

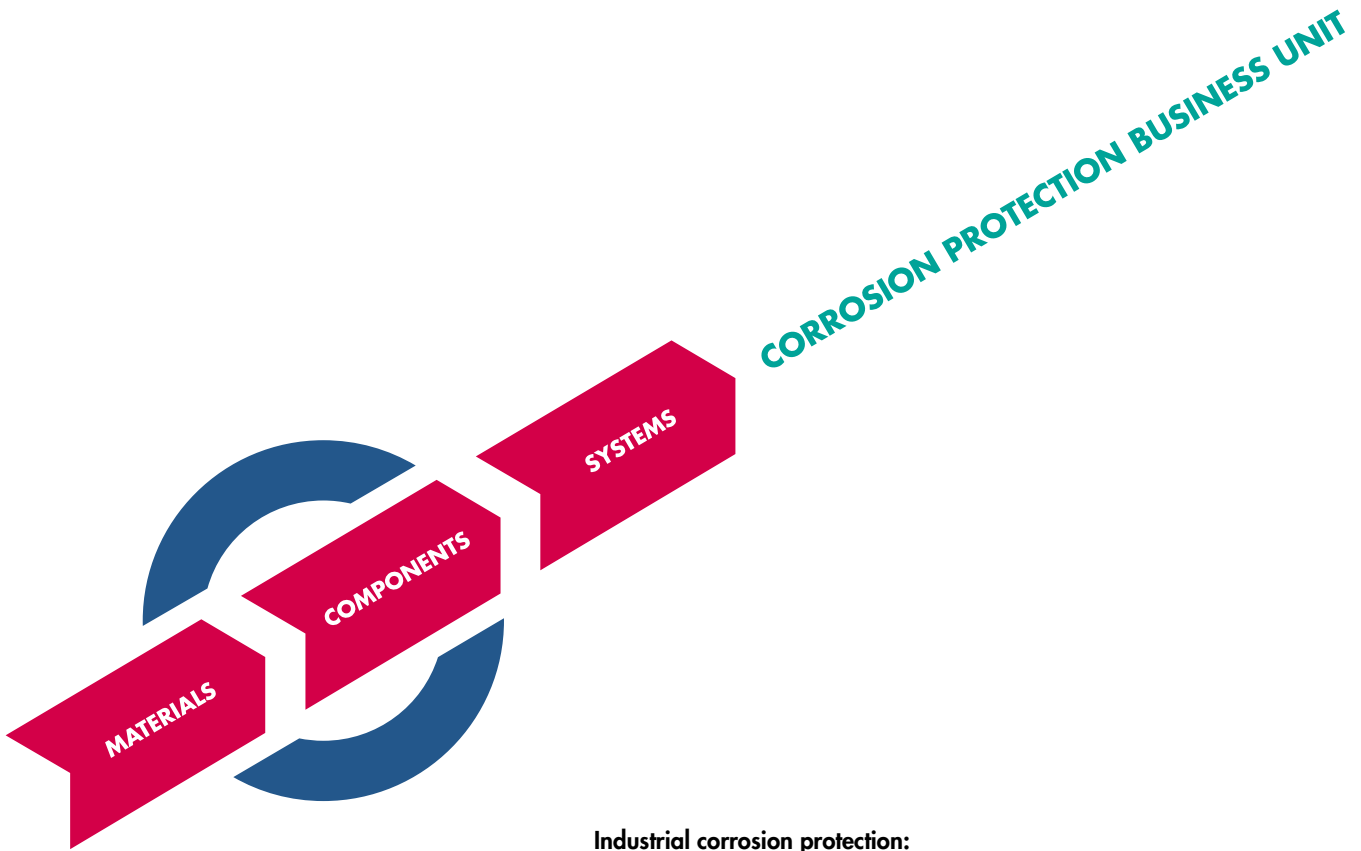
HEAT EXCHANGERS WHICH OFFER A PACK OF ADVANTAGES
PLATE HEAT EXCHANGERS



CONTENTS

Foreword	3
Areas of application	4 - 5
Product description	6 - 7
Design	8 - 9
Material	10 -15
Technical specification	16 -17
Quality assurance	18 -19

COMPLETE SYSTEMS CREATE NEW BENEFITS



Industrial corrosion protection:

A host of suppliers and subcontractors, difficult coordination and non-harmonized bids for materials, components, process equipment, packages and systems make efficient planning and execution of new plants a complex, time-consuming task. It doesn't have to be that way. We can now offer you a fully comprehensive range of products and services for industrial corrosion protection – we are the only producer in the world that is able to do so. We offer a complete system from a single source – from optimized material selection through interface management, production, delivery and installation right up to the warranty.

Our system approach is based on the combined expertise in materials and the decades of experience of three leading companies in corrosion protection.

These companies – SGL TECHNIK, HAW LININGS and KCH – have now been merged into the new SGL ACOTEC GmbH, the German-based headquarters of the global Corrosion Protection Business of the SGL CARBON GROUP.

