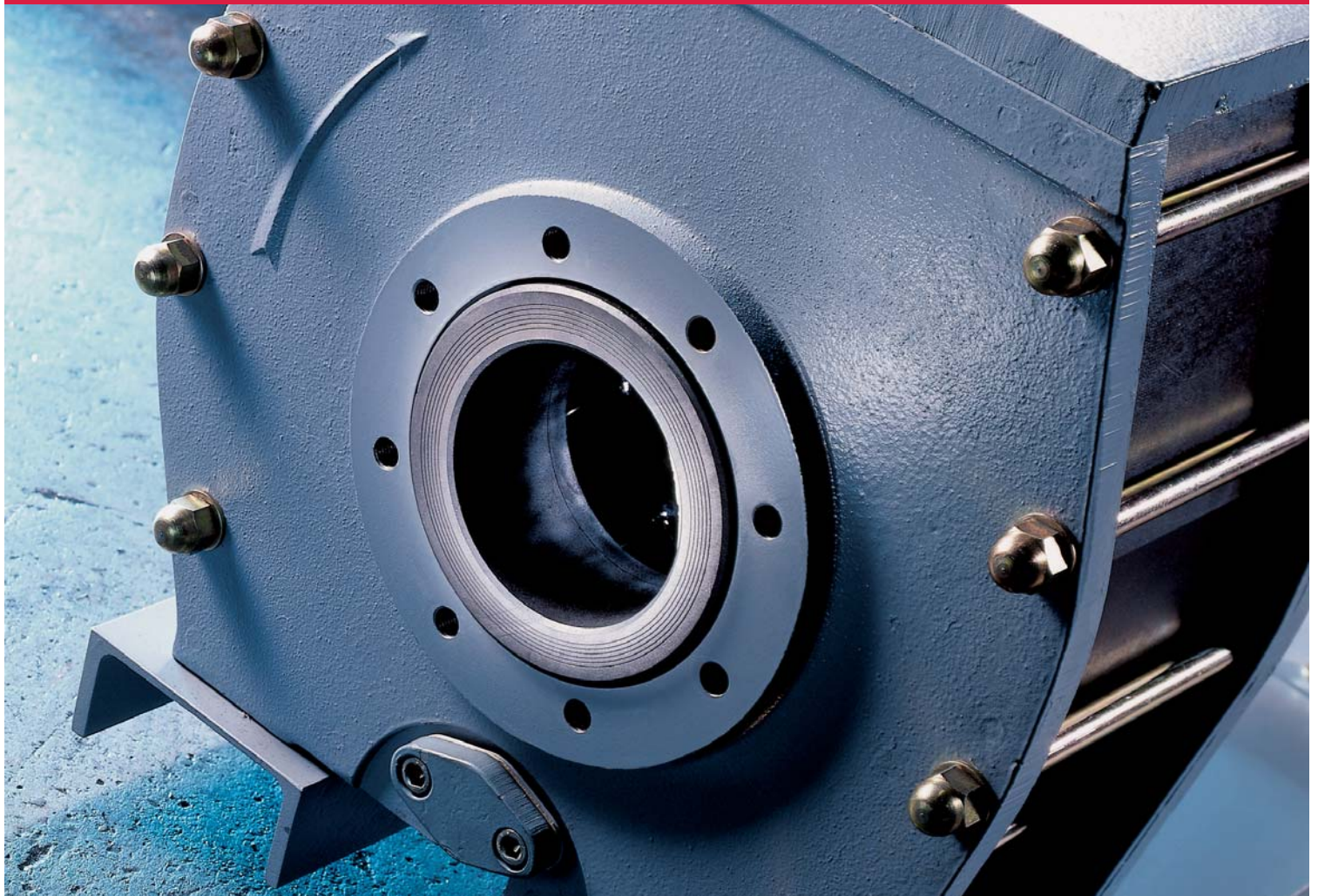


DIABON®

Chemical Pumps
in Graphite

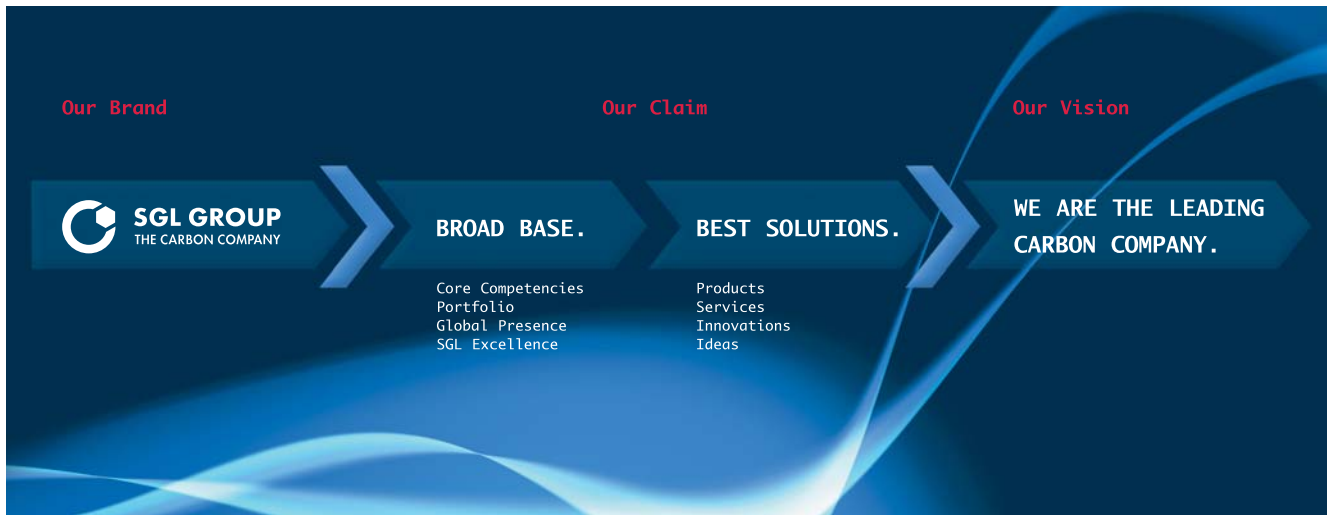
Process Technology



Broad Base. Best Solutions.



