Mpa	380
Compressive strength	MPa	3900
Elasticity Modulus	GPa	410
Weibull modulus (2 parameters)	GPa	8
Max operating temperature (air)	°C	1650
Mean specific heat at 20°C	kJ/kg·K	0.67
Thermal conductivity	W/m·K	105-125
Permeability (20° to 1000°C)		Proof against all gases up to 31 MPa
Electrical resistivity at 20°C	ohm·cm	10^2-10^6

Features of FLOWSIC® heat exchanger

Construction

Italprotec heat exchangers have been designed to allow inter-changeability of component parts.

Silicon Carbide tubes, with diameters of 14.0 x 1.5 mm, have standardised lengths that can be used for any nominal bore of the shell, and are supplied with independent double sealing o-rings for each tube on both sides of the heat exchanger.

A new concept of the triple tube plate (patent pending)

The triple tube plate guarantees reliability and long working life. It is composed of:

1) a main tube plate for the passage of silicon carbide tubes

2) a secondary plate to contain the sealing packages (O-rings, distance ring and push sleeve)

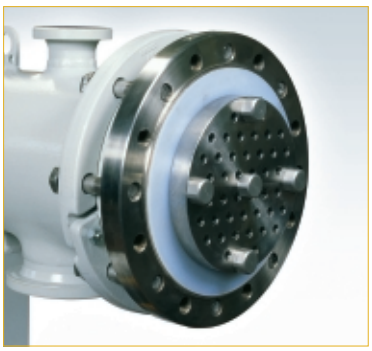
3) a tertiary plate to simultaneously press the sealing components on to the secondary plate

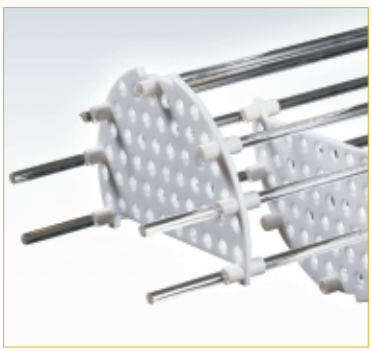
The main features of the triple tube plate are:

- The main tube plate is lined in PFA with body made in AISI 304L.
  The minimum thickness to avoid any corrosion or permeation is 3.5 mm
- The main tube plate has a threaded double drilling, which allows the connection with the shell independently from the head, eliminating the necessity of using an additional locking ring for main tube plate to shell connection
- The sealing packages composed of two O-rings, distance ring and push sleeve are pressed on the sealing-seats obtained in the secondary plate using a tertiary plate. This sealing design, ensures an exceptional and safe double seal on each end of the silicon carbide tube
- Special tie rods in AISI 316L are used to fix the secondary plate against the main tube plate and to press the tertiary plate (push-plate) against the secondary plate. The special tie rods are shielded by threaded caps with O-ring: this eliminates any possible leakage
- Possibility to insert one special safety and control ring between the main tube plates and the heads for:

a) checking any possible leakage coming from the process or service side

b) overpressure with nitrogen between the process and the service side





The design of the triple tube plates ensures:

- **Simple and safety execution.**
- **Perfect tightness of the silicon carbide tubes with the tube plates.**
- **Higher mechanical stability** than tube plates in PTFE (or in glass-filled PTFE) without a steel core.
- **Increased safety at the most severe working conditions:** PFA lined tube plates fully absorb temperature and mechanical variations even at high temperature.
- **Utmost reliability:** the absence of PTFE (or filled PTFE) threaded bushes eliminates the risk of damaging the plastic threads, that are known to be unreliable.
- **Easy maintenance:** no special equipment is needed for the maintenance on the premises: when the heads are disassembled, the triple plates are still secured to the shell.

Universal chemical resistance

All parts coming in contact with acid fluids are made of or lined in materials offering a total resistance to corrosion.