You can save yourself time and trouble in the future – by taking advantage of our comprehensive, system-based range of products and services.



ALL OUR KNOW-HOW GOES INTO OUR PLATE HEAT EXCHANGERS

Plate heat exchangers made of [®]DIABON process equipment graphite offer a host of advantages – advantages which pay off for you in day-to-day service. What makes DIABON graphite plate heat exchangers so special?

The answer is: Our pooled know-how, which is an integral part of the design and manufacture of our plate heat exchangers. Our experience in the field of graphite production and our expertise in heat exchangers result in synergies which benefit you. For SGL ACOTEC offers system-based, customer-focused solutions – and, in the field of plate heat exchangers, advantages which systematically complement each other:

- The special design of the plates means that our graphite plate heat exchangers have a higher heat transfer rate than other graphite heat exchangers
- The compact construction results in a very low space requirement
- Counter-current flow enables optimum utilization of the temperature differential
- By simply changing the number of plates, the heat exchangers can be optimally adapted to any conditions
- The smaller liquid capacity of the heat exchanger makes for a short residence time. Changes in controlled variables can therefore be responded to more quickly
- Different plate corrugation patterns and single or multiple pass arrangement enable great flexibility in the use of the heat exchangers
- Turbulent-flow channel profiles minimize the tendency to fouling
- The film-type PTFE plate gaskets mean that the heat exchangers are corrosion-resistant in various environments, including the gaskets
- Backflushing enables cleaning-in-place (CIP) to be carried out. This means that the plates can be chemically or mechanically cleaned without having to disconnect the heat exchanger from the connections
- Our large stockholding capacity makes for short delivery times for complete exchangers and spare parts.

Based on these many advantages, DIABON graphite plate heat exchangers are used as heaters, coolers, interchangers and condensers for corrosive media – especially in the treatment of:

- Hydrochloric acid (HCl)
- Sulfuric acid (H₂SO₄)
- Hydrofluoric acid (HF)
- Mixed acids (HNO₃/HF)
- Phosphoric acid (H₂PO₄/P₂O₅)
- Other organic and inorganic media.

OUR MOTTO - COMPACT, QUICK, INNOVATIVE

System-based heat exchangers – that is how we convince our customers. For example, in the field of highly corrosion-resistant, compact heat exchangers. In collaboration with Alfa Laval Thermal (Lund, Sweden), we have developed a special DIABON graphite plate heat exchanger: an innovative solution for a compact heat exchanger. Its advantage is that it combines the universal corrosion resistance of graphite with the high efficiency of plate heat exchangers. The basis of this new development is the plastic-bonded graphite [®]DIABON F 100, which was also developed by SGL ACOTEC.

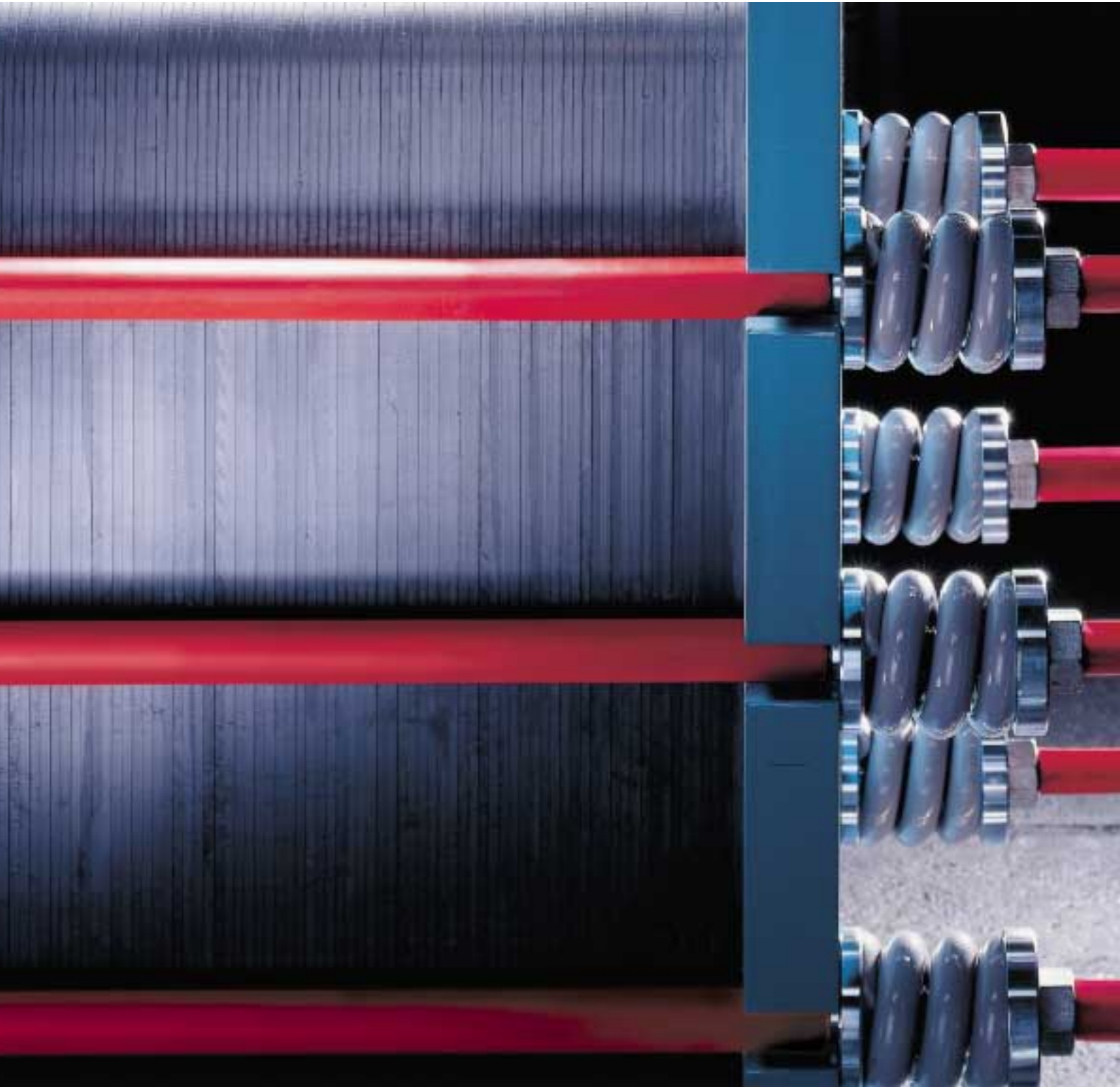
Another innovation is our modern processing center for the synthetic resin-impregnated graphite grades [®]DIABON NS 1 and NS 2. This extends our large range of graphite plates.



