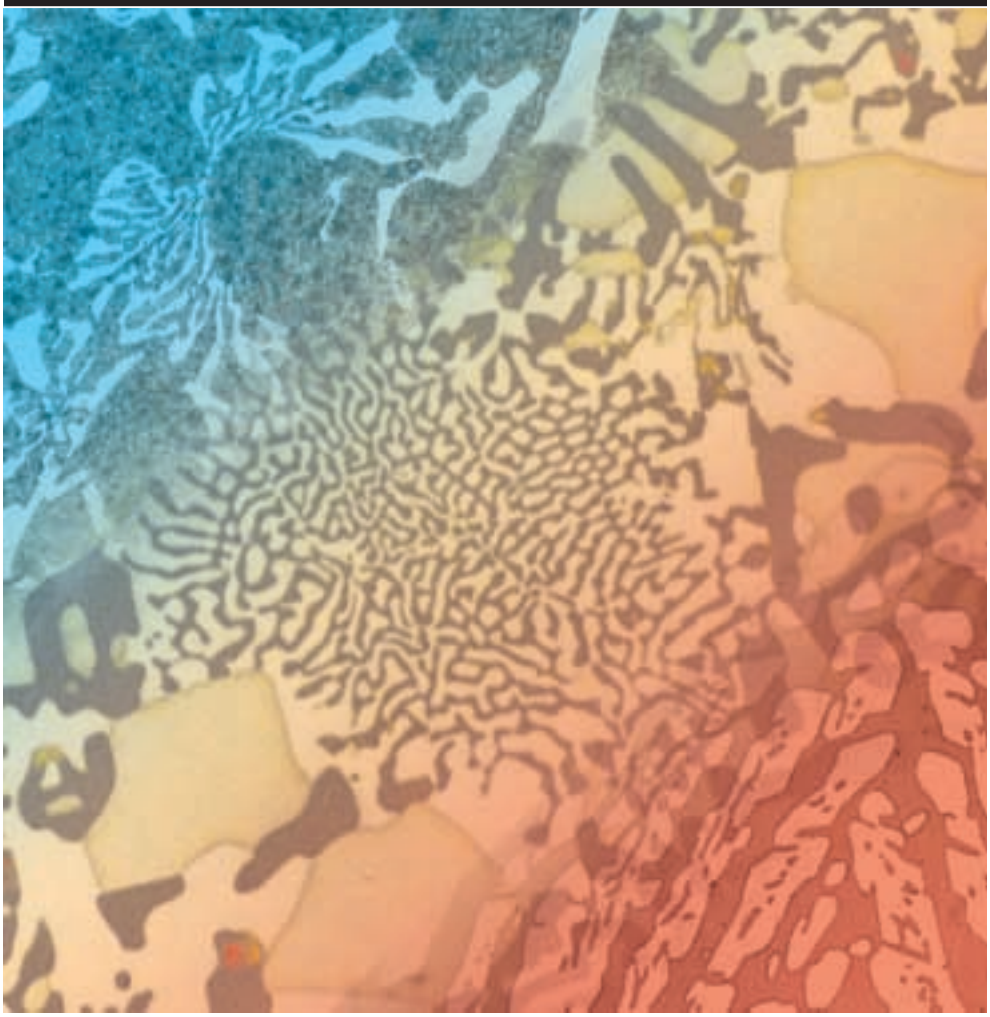
Cast Materials from KSB



"One-stop" Technology for Customized Solutions

- Handling and controlling flows of liquid with pumps and valves can at times pose a special challenge from a materials engineering viewpoint.

- Today, the overall economy of industrial processes and fluid flow systems calls for ever increasing operating pressures and temperatures, which pump units and system components are expected to withstand without failing. Recent years have also seen a tremendous increase in the demands made on the stability under load, particularly with regard to the corrosion and erosion properties of materials, not least as a result of life cycle cost considerations.

- Our design, engineering, foundry, production and materials development departments work hand in hand to keep abreast of these constantly rising customer demands.

- Innovative developments and long-standing experience in the fields of materials testing, chemical analysis, failure analysis, alloy development, casting techniques and anti-corrosion and surface treatments enable us to perfectly match materials of construction and application requirements.

- Based on our extensive materials know-how and our up-to-date technical facilities, we can provide a broad spectrum of services, ranging from R&D via materials selection, analysis and quality management to failure analysis.

- Our castings are tested at KSB's own materials laboratories to ensure the consistently high quality of the materials we produce and employ, so that our products always meet our customers' requirements.

In-house materials laboratories use the latest technical equipment

KSB's materials laboratories in various parts of the world are fully equipped for chemical analyses, metallographic examinations and mechanical testing of metals. These services are also available to our customers, who can benefit from our long-time experience and modern facilities for their own, not necessarily product-related, examinations.

Scanning electron microscope
Opto-electronic analysis of material surfaces

Metallography
Qualitative analysis and evaluation of material surfaces and microstructures as well as quantitative metallography (stereo and reflected light microscopy, differential interference contrast)

Material analysis
Sequential X-ray fluorescence spectrometer for the analysis of metallic materials as well as C, S, N_2 and O_2 analysing equipment

Wear test stands
Analysis of the resistance of materials to hydroabrasive wear (rotating disc, jet tribometry)

Mechanical test facilities

Tensile testing, notched bar impact tests, bending and folding tests as well as hardness tests to DIN, and ferrite content measurements using a Förster probe

Corrosion testing equipment

Electrochemical measuring instruments, exposure test facilities as well as a fluid flow system for establishing the corrosion resistance of materials

Physical and chemical laboratories

Facilities for spectrographic analyses, gas chromatography, viscosity measurements, metallography and various types of heat treatment

Digital data processing, storage and documentation system

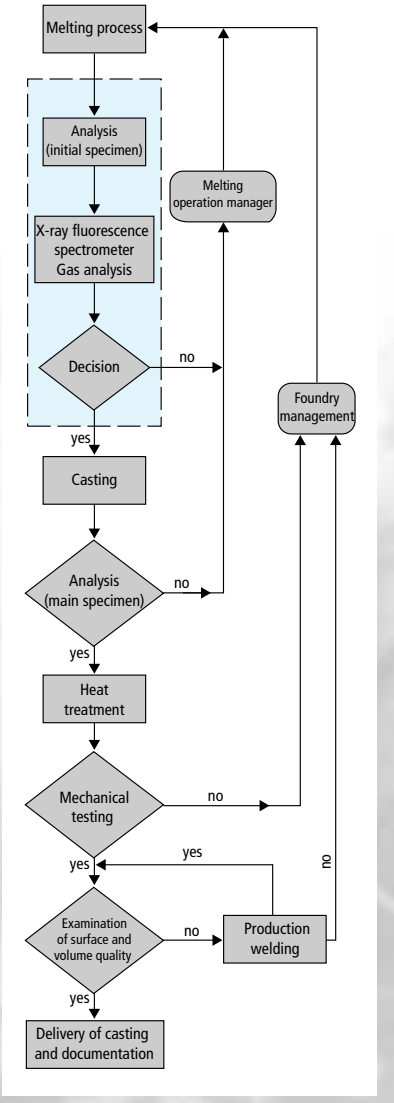
Complete documentation of all test results, readily available for immediate retrieval

Quality management

Castings for pressure-retaining or hydraulic pump and valve components have to be capable of withstanding severe conditions and meeting a variety of requirements.