Please find below an example of the choice of materials:

Components	Acid fluids inside the shell	Acid fluids inside the tubes
Shell	Enamelled or lined steel	Zinc-plated CS, AISI 304L or 316L
Tubes	SiC Hexoloy® SA Ø14x1,5 mm	
Main tube plates	AISI 304L/PFA	
Secondary plates	AISI 304L or 316L	alloys or filled PTFE
Tertiary plates	AISI 304L or 316L	Alloys, CS/PFA lined
Sealing O-rings on SiC tubes	Kalrez® - Viton®; Viton®/PFA - Viton®; Silicon/FEP - Viton® or other elastomers	
Sealing O-rings on shields	Viton® or other elastomers	Kalrez®, Viton®/PFA, Silicon/FEP or Viton®
Screw plug for tertiary plate	AISI 304L or 316L	alloys, CS/PFA lined
Heads	Zinc-plated CS, AISI 304L or 316L	CS/PFA, alloys

Utmost versatility

Process versatility

Depending on the process, with FLOWSIC® heat exchangers acid fluids can circulate either outside or inside silicon carbide tubes.

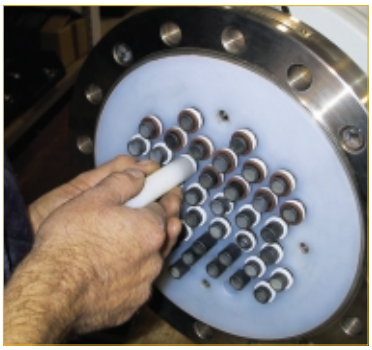
Installation versatility

According to the process and to the available area, installation can be either horizontal or vertical.

Versatility of use

FLOWSIC® heat exchangers are ideal for applications such as:

- Condensation
- Evaporation
- Thin film evaporation
- Liquid/liquid thermal exchange
- Liquid/gas thermal exchange
- Gas/gas thermal exchange



Easy maintenance

During the planned maintenance, any component part can be easily and quickly substituted on the premises: it is enough to disassemble the heads and the tertiary + secondary plate to check the sealing packages (double sealing O-rings + distance ring + press sleeve) and the silicon carbide tubes state.

An appropriate area is of course to be planned to allow sufficient space to pull out in place the silicon carbide tubes without remove the heat exchanger from the plant.

Wide range of materials

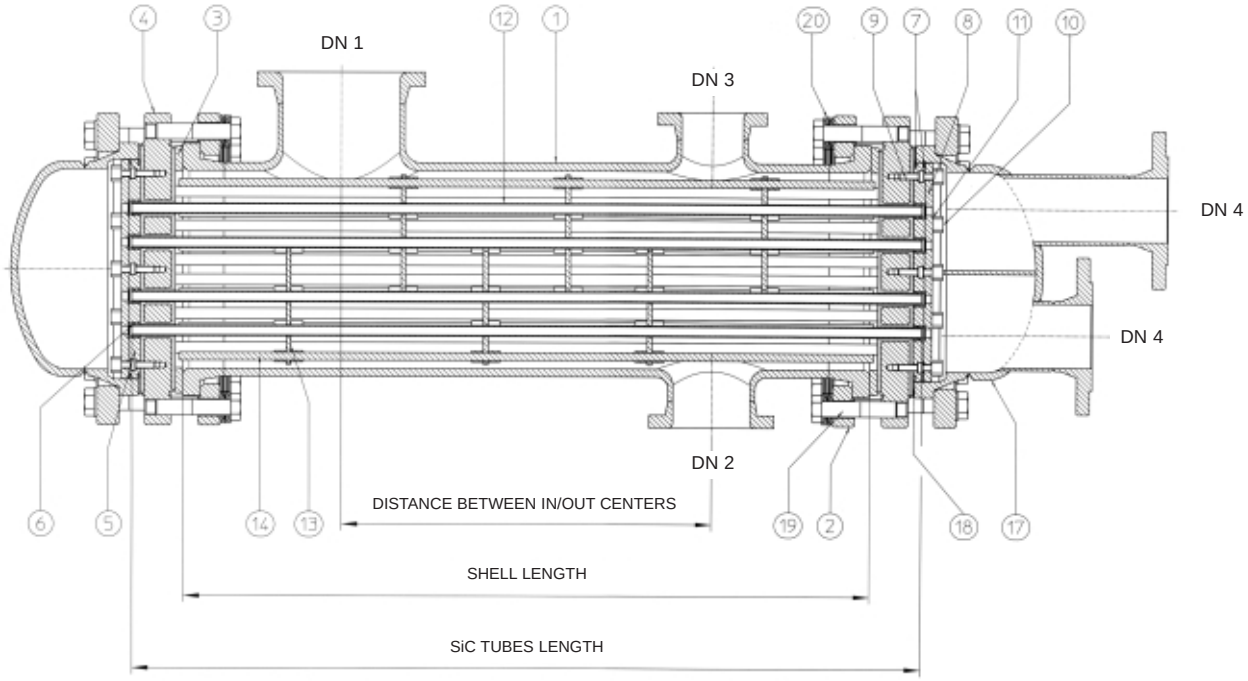
Depending on the process, the circulating fluids and the working conditions, the shell can be made in glass-lined steel, 304L or 316L stainless steel. zinc plated CS or E-TFE lined steel.