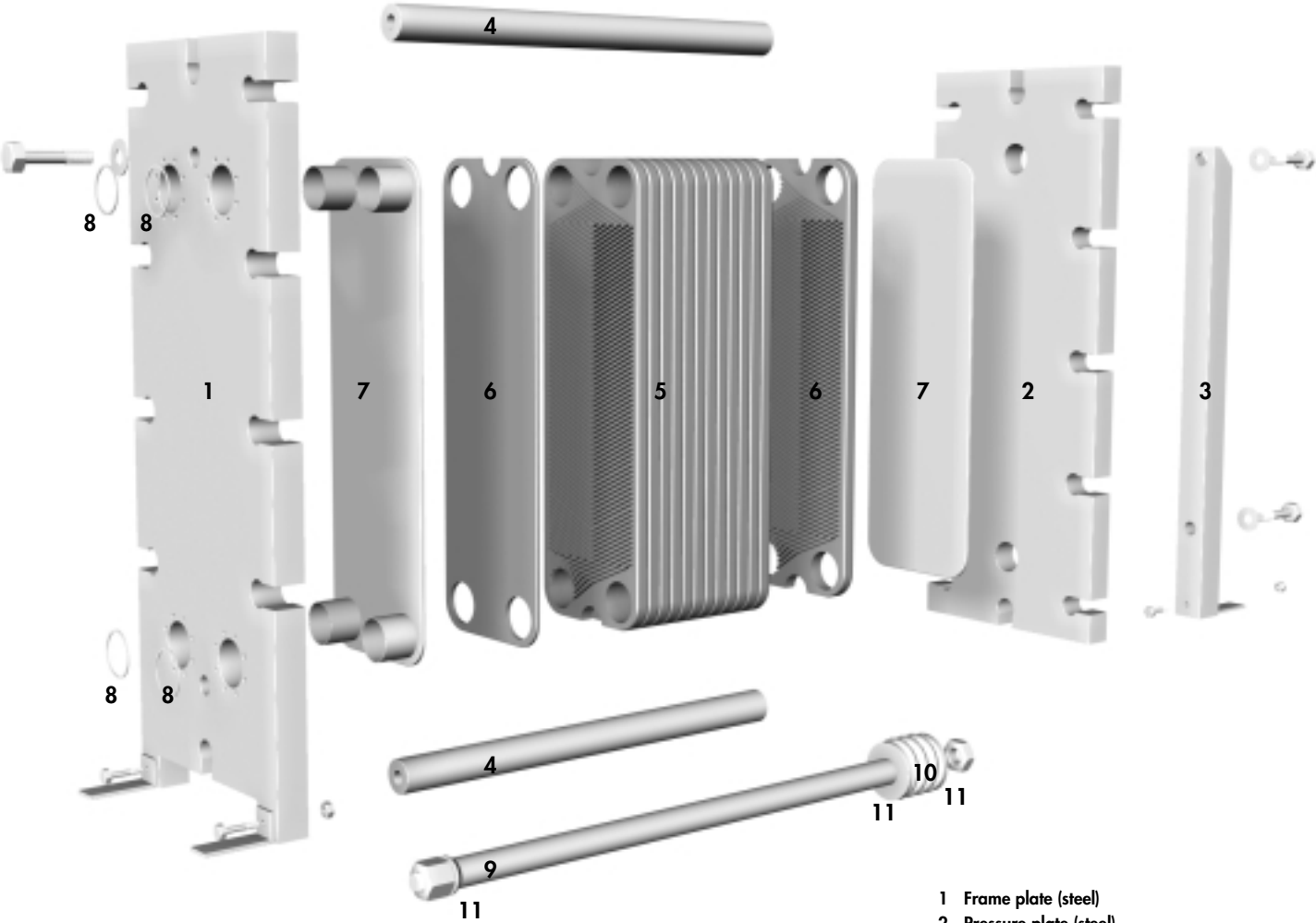
▲ Highly efficient plate profiles in [®]DIABON graphite – available from stock