SGL Group – The Carbon Company



SGL Group – The Carbon Company – is one of the world’s leading manufacturers of carbon-based products. We have a comprehensive portfolio ranging from carbon and graphite products to carbon fibers and composites.

Our core competencies include a wide knowledge of raw materials, specialized production expertise and in-depth application and engineering know-how. As a result, we have built up a comprehensive technology and product portfolio. We operate on a global scale and are close to our customers anywhere at any time. Supported by this broad base, we offer our customers the best solutions. That is what SGL Excellence stands for.

Process Technology

Perfection in Graphite and PTFE

Our Business Line Process Technology is focused on supporting the technical processes of our globally operating customers in the chemical industry, metal manufacturing and environmental protection technology. A maximum degree of know-how and expertise in corrosion protection, a global presence and full-package systems from a single source: that's what our customers need – and get from us:

- ▶ Long-standing experience and a high level of expertise in process technology
- ▶ Comprehensive process, material and design know-how on graphite and PTFE
- ▶ Closeness to customers: cost-effective manufacturing to international and local standards at our production sites in Europe, America and Asia and worldwide customer service
- ▶ A consistently high standard of quality

Our comprehensive range of products and services extends from process equipment and components made from DIABON® graphite and POLYFLURON® virginial, paste-extruded PTFE, through LICUFLON® skived PTFE sheet-lined equipment, FLUROFLEX® bellows, FLUROPIPE® pipe systems, FLUROSIC® silicon carbide heat exchangers and DIABON® graphite or exotic metal pumps, to the planning and assembly of complex systems.



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Criteria for the Use of DIABON® Pumps

For more than 50 years now, SGL Group has been manufacturing reliable pumps from DIABON graphite that withstands the most corrosive media (hydrochloric acid, chlorine compounds, sulfuric acid, phosphoric acid) at operating temperatures of up to 200°C. Our products include a whole range of ISO 2858 pumps and high-capacity pumps whose thermal stability is unmatched, as are their resistance to corrosion and abrasion. Centrifugal and axial pumps in DIABON graphite therefore offer an indisputable technical and economical alternative to fluoroplastic pumps in respect of both their high reliability in service and long service life under extreme operating conditions.

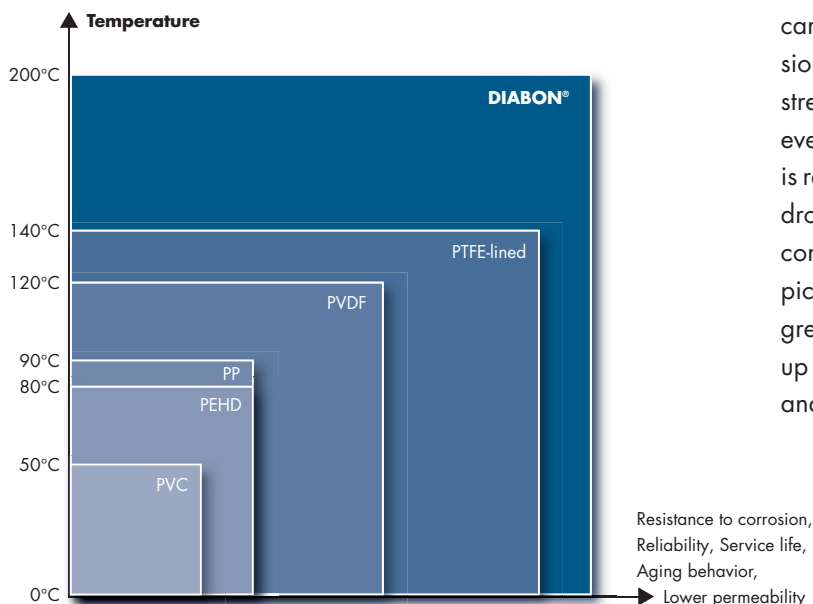


DIABON® impeller

Any pump operator in the chemical industry will sometime be faced with the application limits of plastic pumps (PP, PEHD, PVDF, PTFE, PFA). The service lives of both solid and lined plastic pumps decline with an increase in the temperature, pressure, corrosivity, diffusivity or erosivity of the transferred fluid. Owing to the very high expansion coefficients of plastics, as well as their permeability and thermoplastic behavior, clearance is difficult to allow for in the design of rotating equipment. As a result, the

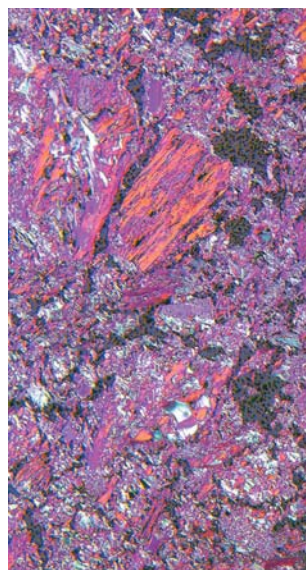
reliability of plastic equipment is impaired and its service life shortened, as is apparent from the numerous failures occurring in chemical plants. Even PTFE- or PFA-lined pumps see their mechanical characteristics and permeability decline when the temperature of the transferred fluid exceeds 140°C.