That is why we produce most of our cast materials ourselves and check them for compliance with our quality standards at every production stage. The chemical composition (ladle analysis) is monitored from the start of the melting process.

A solid chain of quality checks at all stages, from the raw material to the finished product, is one condition for producing flawless, high-quality components that precisely match predefined alloy compositions. A digital data processing and documentation system, which provides us with the high degree of data availability and reliability we need, is another.



Quality control flow chart for high-alloy steel castings

Cast Materials at a Glance

Description / Trade name	Material designation	Material number	Chemical composition (Reference values, wt. %) C	Si	Mn	Cr	Ni	Mo	Cu	Others	Standards
Iron and steel castings		**Maximum single weight: 1700 kg**									
Carbon steel	GP240GH+N	1.0619+N	0.2	0.5	0.7	≤0.3					EN 10213-2
Grey cast iron	GJL-250	JL 1040									EN 1561
Nodular cast iron	GJS-400-15	JS 1030									EN 1563
Nodular cast iron	GJS-400-18-LT	JS 1025									EN 1563
ERN	GGL-NiMo7-7	–	3.2	1.8	0.7		1.8	0.7			KSB MIC [1] 1930
NORIHARD® NH 15 3	GX250CrMo15-3	–	2.6	0.6	0.7	15.0		2.6			KSB MIC [1] 1941
NORILOY® NL 25 2	GX170CrMo25-2	–	1.7	≤1.0	≤1.0	25.0		2.0			KSB MIC [1] 2878
NORICROM®	GX150CrNiMoCuN41-6-2	1.4475	1.5	≤1.0	≤1.0	40.5	6.0	2.5	≤1.2	N	KSB MIC [1] 2711
Stainless and high-alloy steels		**Maximum single weight: 5000 kg**									
Chrome steel	GX8CrNi13	1.4008	≤0.10	≤1.0	≤1.0	13.0	1.5	≤0.5			EN 10283
Martensitic steel	GX4CrNi13-4	1.4317	≤0.06	≤1.0	≤1.0	13.0	4.0	≤0.7			SEW 520
Austenitic steel	GX5CrNiNb19-11	1.4552	≤0.06	≤1.5	≤1.5	19.0	10.0			Nb≥8x%C	EN 10213
	GX5CrNiMoNb19-11-2	1.4581	≤0.06	≤1.5	≤1.5	19.0	11.5	2.3		Nb≥8x%C	EN 10213
	GX5CrNi19-10	1.4308	≤0.07	≤1.5	≤1.5	19.0	10.0				EN 10213
	GX5CrNiMo19-11-2	1.4408	≤0.07	≤1.5	≤1.5	19.0	11.0	2.3			EN 10213
NORINOX®	GX3CrNiMo19-11-2	(1.4409)	≤0.04	≤1.5	≤1.5	19.0	11.0	2.3			KSB MIC [1] 2715
NORILIUM®	GX3NiCrMoCu25-20-5	(1.4539)	≤0.03	≤1.0	≤2.0	20.0	25.0	4.5	1.5	N	KSB MIC [1] 2765
NORICID®	GX3CrNiSiN20-13-5	9.4306	≤0.04	4.5	4.5	20.0	13.0	≤0.2		N	KSB MIC [1] 2872
NORIDUR®	GX3CrNiMoCuN24-6-2-3	1.4593	≤0.04	≤1.5	≤1.5	25.0	6.0	2.5	3.0	N	KSB MIC [1] 2745
NORICLOR®	GX3CrNiMoCuN24-6-5	1.4573	≤0.04	≤1.0	≤1.0	24.0	6.0	5.0	2.0	N	KSB MIC [1] 2747

[1] MIC= material identification code

Cast copper-base alloys		**Maximum single weight: 2500 kg**	Cu	Ni	Al	Sn	Fe	Si	Mn	Others	
Bronze	CuSn10-C-GS	CC480K-GS	89.0	≤2.0		10.0	≤0.2			Pb ≤1.0;Zn≤0.5	EN 1982
Aluminium bronze	CuAl10Fe5Ni5-C-GS	CC333G-GS	≥76.0	5.2	10.0		4.5		3.0	Total ≤0.8	EN 1982

Heat treatment: G = annealed; V = quenched and tempered; N = normalized; L = solution-annealed and quenched

Microstructure: F = ferrite; P = perlite; M = martensite; A = austenite; C = carbides; B = bainite

	Equivalent to			Mechanical properties (reference values)				Heat treatment	Micro-structure	Weld-ability	Comments
			Hardness	0,2% Yield strength	Tensile strength	Percent elongation	Notched bar impact energy				
	ASTM	AFNOR		N/mm^2	N/mm^2	%	J(ISO-V)				
	A 216 WCB			≥240	≥420	≥22	≥24	N	F + P	+	
	A 48: 40B				≥250				P	(+)	Max. single weight 4000 kg
	A 536: Cl. 60–40–18			≥250	≥400	≥15		–	(F)	(+)	
	A 536: Gr. 60–40–18			≥250	≥400	≥18	≥12	G	F	(+)	
			≥300 HV 50				–	B	–		
			750–1000 HV 50					V	M + C	–	Max. single weight 1000 kg
			≥500 HV 50		≥400			V	F + C	–	
			≥350 HV 50		≥500			L	F+A+C	–	
	A743 A217	CA 15		≥170 HB	≥440	≥590	≥15	≥27	V	M	+	
	A743 A487	CA 6 NM	Z4CND 134–M	≥240 HB	≥550	≥760	≥15	≥50	V (I)	M	+	
	A743 A351	CF8C		≥130 HB	≥175	≥440	≥25	≥40	L	A	+	KSB: C ≤ 0.04
				≥130 HB	≥185	≥440	≥25	≥40	L	A	+	
		CF8		≥130 HB	≥175	≥440	≥30	≥60	L	A	+	KSB: C ≤ 0.04
		CF8M		≥130 HB	≥185	≥440	≥30	≥60	L	A	+	
		(CF3M)		≥130 HB	≥210	≥470	≥30	≥120	L	A	+	
				≥130 HB	≥180	≥440	≥20	≥60	L	A	+	
				≥200 HB	≥300	≥600	≥30	≥80	L	A(+F)	+	
	A 890; A 351–CD4MCu	Z3CNDU 265–M		≥200 HB	≥450	≥650	≥23	≥60	L	F+A	+	SEW 410
	A 890 CE3MN			≥200 HB	≥480	≥690	≥22	≥50	L	F+A	+	SEW 410
	B 584. C 90 500			≥70 HB	≥130	≥250	≥18		–		+	
	B 148. C 95 500			≥140 HB	≥250	≥600	≥13		–		+	

Weldability: + ... good (+) ... weldable – ... not weldable

Overview of KSB Cast Materials

KSB's research has culminated in the development of the NORI® series, a group of wear- and/or corrosion-resistant materials. Pumps and valves made of these special materials perform well even under the most severe service conditions.