Compact – maximum performance
with minimal space requirements
▶ [®]DIABON graphite plate heat exchanger





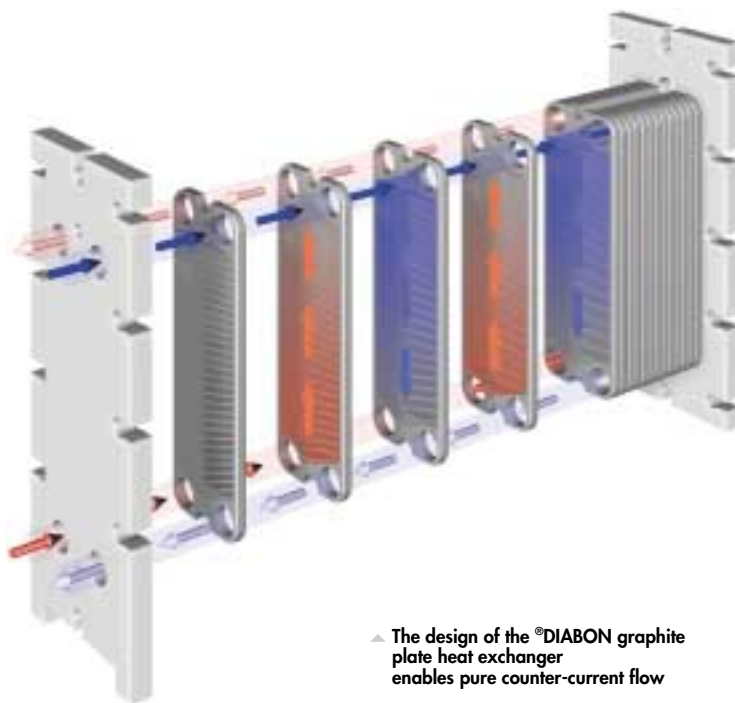
OUR DESIGN – SOLID AND ROBUST



- 1 Frame plate (steel)
- 2 Pressure plate (steel)
- 3 Support column
- 4 Guide bars
- 5 Corrugated plates (®DIABON graphite)
- 6 End plates (®DIABON graphite)
- 7 PTFE linings
- 8 Graphite gaskets
- 9 Tie rod (21CrMoV57)
- 10 Compression spring
- 11 Centering disks

Thanks to their special design, our DIABON graphite plate heat exchangers perform outstandingly in service. The plate pack is secured between two thick steel plates, one fixed and the other movable, by means of tie rods. It is held in line by an upper and a lower stainless steel bar, which are securely fixed to the front frame plate. The rear ends of the two guide bars are fixed to a support column. By this means, the rear frame plate – the pressure plate – can be moved freely after releasing the tie rods. This enables unhindered access to the graphite plates without having to move the exchanger out of its installed position or disconnect it from the pipe connections.

A further advantage of this design is that the difference in the coefficients of expansion of steel and graphite are compensated by means of helical springs.



▲ The design of the [®]DIABON graphite plate heat exchanger enables pure counter-current flow

**Our corrosion protection:
simply resistant**

To protect the frame/pressure plates and the nozzles against corrosion, we use [®]LICUFLON (PTFE) linings.

Here, too, you benefit from our expertise in complete systems. Because we are also skilled and experienced in the field of PTFE linings, you get everything from a single source – in top quality.

**Our plate seal:
absolutely leakproof**

The sealing system of the DIABON graphite plate heat exchanger has very special advantages: A soft PTFE O-ring seal is applied to the 20 mm wide sealing strips of the graphite plates and compressed to a film thickness of about 0.2 mm when tightening up the plate pack.

The advantages of this film-type seal include: Ease of removal when the exchanger is opened, excellent corrosion resistance and an extremely small cross-sectional surface for the media to come in contact with.



▲ ©DIABON NS 1 and NS 2 graphite plates with corrugation pattern for turbulent free flow

**Our graphite grades:
optimum performance in service**

Under the trademarks DIABON F 100, NS 1 and NS 2, a whole range of graphite materials is available. This means that in combination with the different corrugation patterns, we can find an optimum configuration for virtually any application.