To overcome these problems, SGL Group's Business Line Process Technology has developed a composite material under the brand name DIABON. This material, which is manufactured from graphitized carbon and phenolic resin, has outstanding corrosion resistance, thermal stability and mechanical strength. In fact, its corrosion resistance is unlimited even in the most corrosive media. DIABON graphite is resistant to the vast majority of acids, including hydrochloric acid in any concentration, chlorinated compounds, sulfuric acid, phosphoric acid and pickling liquors. Even when used in these highly aggressive media, it easily withstands temperatures of up to 200°C. DIABON is fully impervious to gas and liquids; its permeability is almost zero.

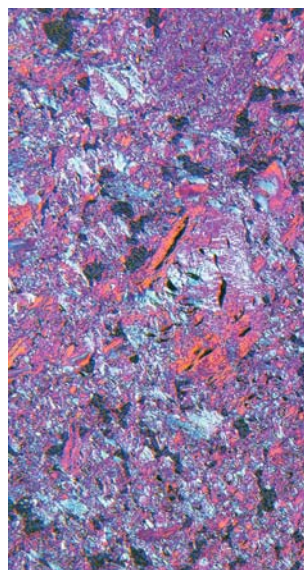


Thanks to its carbon matrix, the composite material has a very low coefficient of thermal expansion. This provides ideal characteristics for the manufacture of rotating equipment in which play needs to be as low as possible in order to ensure an elevated and constant level of hydraulic performance while limiting the internal recirculation between impeller and volute at the same time. Volutes of up to 1.5 meters and large turbines of up to 550 mm in diameter – designed for the manufacture of high-capacity centrifugal pumps and axial pumps of up to 3000 m³/h – are machined from large homogeneous cylinders. For high-pressure applications from 16 bar to 25 bar, SGL Group supplies pump casings with an optional carbon fiber reinforcement applied by the filament winding method. This optimized design enables the material to withstand extreme mechanical stresses such as pressure surges.

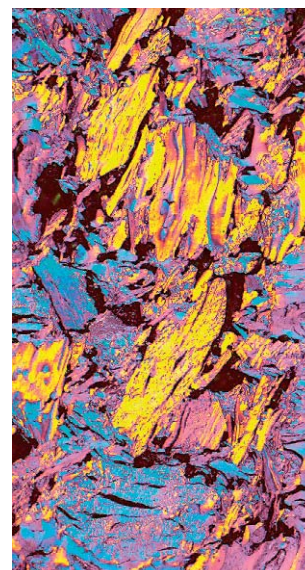
For corrosive media with a high solids content, SGL Group has developed DURABON®, a special composite material based on amorphous carbon. Sandblasting tests conducted in the laboratory have shown that this new



Micrograph of DIABON® NS1



Micrograph of DIABON® NS2



Micrograph of DURABON®

material features a hardness level similar to that of ceramics but without their brittleness. Pumps manufactured from this material have outstanding abrasion resistance even in the most corrosive

media. For such special applications, SGL Group supplies a range of vortex pumps with free passages of up to 50 mm and designed for capacities of up to 150 m³/h.

Graphite brands

Property (guide values)	Unit	DIABON N	DIABON NS1	DIABON NS2	DURABON
Max. service temperature	°C	180	200	200	200
Bulk density	g/cm ³	1.85-1.90	1.88-1.92	1.88-1.92	1.88-1.92
Dyn. modulus of elasticity	MPa	15-20·10 ³	15-20·10 ³	15-20·10 ³	15-20·10 ³
Flexural strength	MPa	20 - 25	25 - 35	30 - 40	25 - 35
Compressive strength	MPa	40 - 50	60 - 80	60 - 80	60 - 80
Tensile strength	MPa	>16	>18	>20	>18
Lin. coefficient of thermal expansion (20 - 200 °C)	K ⁻¹ ·10 ⁶	4 - 6	8 - 10	8 - 10	8 - 10
Thermal conductivity	W/mK	>120	>120	>140	>5
Coefficient of permeability	cm ² /s	10 ⁻⁵	10 ⁻⁶	10 ⁻⁶	10 ⁻⁶
Ash content	%	< 0.5	< 0.5	< 0.5	< 0.5