The right material for the right application

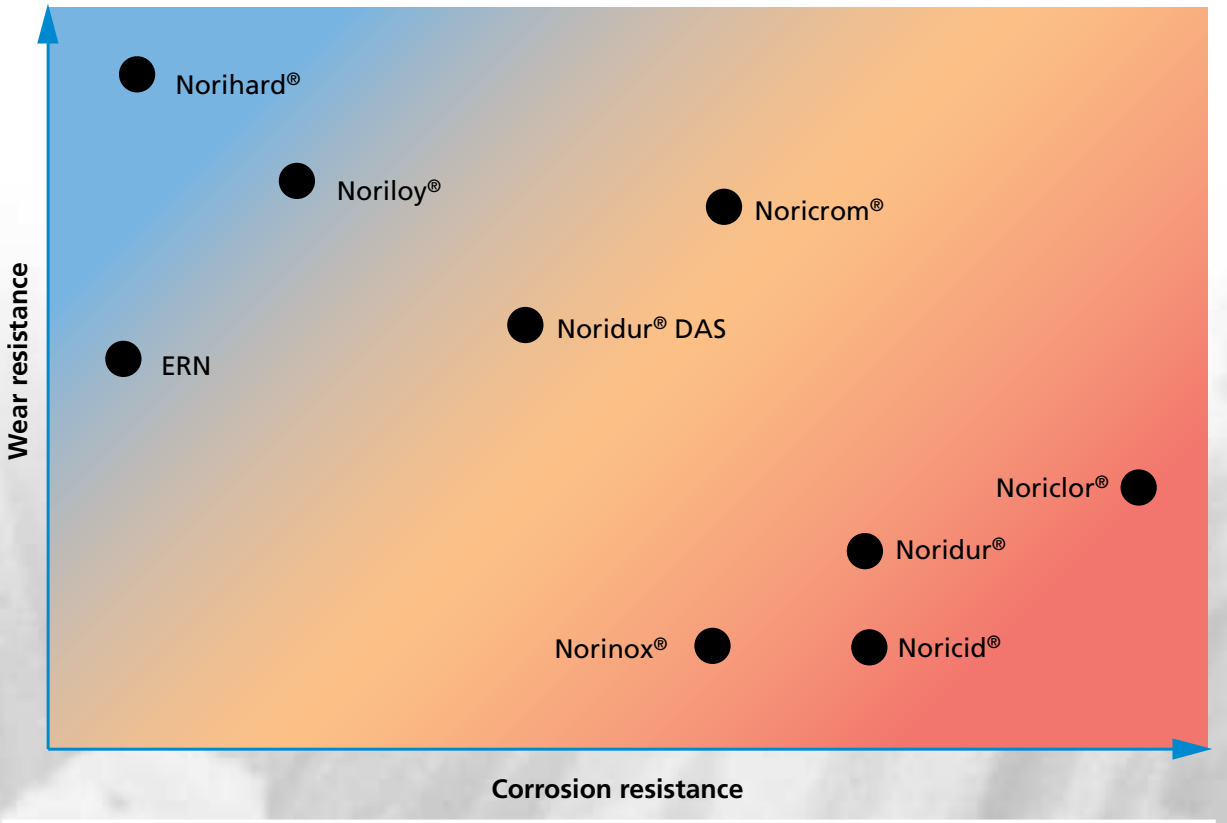
	Wear-resistant			Wear- and corrosion-resistant		Corrosion-resistant			
Application	ERN	Norihard®	Noriloy®	Noridur® DAS	Noricrom®	Norinox®	Noridur®	Noriclor®	Noricid®
Chemical and process industries					x	x	x	x	
High-concentration nitric and chromic acid									x
Sulphuric and phosphoric acid					x		x	x	
Salt mining and processing				x	x		x	x	
Petrochemical industry						x	x		
Coke oven plant				x	x	x	x	x	
Textile and pulp industries						x	x	x	
Food and sugar industries		x	x			x	x		
Aluminium oxide industry / Solids transport		x	x						
Steel and metal-working industries	x	x				x			
Mining industry / Coal mining and extraction		x					x		
Flue gas desulphurization plant		x	x	x	x	x	x	x	
Limestone and milk of lime suspensions		x	x						
Acidic chloride-containing wash liquids				x	x		x	x	
Acidic process water						x	x		
Waste water purification / Sewage treatment plant	x	x			x	x	x	x	
Offshore and marine engineering					x	x	x	x	

KSB materials in detail

On the following pages you will find detailed information about our materials, for example their chemical composition, mechanical properties, specific applications and areas of use.

Overview of KSB Cast Materials

Wear and corrosion resistance



KSB foundry products

E R N

Designation: GGL-NiMo 77

Chemical composition: :

(Reference values, wt. %)

C	3.0 – 3.5
Si	1.2 – 2.0
Mn	0.7 – 1.0
Cr	–
Ni	1.8 – 2.2
Mo	0.6 – 0.9
Cu	–
N	–

Description:

- ERN is a NiMo-alloyed bainitic cast iron.
- Compared with unalloyed lamellar graphite cast iron, ERN is more resistant to abrasive wear.

Products:

Castings for pumps with a maximum single weight of 2 tons

Microstructure: bainitic matrix containing lamellar graphite

Mechanical properties: Reference values at room temperature

Tensile strength R_m (N/mm^2)	–
Yield strength $R_{p0.2}$ (N/mm^2)	–
Elongation at failure A_5 (%)	–
Reduction of area Z (%)	–
ISO-V notch impact energy A_V (J)	–
Fracture toughness K_{IC} (N/mm$^{3/2}$)	–
Vickers hardness HV 50	≥300

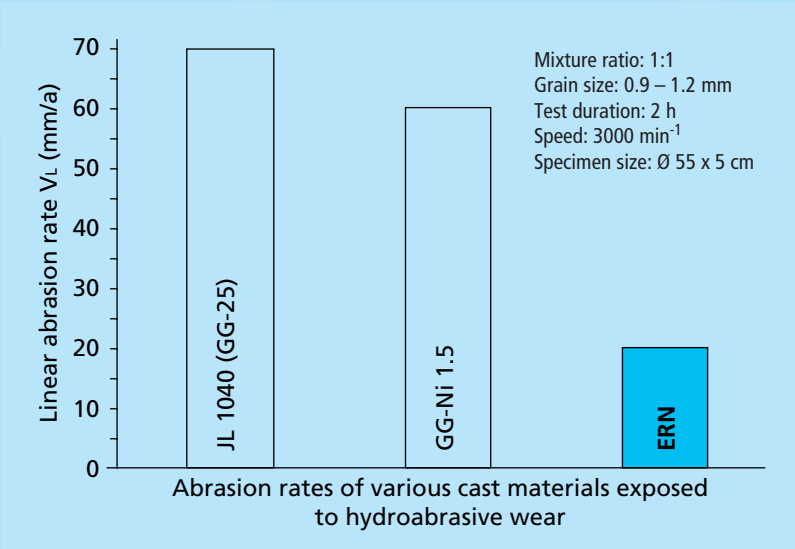
Weldability:

ERN cannot be welded.