Acid fluids can circulate either inside or outside Silicon Carbide tube.

Our engineers are at your disposal to analyse your particular issues and suggest the best solution.

Heat exchanger components

Item	Component part	Material
1	Shel	CS zinc-plated, CS/glass-lined, CS/E-TFE, AISI 304L or 316L
2	Loose flanges	CS zinc-plated
3	Sealing gaskets on shell	PTFE envelope
4	Main tube plates	AISI 304L/PFA lined
5	Secondary tube plates (contain-plate)	AISI 304L or 316L, alloys, filled PTFE
6	Sealing O-rings on SiC tubes	Kalrez®, Viton®/PFA, Silicon/FEP, Viton® or other elastomers
7	Sealing O-rings on secondary plates	Kalrez®, Viton®/PFA, Silicon/FEP, Viton® or other elastomers
8	Tertiary tube plates (push-plate)	AISI 304L or 316L, alloys, CS/PFA lined
9	Special tie rods	AISI 316L
10	Screw plug for tie rods	AISI 316L, alloys, CS/PFA lined
11	O-rings for screw plugs	Viton®, Silicon/FEP, Viton®/PFA or Kalrez®
12	Tubes of tube bundle	Hexoloy® SA SiC
13	Separating baffles	PTFE
14	Spacers	Filled PTFE, AISI 304L or 316L
15	Heads	CS zinc-plated, AISI 304L or 316L, alloys, CS/PFA lined
16	Sealing gaskets for heads	PTFE envelope
17	External bolts, nuts and rings	Galvanized steel
18	Belleville springs Harmonic steel	Harmonic steel