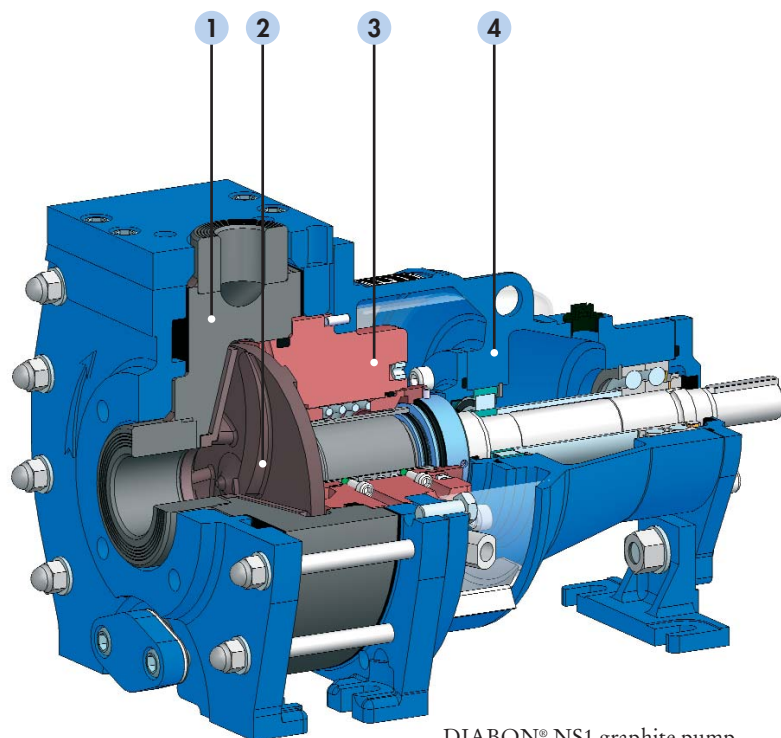
DIABON® Standard Chemical Pumps

for Corrosive Process Fluids

Process fluids of up to 200°C

SGL Group has a long history of supplying excellent pumps for the most corrosive and demanding applications.

Our knowledge, experience and competence in process equipment have made us a leader in the field of corrosive pumps. The standard centrifugal horizontal pumps supplied by SGL Group – ANSI/ISO 2858, NFE 4421 and DIN 24256 – have a proven record of exceptional reliability. Capacities range from 2 to 2000 m³/h and discharge heads from 8 to 174 m. The pumps are available with DIN or ANSI flanges.



DIABON® NS1 graphite pump

1 Graphite volute

The volute case is machined from a single block of DIABON. It is clamped between two metallic plates that absorb the tightening force of the attached piping. For extremely abrasive applications, the volute case can be protected by a ceramic coating or made of DURABON.

2 Graphite impeller

The impeller is machined from a single DIABON graphite block. Back vanes and recirculation holes allow pressure relief on the shaft seal and balancing of the axial thrust on bearings. The impeller, threaded and cemented to the metallic shaft, permits trouble-free rotor torque transmission independently of the direction of rotation.

For use in liquids containing solids, the impeller can be protected by a ceramic coating or made of DURABON in order to substantially improve its resistance to erosion and abrasion.

3 Seal casing

The seal casing is made from a single block of DIABON as well.

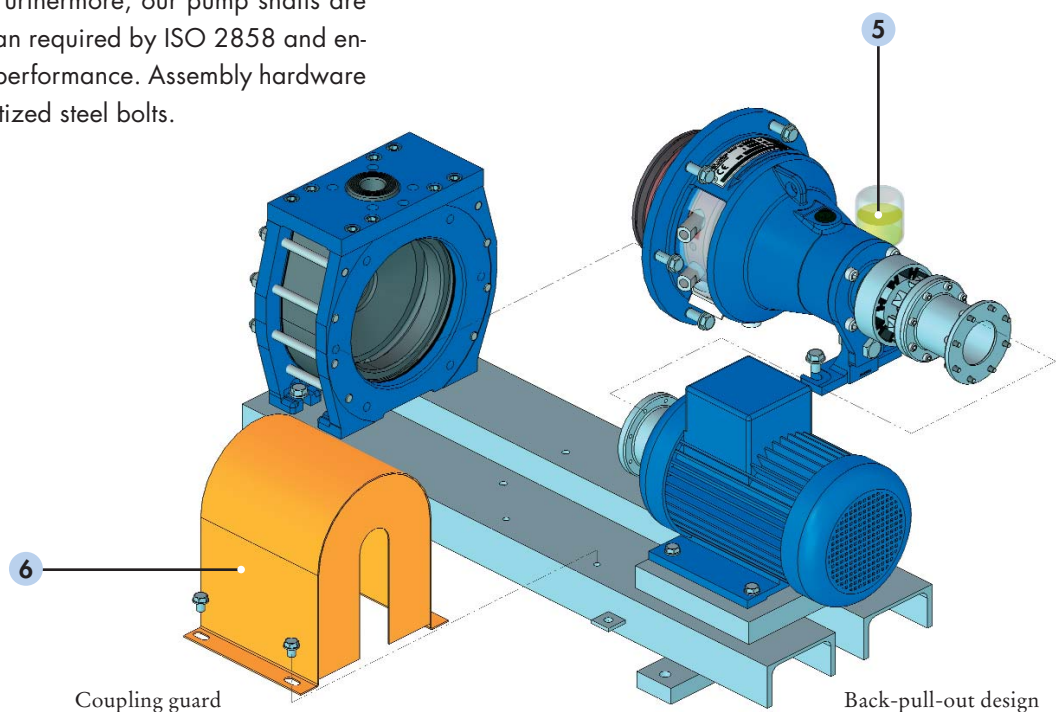
4 Bearing housing designed for high performance

The bearing housing is made of cast iron and designed for maximum rigidity. The distance between the bearings is maximized to restrict shaft deflection and to guarantee a long service life of the mechanical seals. Furthermore, our pump shafts are much "stiffer" than required by ISO 2858 and ensure the highest performance. Assembly hardware includes chromitized steel bolts.

5 Lubrication system

A constant-level oiling system comes standard on the new ISO pumps.

This ensures continuous lubrication and excellent heat distribution. The system maintains the correct level of lubricant and allows rapid visual checking.



6 Coupling guard

The coupling guard is available in two versions: A carbon steel version and a non-metal variant for applications in an explosive environment.

"Back-pull-out" design

Our standard chemical pumps are of the "back-pull-out" type. This design allows the inspection and maintenance of the bearing housing assembly without disconnecting the piping and volute. Moreover, the bearing housing assembly can be replaced in an emergency, thus simplifying on-site operations and considerably reducing downtime.