Application:

ERN is used for chemically non-aggressive fluids low in abrasive solids content.
Typical applications are municipal waste water, sinter water (maximum scale content 3 g/l), water containing granulated material, milk of lime and industrial effluent.

Wear resistance:



Test performed with a silica sand and water mixture

Norihard®

Designation: GX250CrMo15-3

Chemical composition:

(Reference values, wt. %)

C	2.4 – 2.8
Si	0.3 – 0.8
Mn	0.5 – 0.8
Cr	14.0 – 16.0
Ni	–
Mo	2.4 – 2.8
Cu	–
N	–

Description:

- Norihard® is a martensitic white iron alloyed with chromium and molybdenum.
- Soft-annealing after casting will make the material suitable for any type of machining, including drilling and thread cutting.
- Finish-machined parts are subsequently hardened by further heat treatment.
- The hardness of the finished component ranges between 750 and 1000 HV 50, depending on the wall thickness.
- Contrary to self-hardening materials, such as Ni-Hard alloys, Norihard® is suitable for components of any configuration or design.

Products:

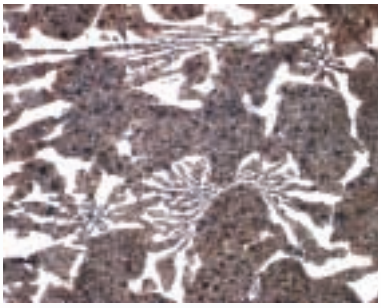
Castings with a maximum single weight of 2 tons

Weldability:

Components of Norihard® cannot be welded

Application:

Norihard® is used for abrasive fluids containing large amounts of solids such as bauxite and sinter



Microstructure: martensitic matrix containing primary and secondary carbides

slurries, milk of lime and limestone suspensions, as well as wash water and effluent with a high sand content. Using Norihard® for handling bauxite and aluminium oxide suspensions significantly increases the service life of pump components.

Field test results:

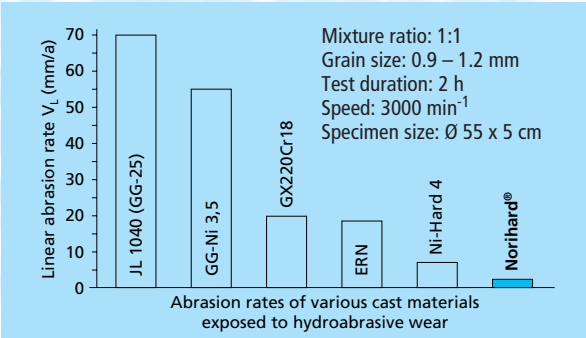
Material	Bauxite suspension Solids content 600–700 g/l Pump type KWP 150–400	Aluminium-oxide suspension Solids content 300–400 g/l Pump type KWP 150–315
JL 1040 (GG-25)	1,500 h	1,000 h
Ni-Hard 4	5,000 h	5,500 h
Norihard®	> 7,000 h	> 10,000 h

Total service life of pumps as a function of their materials of construction

Mechanical properties:

Reference values at room temperature	
Tensile strength R_m (N/mm²)	–
Yield strength $R_{p0.2}$ (N/mm²)	–
Elongation at failure A_5 (%)	–
Reduction of area Z (%)	–
ISO-V notch impact energy A_V (J)	–
Fracture toughness K_{IC} (N/mm$^{3/2}$)	≥ 25
Vickers hardness HV 50	≥ 750

Wear resistance:



Test performed with a silica sand and water mixture

Noriloy®

Designation: GX170CrMo25-2

Chemical composition:

(Reference values, wt. %)

C	1.5 – 1.8
Si	≤1.0
Mn	≤1.0
Cr	24.0 – 26.0
Ni	–
Mo	1.5 – 2.5
Cu	–
N	–

Description:

- Noriloy® is a chromium- and molybdenum-alloyed white iron with a ferritic matrix.
- Soft-annealing after casting will make the material suitable for any type of machining, including drilling and thread cutting.
- Finish-machined parts are hardened and tempered by further heat treatment.
- Contrary to self-hardening materials, such as Ni-Hard alloys, Noriloy® is suitable for components of any configuration or design.
- In hardened condition, the matrix still contains enough chromium and molybdenum to ensure good corrosion resistance in slightly acidic media.

Products:

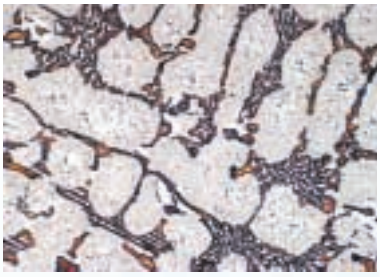
Castings with a maximum single weight of 2 tons

Weldability:

Components of Noriloy® cannot be welded

Application:

Noriloy® finds specific application in highly abrasive, slightly corrosive fluids with a high solids content such as the products of semi-dry processes, in waste incineration plant, milk of lime and limestone suspensions, aggressive pit water containing ore, coal or mine tailings, and in acidic, heavily sand or solids-laden waste water and slurries.



Microstructure: ferritic matrix containing primary and secondary carbides

Field test results:

Material	Milk of lime containing $CaSO_3$ Chloride content: 1000–5000 ppm pH: 6–10, T: 60 °C Solids content: 20–45 by weight% Pump type KWP 80–500	Limestone suspension Chloride content: 1000–7000 ppm pH: 6.5–9, T: 40 °C Solids content 40–65 by weight% Pump type KWP 250–500
GX40Cr-NiMo27-5	approx. 10,000 h	approx. 1,500 h
Noriloy®	40,000 – 50,000 h	30,000 – 40,000 h

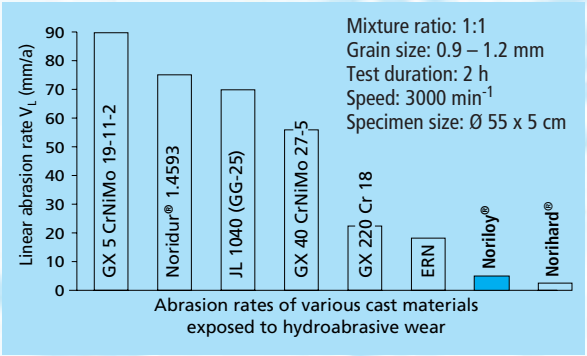
Total service life of pumps as a function of their materials of construction

Mechanical properties:

Reference values at room temperature

Tensile strength R_m (N/mm²)	≥ 400
Yield strength $R_{p0.2}$ (N/mm²)	–
Elongation at failure A_5 (%)	–
Reduction of area Z (%)	–
ISO-V notch impact energy A_V (J)	–
Fracture toughness K_{IC} (N/mm$^{3/2}$)	≥ 25
Vickers hardness HV 50	≥ 500

Wear resistance:



Test performed with a silica sand and water mixture

Noridur® DAS

Designation:
GX3CrNiMoCuN24-6-2-3
specially heat-treated

Chemical composition:
(Reference values, wt. %)

C	≤0.04
Si	≤1.5
Mn	≤1.5
Cr	23.0 – 26.0
Ni	5.0 – 8.0
Mo	2.0 – 3.0
Cu	2.75 – 3.5
N	0.1 – 0.2

Description:
- Noridur® DAS is a wear-resistant duplex stainless steel with a precipitation-hardened microstructure characterized by an austenitic matrix containing intermetallic phases as well as some residual ferrite.
- Its chemical composition is identical to that of the Noridur® duplex stainless steel.
- As a result of additional special heat treatment, precipitation of hard, wear-resistant intermetallic phases in the ferritic part of the matrix of base material Noridur®.
- It offers better resistance to hydroabrasive wear than Noridur® and at the same time good corrosion resistance in acidic chloride-containing media.