Our maintenance: simplicity itself

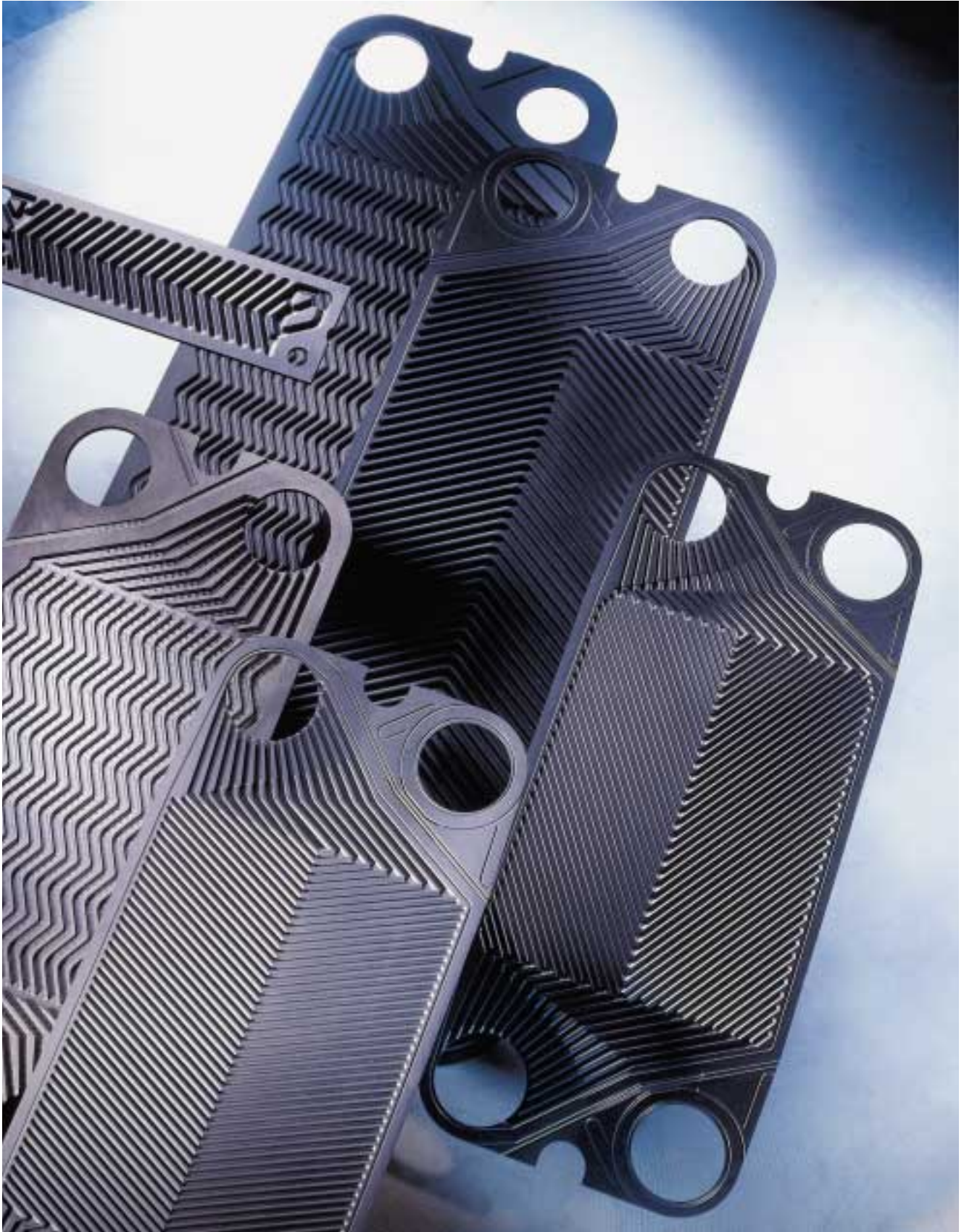
Economical for you: maintenance of DIABON graphite plate heat exchangers is simpler than with all other graphite heat exchangers. So it can be easily carried out on site – by your personnel. In addition, our specialists are always at your service to give training or carry out installation work. We also supply spare parts quickly and with ease – from stock.



▲ ©DIABON F 100 graphite plates with corrugation pattern for high turbulence

▶ ©DIABON graphite, ©LICUFLON (PTFE) and steel components with 260 µm corrosion-resistant coating for long service life