Highly Reliable

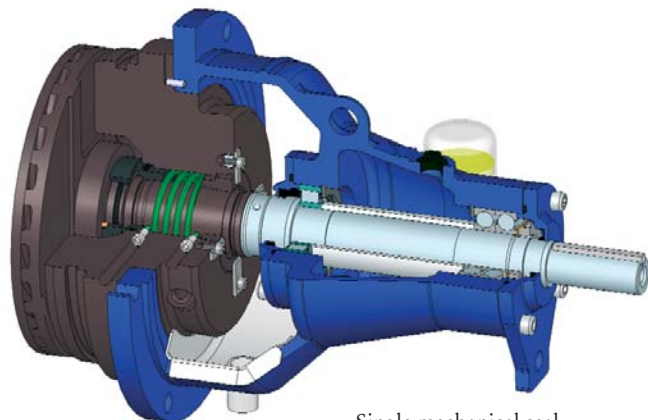
Mechanical Seals

Our mechanical seals are designed to meet the latest standards of quality and safety. The materials for our mechanical seals are selected on the basis of our experience to match the abrasion and corrosion characteristics of the process fluid. Since all parts in contact with the process fluid must withstand corrosive conditions and high temperatures, we specify silicon carbide and/or carbon seal faces.

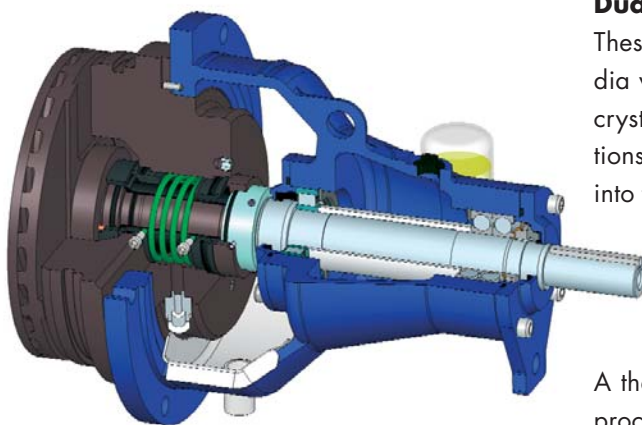
Single mechanical seal

Our standard seal for graphite pumps is suitable for clean corrosive fluids, non-crystallizing fluids, temperatures up to 100°C and pressures up to 16 bar.

An external flushing device can be added for applications involving the risk of crystallization.



Single mechanical seal



Dual mechanical seal

Dual mechanical seal (tandem or double)

These seal arrangements are suitable for those media which contain solids or involve a high risk of crystallization. They are also suitable for applications where leakage of toxic or corrosive media into the environment must be avoided. Suitable for fluids with a low lubricating power, high temperatures up to 200°C and pressures up to 16 bar.

A thermosiphon may be added to ensure that no process fluid can pass to the atmospheric side of the seals.

Mechanical seal

	Process side	Atmospheric side
Single mechanical seal	SiC/Carbon SiC/SiC	
Dual mechanical seal	SiC/Carbon SiC/SiC	SiC/Carbon SiC/Carbon

SiC = Silicon carbide

ISO MAG-DIABON® Pumps

Magnetic-Drive Chemical Pumps

Our ISO MAG-DIABON pumps combine the advantages of our DIABON pump with those of the magnetic drive coupling. The absence of mechanical seals virtually eliminates the need for maintenance. The number of wearing parts is limited, which prolongs the pumps' service life.

Key features of the ISO MAG-DIABON pump include the following:

1 Magnets

The modular magnets are made of high-quality samarium cobalt adapted to the drive assembly. They are characterized by a high-density magnetic field, which permits a compact drive.

The inner rotor encapsulated in graphite allows higher process temperatures than those possible with PTFE pumps.

2 Ceramic can

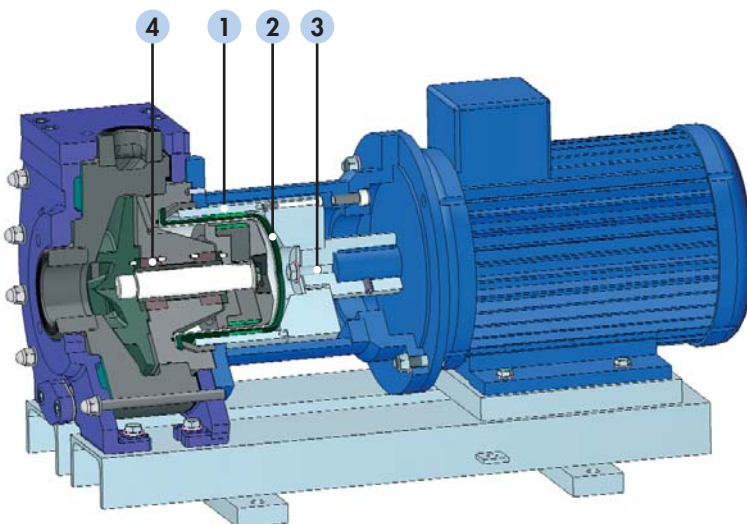
Our magnetic drive pumps are made absolutely tight by a ceramic can. The absence of welds or joints means there is no risk of media leakage or pollution. The non-metallic can also prevents the formation of eddy currents.

3 Torque

Torque transmission to the shaft and pump impeller is ensured by a torque slip clutch. The pump can therefore withstand a reverse-direction start without sustaining any damage.

4 Bearings

Inside wetted bearings are made from pure silicon carbide. They are lubricated by the pumped liquid.