Products:
Castings with a maximum single weight of 1 ton

Weldability:
Components of Noridur® DAS cannot be welded

Corrosion resistance:

Material	Corrosion rate (mm/a)
Noridur® 1.4593	<0.01
Noricrom® 1.4475	<0.01
Noridur® DAS	0.08
GX 40 CrNiMo 27-5 (1.4464)	0.3

Test conditions:
Exposure tests
Test medium: 0.1 n HCl (O_2-free)
pH: 1.0
Temperature: 60 °C

Application:
The applications of Noridur® DAS are manifold: it is suitable for handling corrosive fluids with high solids content in industrial and chemical processes, in waste water installations and in the environmental protection sector.
Noridur® DAS is mainly used for pump components subject to hydraulic loads and in contact with gypsum suspensions and limestone slurries in flue gas desulphurization systems. It is the choice material in those areas where the demand is for longer warranty terms and service lives.

Microstructure: austenitic matrix containing intermetallic phases and residual ferrite

Field test results:

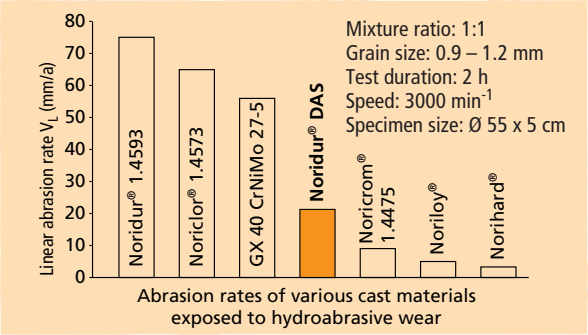
Material	Gypsum and limestone suspension Chloride content: up to 50,000 ppm pH: approx. 5, T: 60 °C Solids content: 15 – 20 % by weight Pump type KWP 600–803
Duplex stainless steel	approx. 10,000 h
Noridur® DAS	45,000 – 50,000 h

Total service life of pumps as a function of their materials of construction

Mechanical properties:
(Reference values at room temperature)

Tensile strength R_m (N/mm²)	≥ 500
Yield strength $R_{p0.2}$ (N/mm²)	–
Elongation at failure A_5 (%)	–
Reduction of area Z (%)	–
ISO-V notch impact energy A_V (J)	–
Fracture toughness K_{IC} (N/mm$^{3/2}$)	≥ 30
Vickers hardness HV 50	≥ 240

Wear resistance



Abrasion rates of various cast materials exposed to hydroabrasive wear

Test performed with a silica sand and water mixture

Noricrom®

Designation:
GX150CrNiMoCuN41-6-2
Material number: 1.4475

Chemical composition:
(Reference values, wt. %)

C	1.4 – 1.7
Si	≤1.0
Mn	≤1.0
Cr	39.5 – 42.0
Ni	5.0 – 7.0
Mo	2.0 – 3.0
Cu	≤1.20
N	0.1 – 0.2

Description:

- Noricrom® is a triplex stainless steel with a ferritic-austenitic matrix and a carbide content of approximately 30% by volume.
- The balanced formation of the multi-phase microstructure is the result of special heat treatment.
- The carbides in the matrix form a dense, net-like structure, which accounts for the material's optimum wear resistance.
- The high chrome and molybdenum contents provide excellent corrosion resistance in highly acidic, chloride-containing media.
- There is no need for special component designs or configurations.
- The material is protected by patent (patent number EP 0 760 019 B1).

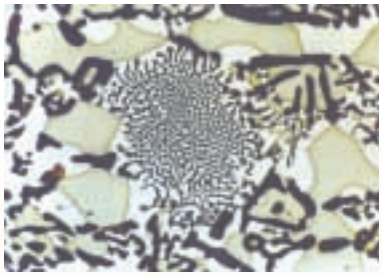
Products:
Castings with a maximum single weight of 1 ton

Weldability:
Components of Noricrom® cannot be welded

Corrosion resistance:

Material	Corrosion rate (mm/a)
Noridur® 1.4593	<0.01
Noricrom® 1.4475	<0.01
Noridur® DAS	0.08
GX 40 CrNiMo 27-5 (1.4464)	0.3

Test conditions:
Exposure tests
Test medium: 0.1 n HCl (O_2-free)
pH: 1.0
Temperature: 60 °C



Microstructure: ferritic-austenitic matrix with primary carbides

Application:
Noricrom® 1.4475 is, for example, used in flue gas desulphurization processes involving highly acidic, chloride-containing fluids with high solids contents.

Field test results:

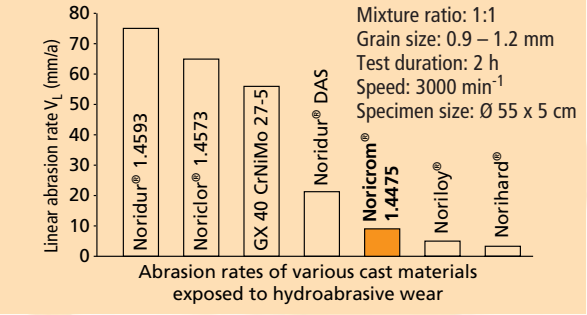
Material	Material number	Gypsum suspension Chloride content: up to 70,000 ppm pH: >4, T: 65 °C Solids content: 25 % by weight		
		Impeller KWP K 125-400 (n = 1480 min^{-1})	Impeller (n = 740 min^{-1}) KWP K 600–823	
			highest spray level	lowest spray level
GX4CrNiMoCu24-6-2-3	1.4593	–	8,000 h	10,000 h
Noridur® DAS	–	12,000 h	20,000 h	30,000 h
Noricrom® [1]	1.4475	> 70,000 h	45,000 h	65,000 h

Total service life of pumps as a function of their materials of construction
[1] Projection based on practical experience

Mechanical properties:
Reference values at room temperature

Tensile strength R_m (N/mm^2)	≥ 500
Yield strength $R_{p0.2}$ (N/mm^2)	–
Elongation at failure A_5 (%)	–
Reduction of area Z (%)	–
ISO-V notch impact energy A_V (J)	–
Fracture toughness K_{IC} ($N/mm^{3/2}$)	≥ 30
Vickers hardness HV 50	≥ 350

Wear resistance:



Test performed with a silica sand and water mixture

Norinox®

Designation:
GX3CrNiMo19-11-2
Material number:
comparable to 1.4409

Chemical composition:
(Reference values, wt. %)

C	≤0.04
Si	≤1.5
Mn	≤1.5
Cr	18.0 – 20.0
Ni	10.0 – 12.0
Mo	2.0 – 3.0
Cu	–
N	–

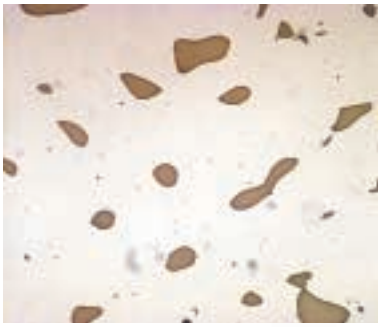
Description:

- Norinox® is an austenitic stainless steel.
- It is comparable to low-carbon steel quality CF 3M to ANSI/ ASTM A351/A743.
- Average carbon content 0.032 ±0.006 % by weight (KSB ladle analysis reports)
- After solution-annealing, Norinox® is fully resistant to intergranular corrosion thanks to its low carbon content.
- As per the Application Expertise of TÜV Bavaria (German Association for Technical Supervision) supplementing the relevant technical instructions published by the German Pressure Vessel Society (AD-Merkblatt W5/W10), Norinox® is suitable for use with temperatures ranging from -105 °C to +400 °C.
- The minimum yield strength at elevated temperature $R_{p0.2}$ at 400 °C is 110 N/mm².

Products:
Castings with a maximum single weight of 2.5 tons

Weldability:
Using compatible filler metals and one of the welding processes commonly used for austenitic high-alloy steels, components of Norinox® can be easily welded. Thanks to the material's very low carbon content, it is not necessary to solution-anneal the product after production welding provided the appropriate welding parameters are observed.

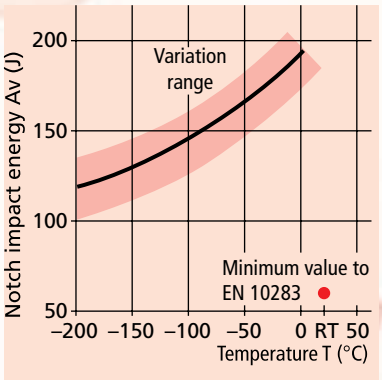
Application:
Norinox® covers a wide application spectrum for pumps and valves



Microstructure: austenitic matrix containing delta-ferrite (≤10%)

used in industry, process engineering, marine and offshore application, environmental engineering and waste water management.

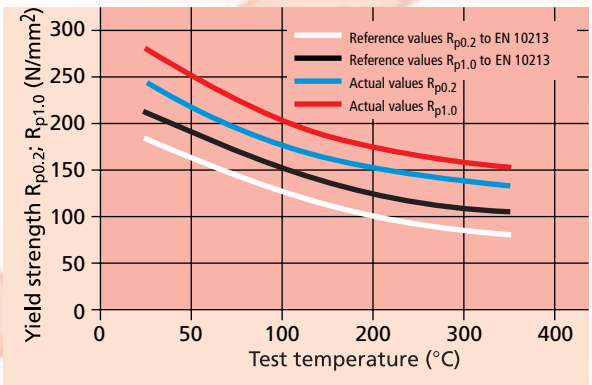
Notch impact energy at low temperatures (ISO-V notched specimen):



Mechanical properties:
Reference values at room temperature

Tensile strength R_m (N/mm²)	470–670
Yield strength $R_{p0.2}$ (N/mm²)	≥ 210
Elongation at failure A_5 (%)	≥ 30
Reduction of area Z (%)	≥ 45
ISO-V notch impact energy A_V (J)	≥ 120
Fracture toughness K_{IC} (N/mm$^{3/2}$)	–
Brinell hardness	130–200

Tensile strength at elevated temperatures:



Noridur®

Designation:
GX3CrNiMoCuN24-6-2-3
Material number: 1.4593

Chemical composition:
(Reference values, wt. %)

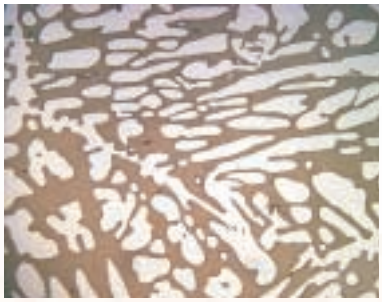
C	≤0.04
Si	≤1.5
Mn	≤1.5
Cr	23.0 – 26.0
Ni	5.0 – 8.0
Mo	2.0 – 3.0
Cu	2.75 – 3.5
N	0.10 – 0.2

Description:

- Noridur® is a duplex stainless steel containing austenite and ferrite in a 1:1 ratio
- Its higher strength compared with austenitic steels and its high ductility are of advantage for the configuration and design of components
- Maximum application temperature: 290 °C
- Higher resistance to cavitation and wear than austenitic steels
- Excellent resistance to uniform corrosion in highly acidic media and to localized corrosion in chloride-containing fluids.
- The mean pitting resistance equivalent (PREN) (%Cr+3.3%Mo+16%N) is 35.7.
- Noridur® offers higher resistance to stress corrosion cracking and is less susceptible to corrosion fatigue in chloride-containing media than austenitic steels.

Products:
Castings with a maximum single weight of 5 tons

Weldability:
Using compatible filler metals and an appropriate welding process, components of Noridur® can be easily welded. Thanks to the material's very low carbon content, it is not necessary to solution-anneal the product after production welding provided the relevant welding parameters are observed.



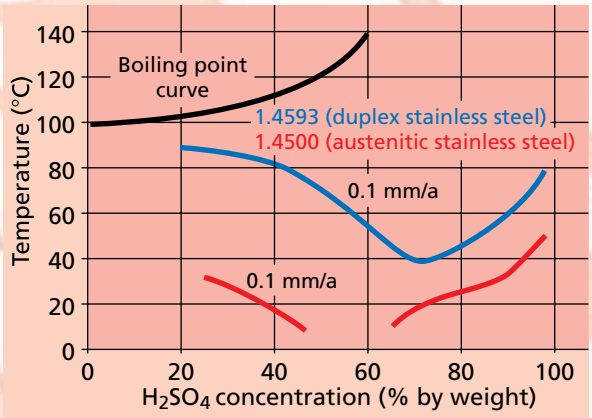
Microstructure: ferritic-austenitic, containing approximately 50% austenite

Application:
Noridur® is used in a wide range of applications in industrial and chemical processes, in waste water systems, in environmental engineering, as well as in the marine and offshore sectors.
Noridur® is specifically applied for handling any type of chloride-containing fluid, reducing acid and acidic process water or scrubber suspensions.