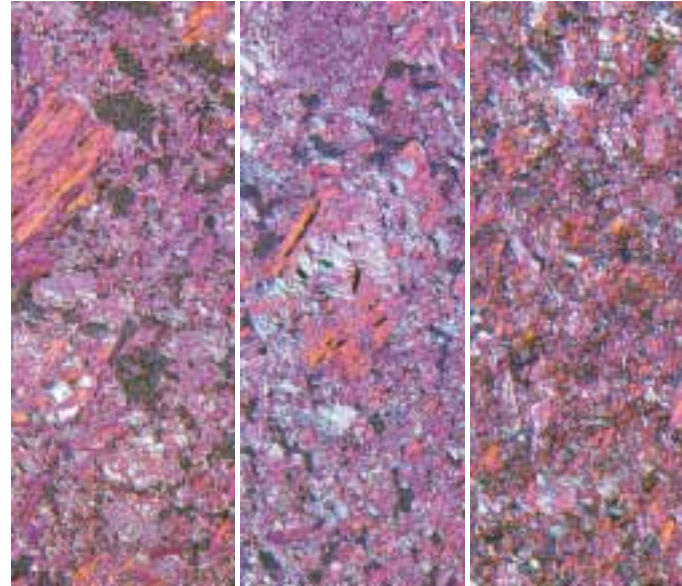


OUR GRAPHITES ARE HIGH-PERFORMANCE MATERIALS

Whichever material is being used, you can rely on the highest quality – and, therefore, on plate heat exchangers which are dependable in service through their economy and durability.

Our top grade: DIABON F 100 graphite

DIABON F 100 is our trademark for a fluoroplastic-bonded, non-porous fine-grain graphite with an extremely homogeneous material structure. The plastic is finely dispersed between the grains of graphite. DIABON F 100 graphite plates have an anti-adhesive, non-porous surface. Together with the high-turbulence channel corrugation pattern, a dual benefit is achieved: maximum efficiency accompanied by a minimal tendency to fouling. The fluoroplastic, which envelops the grains of graphite like a protective skin, produces outstanding corrosion resistance in oxidizing media such as mixtures of HNO_3 and HF. DIABON F 100 graphite is used for applications with liquid media at service temperatures up to 140 °C.



▲ Micrograph
®DIABON NS 1
graphite
Magnification 50x

▲ Micrograph
®DIABON NS 2
graphite
Magnification 50x

▲ Micrograph
®DIABON F 100
graphite
Magnification 50x

Our standard grade: DIABON NS 1 graphite

DIABON NS 1 is our trademark for a synthetic resin-impregnated, fine-grain graphite with a homogeneous material structure and a uniform pore distribution. The pores of the raw graphite are completely sealed with synthetic resin. DIABON NS 1 graphite plates are mainly used at higher temperatures up to 180 °C. This material's high temperature fatigue resistance and relative insensitivity to thermal shock enable it to be used for large temperature differentials. In combination with the simple geometry of the flat plates, a higher level of safety is achieved than with other graphite heat exchangers – especially in critical applications.

The corrugations consist of S-shaped milled channels without intersections. This results in a turbulent flow which tolerates a certain proportion of solids or fibers in the medium – while the pressure drop is kept small. DIABON NS 1 graphite plates are equally well suited to gaseous and vaporous media and to liquid service.

Our easy-care grade: DIABON NS 2 graphite

DIABON NS 2 is our trademark for a synthetic resin-impregnated, fine-grain graphite with an extremely homogeneous material structure and a uniform pore distribution. It is characterized by higher strength and lower sensitivity to swelling than DIABON NS 1 graphite. Again with DIABON NS 2, the pores of the raw graphite are completely sealed with synthetic resin.

DIABON NS 2 graphite is essentially used in the same fields of application as DIABON NS 1 graphite. However, because DIABON NS 2 graphite plates have improved strength values and fewer, smaller pores, they are especially suitable for more severe corrosive conditions.

Our materials: tested and approved by the German Technical Supervisory Board (TÜV)

Maximum permitted material temperatures of 200 °C for DIABON NS 1 and NS 2 graphite and 140 °C for DIABON F 100 graphite were established by means of extended-time tests.

◀ The whole range:
®DIABON F 100, NS 1 and NS 2 graphite

Our plates: corrosion-resistant

Carbon and graphite are outstandingly corrosion-resistant. Therefore they are attacked only by strongly electronegative elements such as oxygen at temperatures above 500 °C and elemental halogens. Strongly oxidizing acids such as chromic acid can also destroy the carbon. The corrosion resistance is essentially determined by the behavior of the synthetic resin in the case of DIABON NS 1 and DIABON NS 2 graphite and of the fluoro-plastic content in the case of DIABON F 100 graphite. If in doubt, corrosion tests can be carried out with standardized material specimens. Analysis of the results in our laboratories then shows whether the material is suitable.

DIABON graphite plate heat exchangers are chiefly used in the following media:

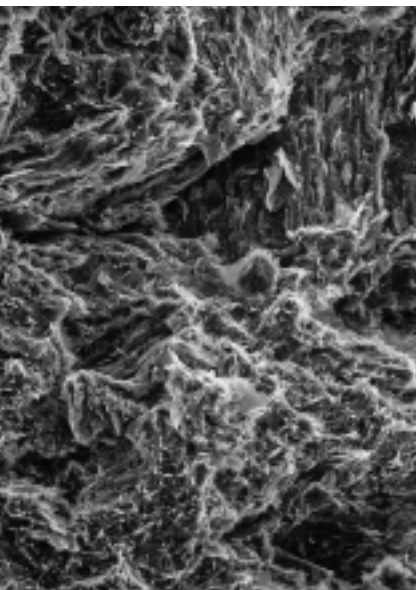
- Hydrochloric acid and HCl gas in all concentrations
- Sulfuric acid up to 90 %
- Hydrofluoric acid up to 60 %
- Mixed acid (HF/HNO₃) up to 30 %
- Phosphoric acid in all concentrations
- Other organic and inorganic media.