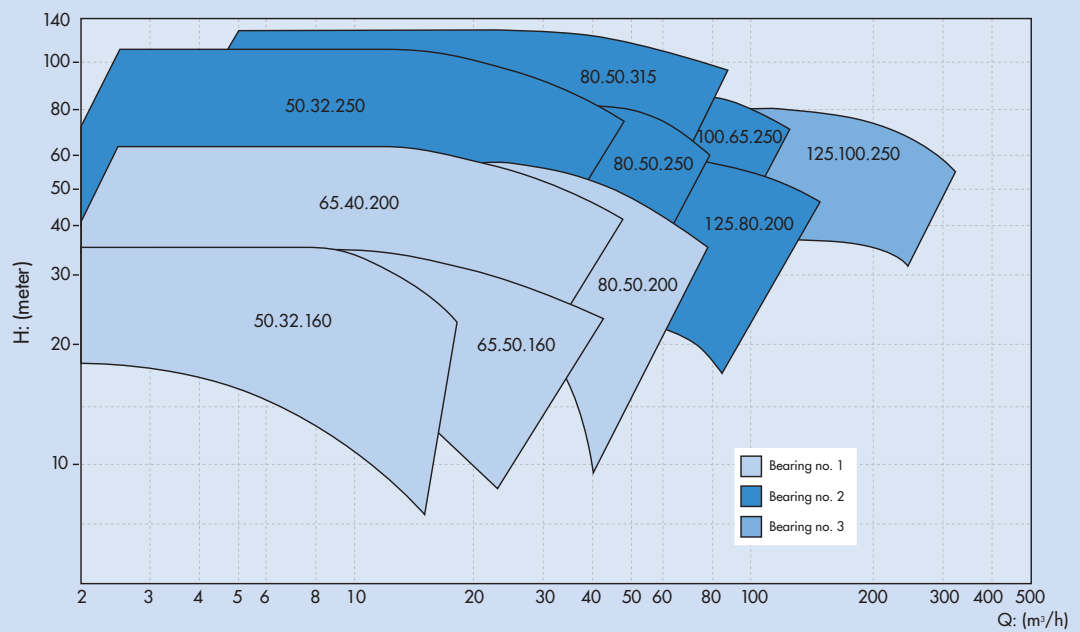


Monoblock magnetic drive DIABON® pump

Characteristic Curves of Pumps

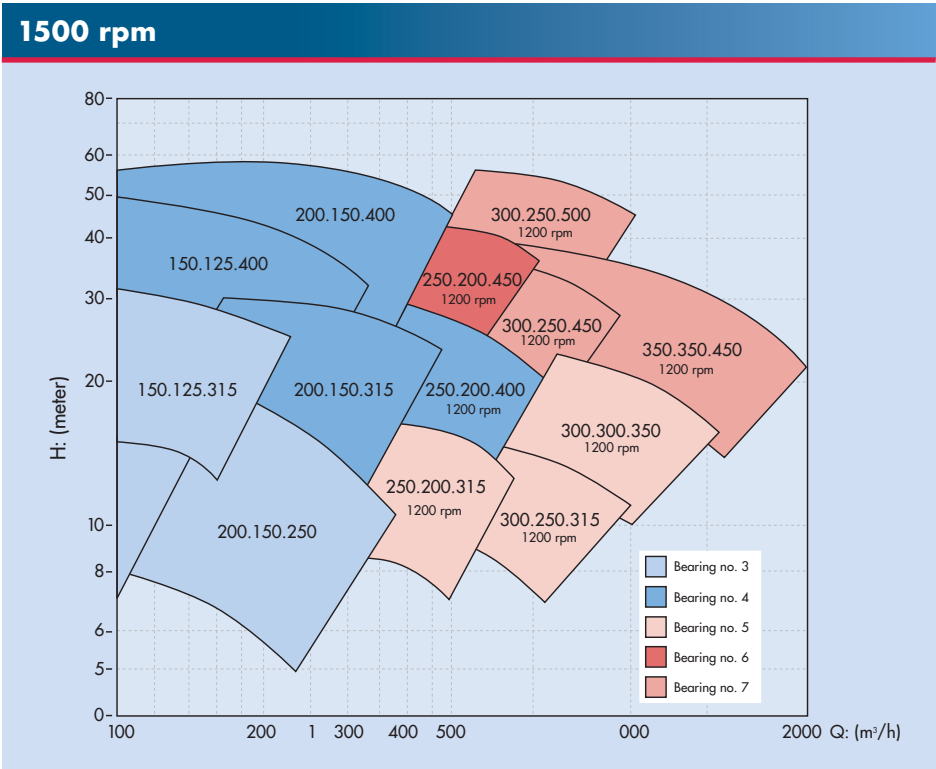
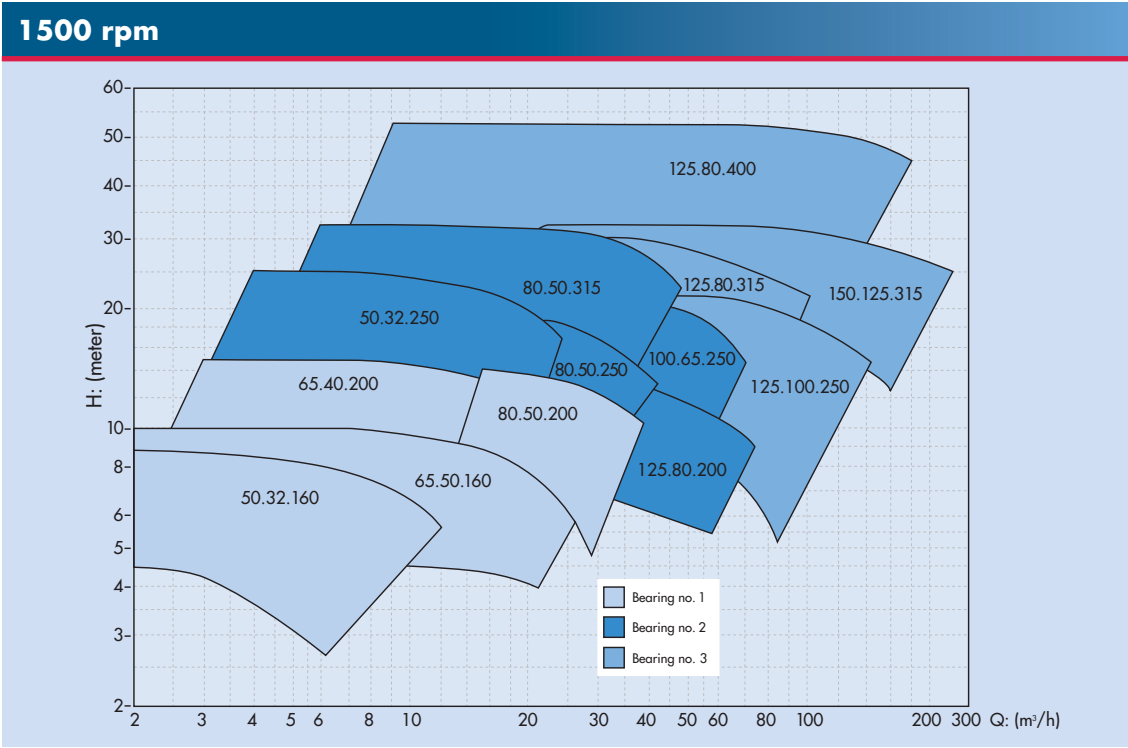