Main features of heat exchangers

Shell		SiC tubes length						
		1000	1500	2000	2500	3000	3500	400
DN 100 - 4"	n° of SiC tubes	8	8	8	8	8	8	8
	Shell length (mm)	890	1390	1890	2390	2890	3390	3890
	Exchange area (m^2)	0,32	0,49	0,67	0,84	1,02	1,20	1,37
	Distance between IN/OUT centers (mm)	590	1090	1590	2090	2590	3090	3590
DN 150 - 6"	n° of tubes	22	22	22	22	22	22	22
	Shell length (mm)	880	1380	1880	2380	2880	3380	3880
	Exchange area (m^2)	0,87	1,35	1,84	2,32	2,77	3,25	3,74
	Interasse ingresso/uscita centers (mm)	530	1030	1530	2030	2530	3030	3530
DN 200 - 8"	n° of tubes	42	42	42	42	42	42	42
	Shell length (mm)	880	1380	1880	2380	2880	3380	3880
	Exchange area (m^2)	1,66	2,58	3,51	4,43	5,35	6,28	7,20
	Distance between IN/OUT centers (mm)	480	980	1480	1980	2480	2980	3480
DN 250 - 10"	n° of tubes	80	80	80	80	80	80	80
	Shell length (mm)	870	1370	1870	2370	2870	3370	3870
	Exchange area (m^2)	3,13	4,89	6,65	8,41	10,16	11,92	13,68
	Distance between IN/OUT centers (mm)	470	970	1470	1970	2470	2970	3470
DN 300 - 12"	n° of tubes	114	114	114	114	114	114	114
	Shell length (mm)	870	1370	1870	2370	2870	3370	3870
	Exchange area (m^2)	4,46	6,97	9,47	11,98	14,48	16,99	19,50
	Distance between IN/OUT centers (mm)	470	970	1470	1970	2470	2970	3470

The indicated dimensions on the shell are valid for glass-lined shell only.

The standard flange connections are conform to PN 10 or ANSI 150 lbs., other flange connections on request.

Main Features

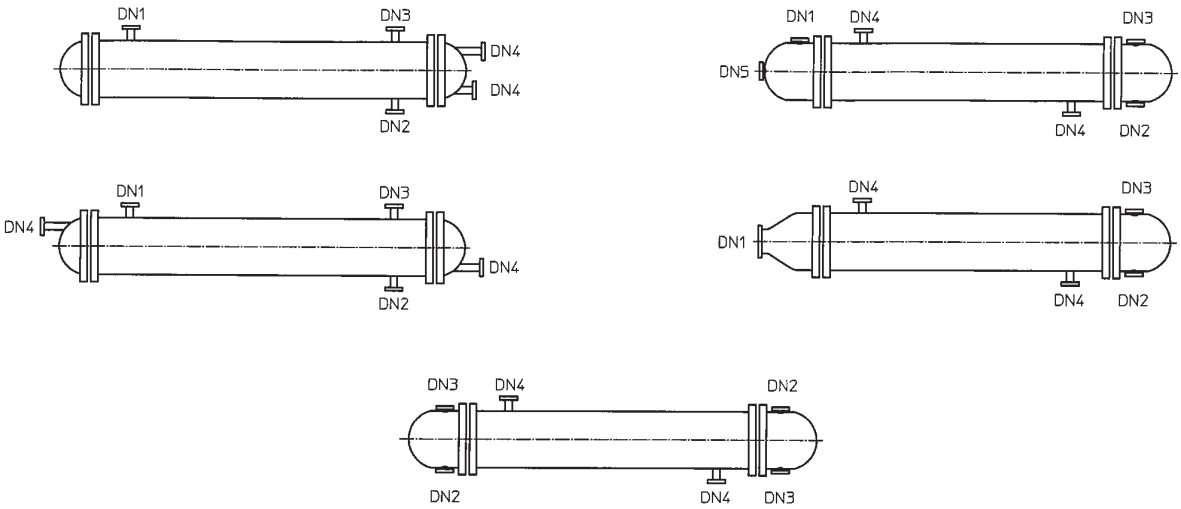
Exchange area:	0,30 - 19,50 m2
Shell:	DN 100 - DN 300
Flanges:	PN 10 o ANSI 150 lbs
SiC Tubes length:	1000 - 4000 mm