Mechanical properties:
(Reference values at room temperature)

Tensile strength R_m (N/mm²)	≥ 650
Yield strength $R_{p0.2}$	≥ 450
Elongation at failure A_5 (%)	≥ 23
Reduction of area Z (%)	≥ 50
ISO-V notch impact energy A_V (J)	≥ 60
Fracture toughness K_{IC} (N/mm$^{3/2}$)	–
Vickers hardness HV 50	≥ 200

Corrosion resistance:



ISO-corrosion diagram of corrosion resistance in flowing sulphuric acid (flow velocity v = 10 m/s)

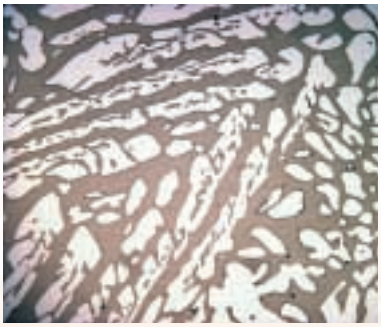
Noriclor®

Designation:
GX3CrNiMoCuN24-6-5
Material number: 1.4573

Chemical composition:
(Reference values, wt. %)

C	≤0.04
Si	≤1.0
Mn	≤1.0
Cr	22.0 – 25.0
Ni	4.5 – 6.5
Mo	4.5 – 6.0
Cu	1.5 – 2.5
N	0.15 – 0.25

Description:
- Noriclor® is a super duplex stainless steel containing austenite and ferrite in a 1:1 ratio.
- Its higher strength compared with austenitic steels and its high ductility are of advantage for the configuration and design of components.
- Maximum application temperature: 290 °C.
- Higher resistance to cavitation and wear than austenitic steels.
- Excellent resistance to uniform corrosion in highly acidic media and to localized corrosion in fluids with a high chloride content, in particular at elevated temperatures.
- Significantly higher resistance to pitting and crevice corrosion than duplex stainless steel.
- The mean pitting resistance equivalent (PREN) (%Cr+3.3%Mo+16%N) is 43.7.
- Compared with austenitic stainless steels, Noriclor® is more resistant to stress corrosion cracking and less susceptible to corrosion fatigue in chloride-containing media.
- Compared with other stainless steels, Noriclor® is more resistant to hydroabrasive wear.
- In many applications, Noriclor® is an excellent substitute for the more expensive corrosion resistant nickel-base alloys.



Microstructure: ferritic-austenitic, containing approximately 50% austenite

Products:
Castings with a maximum single weight of 2.5 tons

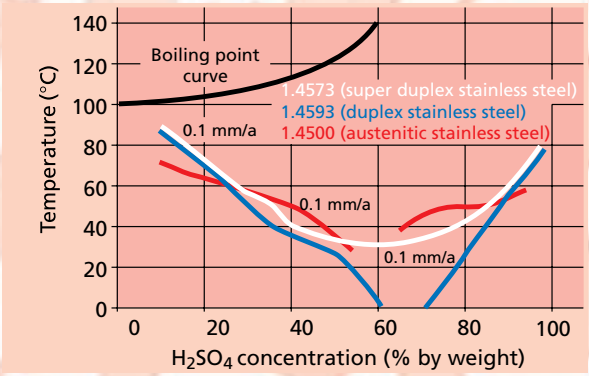
Weldability:
Using compatible filler metals and an appropriate welding process, components of Noriclor® can be easily welded. Thanks to the material's very low carbon content, it is not necessary to solution-anneal the product after production welding provided the relevant welding parameters are observed.

Application:
Noriclor® is used for those acids in the range of critical concentrations and for those media with a high chloride content, in particular at elevated temperatures, where Noridur® provides insufficient corrosion resistance.
Noriclor® is typically employed for handling aggressive media in chemical processes, in waste water transport, in environmental engineering and in the marine and offshore sectors.

Mechanical properties:
(Reference values at room temperature)

Tensile strength R_m (N/mm²)	≥ 690
Yield strength $R_{p0.2}$ (N/mm²)	≥ 480
Elongation at failure A_5 (%)	≥ 22
Reduction at fracture Z (%)	≥ 50
ISO-V notch impact energy A_V (J)	≥ 50
Fracture toughness K_{IC} (N/mm$^{3/2}$)	–
Brinell hardness	≥ 200

Corrosion resistance:



ISO-corrosion diagram of corrosion resistance in static sulphuric acid

Noricid®

Designation:
GX3CrNiSiN20-13-5
Material number: 9.4306

Chemical composition:
(Reference values, wt. %)

C	≤0.04
Si	4.0 – 5.0
Mn	4.0 – 5.0
Cr	19.0 – 21.0
Ni	12.0 – 14.0
Mo	≤0.2
Cu	–
N	≤0.15

Description:

- Noricid® is a special austenitic stainless steel characterized by a high resistance to oxidizing acids.
- In 80 – 98% boiling nitric acids it is clearly superior to standardized austenitic stainless steels of the variety containing 18% chromium and 10% nickel.
- Its high resistance to oxidizing acids results from SiO_2 protective layers.
- The very low carbon content of Noricid® warrants its resistance to intergranular corrosion.

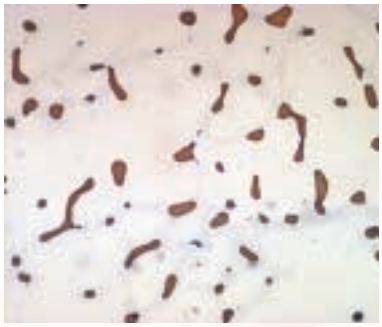
Mechanical properties:
(Reference values at room temperature

Tensile strength R_m (N/mm²)	≥ 600
Yield strength $R_{p0.2}$	≥ 300
Elongation at failure A_5 (%)	≥ 30
Reduction of area Z (%)	≥ 30
ISO-V notch impact energy A_V	≥ 80
Fracture toughness K_{IC} (N/mm$^{3/2}$)	–

Products:
Castings with a maximum single weight of 2.0 tons

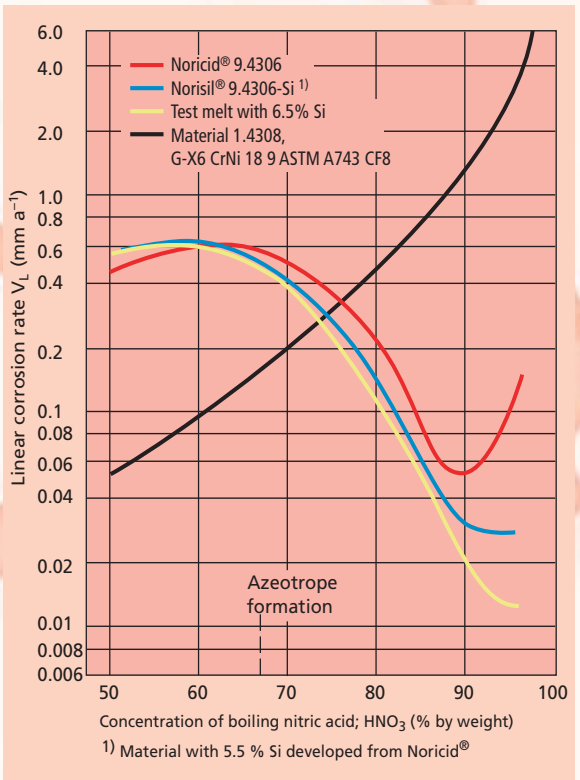
Weldability:
Using compatible filler metals and an appropriate welding process, components of Noricid® can be easily welded. Thanks to the material's very low carbon content, it is not necessary to solution-anneal the product after production welding provided the relevant welding parameters are observed.