You will find detailed corrosion tables in our DIABON graphite material brochure.

Our DIABON graphite cannot handle everything

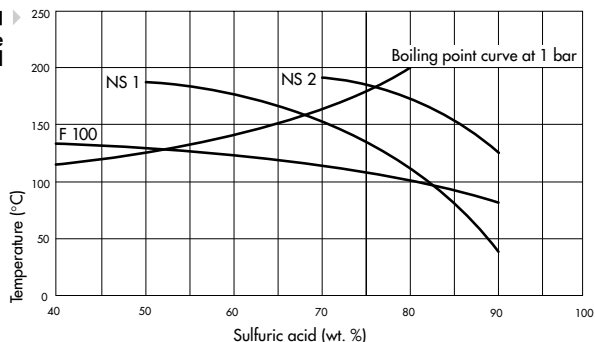
A reduction in service life is likely with the following media, depending on concentration and temperature:

- Elemental chlorine and bromine in aqueous solution
- Nitrous gases (NO_x) in sulfuric acid
- Acids with a high oxidation potential (e. g. chromic acid, > 90 % sulfuric acid)
- Organic solvents with high polarity (e. g. THF, NMP, DMF, MIBK, MEK)
- Strong alkalis and amines.

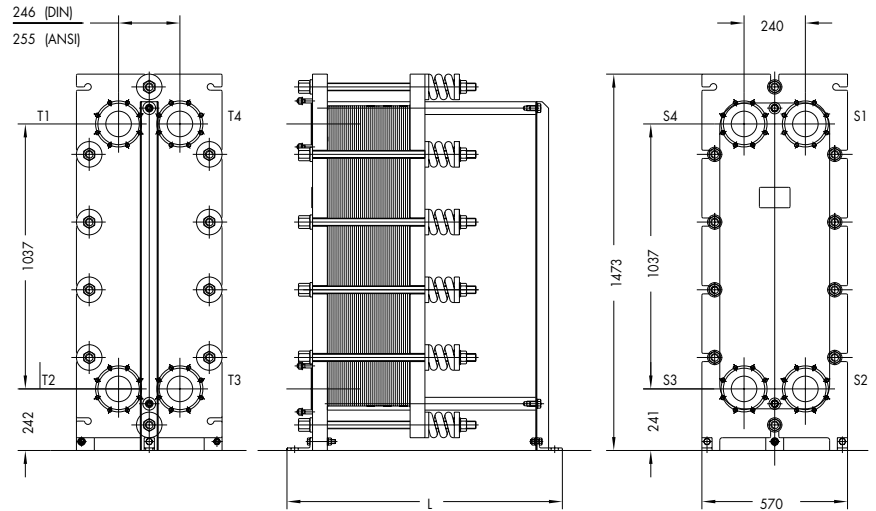


▲ Scanning electron micrograph of a [®]DIABON F 100 graphite fracture surface. The good distribution of the plastic is apparent from the thin film between the graphite particles

Corrosion resistance of [®]DIABON F 100, NS 1 and NS 2 graphite in sulfuric acid







®DIABON graphite plate heat exchanger P 40

Plates:

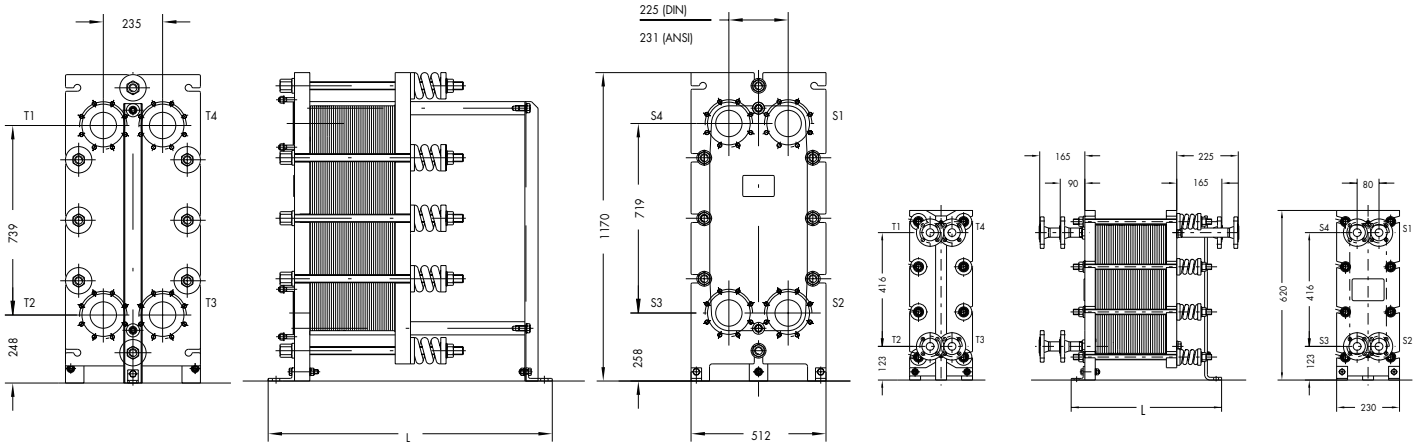
Plate material	®DIABON F 100 graphite	®DIABON NS 1 (NS 2) graphite
Corrugation pattern	turbulent flow	free flow
Typical heat transition coefficients [W/K.m ²]	2000	4000
Exchange area per plate [m ²]	0.4	0.3039
Max. no. of plates per frame	130	96
Plate thickness [mm]	8	10
Liquid capacity [l]	1.5	1.4
Weight of a plate [kg]	6.1	7.1
Plate seals	PTFE, plastic	PTFE, plastic