3000 rpm



Characteristic Curves

of Pumps

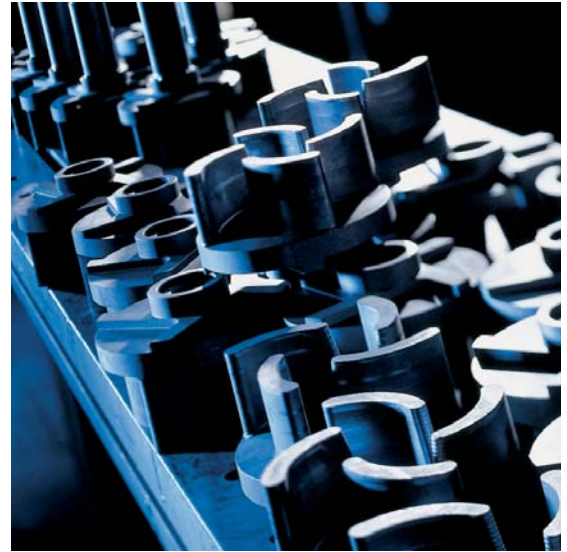


Construction

Details



DIABON® volute case



DIABON® impellers

Besides the standard ISO designs, we fulfill special requirements and develop pumps that can also be used safely and reliably for more demanding applications. In such cases, we work closely with our customers; our team of engineers and specialists is able to design equipment perfectly adapted to your needs or specifications.

Open impeller

Open impellers are our standard for diameters up to 400 mm. They are suitable for media containing solids, as these impellers are less sensitive to clogging. The gap between impeller and front face of the volute is adjusted to the ideal value.

Closed impeller

For larger impeller diameters, our graphite pumps can be equipped with closed impellers in order to decrease the axial stresses on bearings and to optimize their efficiency.

Special products

We offer special products, which include:

- ▶ Large pumps such as 300-300-350 (flow: 100 to 1000 m³/h, discharge head: 1 to 50 m) made of DIABON NS1
- ▶ Axial pumps (flow: 100 to 3500 m³/h, discharge head: 1 to 15 m) made of DIABON NS1
- ▶ Closed-circuit lubrication systems for double mechanical seals
- ▶ Cooling or heating of the pump casing
- ▶ Cooling or heating of the bearing housing
- ▶ Priming systems on base plate

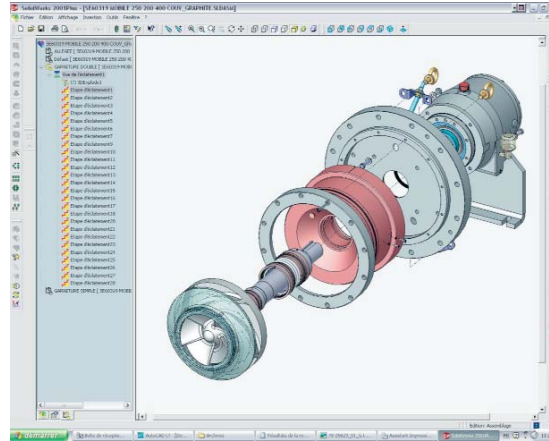
Quality at Every Step – Pump Design and Production

Design and development step

Our team of developers consists of many experienced engineers of various disciplines with specialist knowledge of hydraulics, mechanics and chemistry.

For design, we use the most advanced 3-dimensional computer-aided design software such as SolidWorks and ANSYS. Each graphite part is modeled using finite element analysis to check mechanical stresses.

Thermal expansion is closely calculated to ensure optimal performance.