Operating Conditions

Temperature:	-20/+180°C
Pressure:	-1/+6 bar

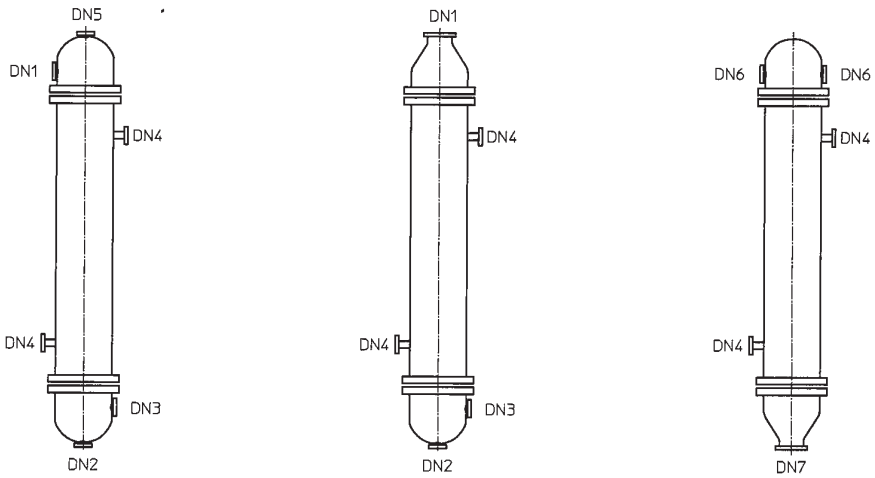
Consult factory for different working conditions

Standard connections for horizontal heat exchangers



Shell	DN1	DN2	DN3	DN4	DN5
DN 100 - 4”	50 – 2”	40 – 1 1/2”	25 – 1”	25 – 1”	40 – 1 1/2”
DN 150 - 6”	80 – 3”	50 – 2”	40 – 1 1/2”	40 – 1 1/2”	40 – 1 1/2”
DN 200 - 8”	100 – 4”	80 – 3”	50 – 2”	50 – 2”	50 – 2”
DN 250 - 10”	150 – 6”	100 – 4”	80 – 3”	80 – 3”	50 – 2”
DN 300 - 12”	200 – 8”	100 – 4”	80 – 3”	80 – 3”	50 – 2”

Standard connections for vertical heat exchangers



Shell	DN1	DN2	DN3	DN4	DN5	DN6	DN7
DN 100 - 4”	50 – 2”	40 – 1 1/2”	25 – 1”	25 – 1”	40 – 1 1/2”	40 – 1 1/2”	25 – 1”
DN 150 - 6”	80 – 3”	50 – 2”	40 – 1 1/2”	40 – 1 1/2”	40 – 1 1/2”	50 – 2”	25 – 1”
DN 200 - 8”	100 – 4”	80 – 3”	50 – 2”	50 – 2”	50 – 2”	80 – 3”	50 – 2”
DN 250 - 10”	150 – 6”	100 – 4”	80 – 3”	80 – 3”	50 – 2”	100 – 4”	50 – 2”
DN 300 - 12”	200 – 8”	100 – 4”	80 – 3”	80 – 3”	50 – 2”	150 – 6”	50 – 2”

PED 97/23/CE Table 1 - Process Shell-Side

Shell	SiC tubes length						
	1000	1500	2000	2500	3000	3500	4000
DN 100 - 4”	I	I	II	II	II	II	II
DN 150 - 6”	II	II	II	II	III	III	III
DN 200 - 8”	II	III	III	III	III	III	III
DN 250 - 10”	II	III	III	III	III	III	IV
DN 300 - 12”	III	III	III	III	III	IV	IV

PED 97/23/CE Table 1 - Process Tubes-Side

Shell	SiC tubes length						
	1000	1500	2000	2500	3000	3500	4000
DN 100 - 4”	I	I	I	I	I	I	I
DN 150 - 6”	II	II	II	II	II	II	II
DN 200 - 8”	II	II	II	II	II	III	III
DN 250 - 10”	III	III	III	III	III	III	III
DN 300 - 12”	III	III	III	III	III	III	III

1) Exceptionally, vessels intended to contain an unstable gas and falling within categories I or II on the basis of table 1 must be classified in category III.

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BR. FWC. 03/001 REV. 1