Frame:

Width [mm] x height [mm]	570 x 1473	
Length L [mm]	912/1162/1512/1762	
Max. no. of plates for length L	25/55/100/130	16/40/72/96
Weight excl. ®DIABON graphite [kg]	900-940	
Connections – frame plate:	DN100 (DN80) DIN2501 PN16	
Pressure plate: T1-T4	or DN4" ANSI 150 lbs	
Test pressure with water [bar]	standard: 9.1 / special design: 10.5	
Design temperature	140	180

Materials:

Frame and pressure plate	P265GH or SA516 Gr. 60
Tie rods and stud bolts	21CrMoV57 alt. SA193 Gr. B7
Nuts	24CrMo5V alt. SA194 2H
Compression springs	50CrV4
Guide bars	1.4301 (stainless steel grade)
Lining of frame/pressure plates and connections	PTFE (®LICUFLON)
Painting	2-component epoxy paint
	1 priming coat of Hempadur 15570, 100 µm
	1 intermediate coat of Hempadur 15570, 100 µm
	1 top coat of Hempthane 55210, 60 µm
	shade: similar to RAL 5002



®DIABON graphite plate heat exchanger P 25

®DIABON graphite plate heat exchanger P 05

®DIABON F 100 graphite turbulent flow (high and low theta)	®DIABON NS 1 (NS 2) graphite free flow	®DIABON F 100 graphite turbulent flow	®DIABON NS 1 (NS 2) graphite free flow
2200	4500	2000	4500
0.25	0.1766	0.05	0.026
160	100	80	64
6.5	10	8	10
0.7	0.6	0.18	0.12
2.7	4.2	0.75	0.95
PTFE, plastic	PTFE, plastic	®SIGRAFLEX graphite	PTFE, plastic
512 x 1170		230 x 620	
912/1162/1512/1762		350/450/550/650/750/850	
32/70/125/160	20/45/80/100	18/30/43/55/68/80	14/24/34/44/54/64
610-650		105-125	
DN100(DN80) DIN2501 PN16 or DN4" (DN3") ANSI 150 lbs		DN25 DIN2633 PN6 or DN1" ANSI 150 lbs	
standard: 9.1 / special design: 10.5		standard: 9.1 / special design: 10.5	
140	180	140	180



OUR PRINCIPLE – QUALITY FIRST AND LAST

No question: Continuous quality assurance is an integral part of SGL CARBON's corporate philosophy. So in order to guarantee consistently high quality, we work to a targeted quality management system as a basis for meeting our quality commitment. As the world's largest manufacturer of carbon and graphite products, process equipment and systems for the chemical industry and environmental protection units, we find targeted quality management vital in ensuring that customers' specified quality standards are attained – and seen to be attained.



Our quality management system is certified in accordance with ISO 9001. For production of DIABON graphite plate heat exchangers, this means that both the raw materials – graphite semi-finished products, PTFE films, plastics and other bought-in parts – and the finished products made from them are subjected to stringent testing. To give you security in black and white, we keep complete records of these tests.

◀ Pressure test on a [®]DIABON graphite plate heat exchanger

© SGL ACOTEC GmbH, Siershahn (Germany), 2000
® registered trademarks of SGL CARBON GROUP
companies

This information is based on our present state of knowledge and is intended to provide general notes on our products and their uses. It should therefore not be construed as guaranteeing specific properties of the products described or their suitability for a particular application. Any existing industrial property rights must be observed. The quality of our products is guaranteed under our "General Conditions of Sale".

PE-204/01-2001e Printed in Germany



SGL CARBON GROUP

**Corrosion Protection
Business Unit**

SGL ACOTEC GmbH

Werner-von-Siemens-Straße 18
D-86405 Meitingen / Germany
Phone +49 (82 71) 83-15 64
Fax +49 (82 71) 83-21 01
bspe@sglcarbon.de
www.sglcarbon.com