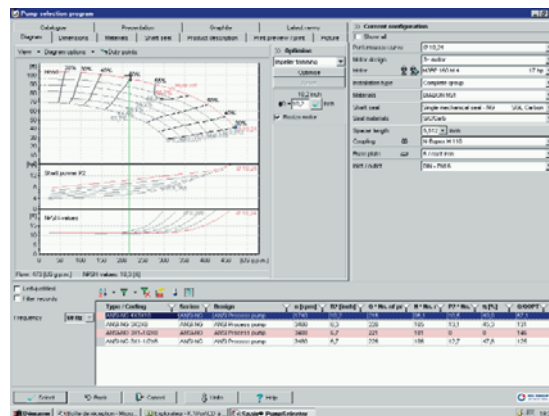


SolidWorks screenshot

Selection step during quotation

Spaix Classic, our pump dimensioning software, guarantees that our customers receive a technical and commercial offer perfectly suited to their requirements.

It enables us to promptly respond to your inquiries – thanks to our continually updated database.



Spaix screenshot

Performance test

Our pump production centers in Europe and America are equipped with test benches for testing pumps of any design. This enables the properties of individual pumps – flow, discharge head, efficiency, power and NPSH – to be specifically matched to the customer's requirements. The ability to simulate all applications ensures our pumps' excellent reliability.



Performance test

Customer Service

with a Full Package of Benefits



Individual tube testing on a shell and tube heat exchanger

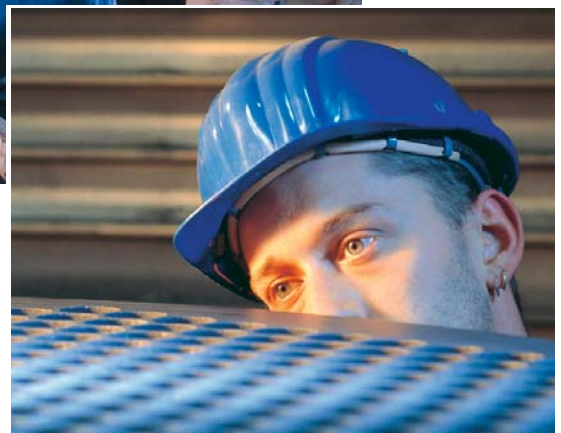
Our continuing partnership with customers is based on the excellent services and system solutions we provide. These are a key part of our commitment.

All items of SGL Group's DIABON process equipment are quality products manufactured in our own plants from high-grade materials using the latest technologies. If a product still fails to meet your requirements, SGL Group's worldwide network of service centers will be on hand to help. We see every problem as a fresh opportunity. Give us the chance to prove it.

Spare parts and repairs

SGL Group's responsibility for its products doesn't end when customers take delivery of DIABON equipment. In fact, we give our customers systematic support all the time it's in use. This support is a key part of our customer service.

The long service life of our graphite equipment depends crucially on its high quality and the servicing and/or cleaning it gets when in contact with highly corrosive and contaminated media.



Visual inspection of a tube sheet

Quality Management by Process Technology

As a manufacturer of carbon and graphite products, process equipment and systems for the chemical industry and environmental protection technology, SGL Group maintains a targeted quality management system designed to attain and meet the product quality standards demanded by customers. Our quality management system meets the requirements of DIN EN ISO 9001:2000 and Pressure Equipment Directive 97/23/EC Annex III, Module H/H1 and has been certified by the approved associations of DQS and TÜV SÜD. In process equipment construction, Quality Management is responsible for the testing and approval of semi-finished graphite products, impregnating resin, cement components, outsourced parts, process equipment and components.



Heat exchanger during pressure testing



Synthetic resin impregnation, cementing and assembly are all subject to continuous monitoring.

Appropriate marking of the semi-finished graphite products before and after synthetic resin impregnation, during machining and thereafter until assembly of the complete equipment or plant provides comprehensive evidence of the semi-finished products employed. Consequently, they meet the traceability requirement of specification AD 2000-Merkblatt N2 for pressure vessels made from electrographite and hard burned carbon. The conditions for synthetic resin impregnation of the semi-finished graphite products and those for cementing of the components are stipulated, monitored and checked.

Evidence of the quality characteristics of the material grades employed, as required by specification AD 2000-Merkblatt N2, is provided in a report issued by the testing laboratory of TÜV SÜD Industrie Service GmbH.

Process Technology Brochures

- ▶ **Process Technology – We Combat Corrosion –
from Process Equipment and Components to Complex Systems**
- ▶ **DIABON® Graphite for Engineered Process Equipment**
- ▶ **DIABON® Shell and Tube Heat Exchangers**
- ▶ **DIABON® Block Heat Exchangers**
- ▶ **DIABON® Plate Heat Exchangers**
- ▶ **DIABON® Economizers for Heat Recovery**
- ▶ **DIABON® and LICUFLO® Columns and Column Internals**
- ▶ **DIABON® Hydrogen Chloride Synthesis Plants**
- ▶ **DIABON® and Exotic Metal Pumps**
- ▶ **DIABON® Safety Disks**
- ▶ **Systems – Solutions for Corrosive Processes**
- ▶ **ECOPOR® Porous Burners**

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The data contained herein represent the current state of our product knowledge and are intended to provide general information on our products and their application spectra. In view of the variety and large number of application possibilities, these data should be regarded merely as general information that gives no guarantee of any specific properties and/or suitability of those products for any particular application. Consequently, when ordering a product, please contact us for specific information on the properties required for the application concerned. On request, our technical service will supply a profile of characteristics for your specific application requirements without delay.

Process Technology

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