Application:
Noricid® is used for handling highly oxidizing acids such as concentrated nitric, chromic or sulphuric acid.



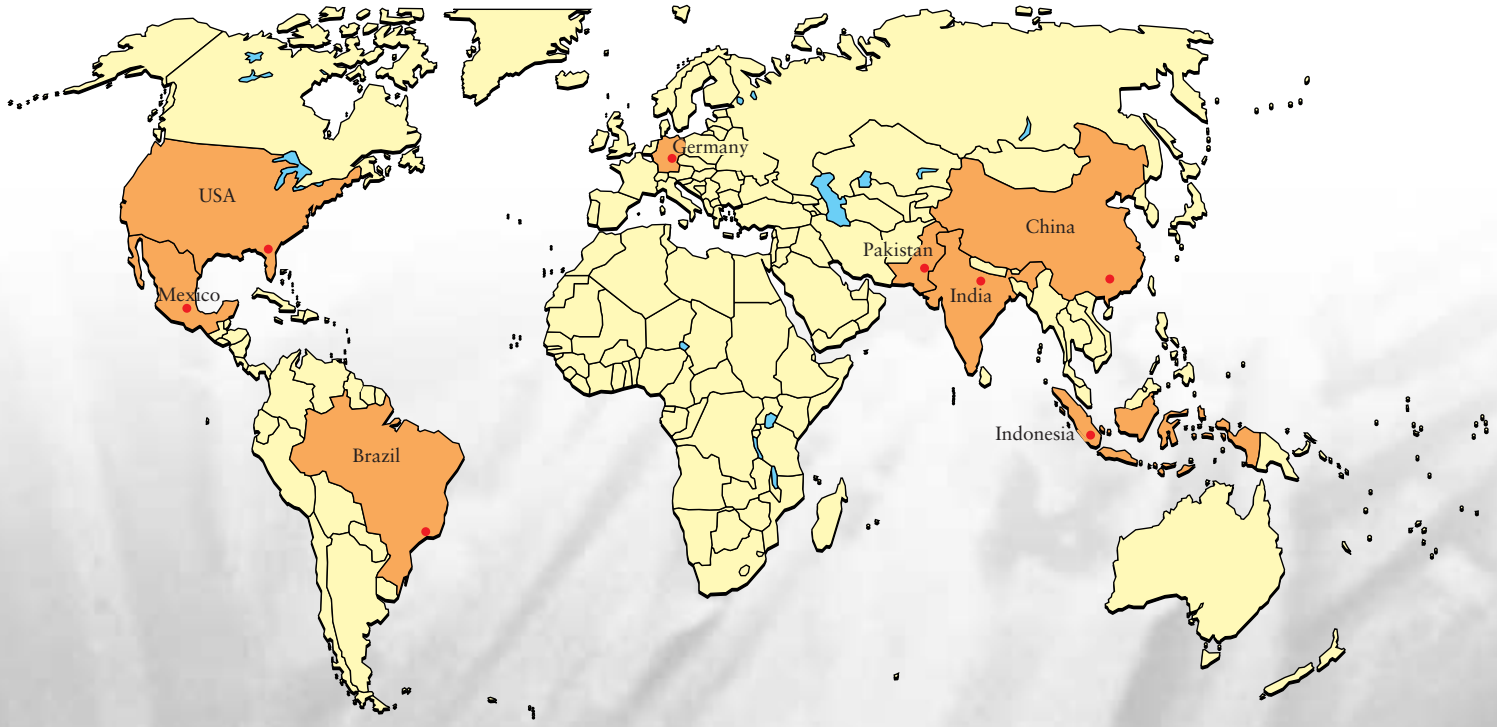
Microstructure: austenitic matrix containing approximately 10–15% delta ferrite

Corrosion resistance:



Casting Competence Around the World

Casting Competence Centres



The KSB Group operates foundries in the United States, Mexico, Germany, Brazil, Indonesia, Pakistan, India and in the People's Republic of China.
These produce more than forty different cast materials ranging from grey cast iron to high-alloy steel and white iron. Drawing on decades of experience, our experts apply their extensive know-how to all kinds of castings with single weights of up to 5 tons.
A total volume of more than 10,000 tons of castings leaves our foundries each year. They serve as components for a wide variety of pumps and valves, but also for similar products of customers outside the KSB Group.
Top technology and maximum economic efficiency are our guidelines in manufacturing these castings, which are used in the broad product spectrum of the KSB Group delivered to every part of the world.

In recent years, our Pegnitz foundry has developed into the centre of KSB casting technology. Here, the high standards to be met by all KSB foundries are established, and compliance with these standards is monitored.

Certification

- Certification to DIN EN ISO 9001
- TÜV-approved manufacturer according to AD-Merkblatt WO/TRD 100 published by the German Pressure Vessel Society
- TÜV-approved materials testing laboratory
- Lloyds Register of Shipping approval
- Det Norske Veritas approval
- German Lloyd approval
- Bureau Veritas approval
- Qualified manufacturer to ASME Code III NCA-38a

Environmental protection management

- Certification to DIN EN ISO 14001

Cement Transport

Pneumatic conveyors for transporting bulk goods are widely used in transport and process engineering. Propelled by a continuous flow of gas, the mixture of carrier gas and bulk particles moves through the discharge pipe at a gas velocity of around 20 to 30 m/s. At this velocity, the impact of the cement dust against the Norihard® valve discs in the transport pipes is comparable to that of the grit from a sand blast apparatus. Even under these severe conditions, the discs provide tight shut-off and have the necessary wear resistance for cost-efficient operation of the system.

Sugar Production

After farmers deliver their sugar beet to the factory, the produce first has to be cleaned with water. Even if the beets are harvested with the latest farm equipment, they can be literally covered in sticky mud, especially after a period of foul weather. The resulting mixture of sand and water is extremely abrasive and calls for the use of a highly abrasion-resistant material like Norihard®. Pumps whose casings and impellers are made of this KSB-manufactured material will give many years of reliable service.

Flue Gas Desulphurization

KSB knows how to build extremely hard-wearing and corrosion-resistant scrubber pumps. Pumps made from precipitation-hardened Noridur® DAS have been successfully employed in the flue gas desulphurization systems of fossil fuel-fired power stations around the world for decades. With the help of these pumps, sulphur dioxide (SO_2), the so-called greenhouse gas, which is produced when fossil fuels such as wood, coal and mineral oil are burned, is "scrubbed" with a ground limestone / water suspension and transformed to gypsum. As scrubber systems are commonly operated continuously for many years at a time, the pumps installed in these systems have to be extremely durable and resistant.

Chemical and Process Engineering

Zero-leakage pumps are today a preferred option for the reliable transport of some of the extremely corrosive and aggressive fluids found in chemical and process engineering. The reliability and useful life of these pumps largely depend on the correct selection of the material of construction. In the case of chemical pumps, two major criteria need to be considered: the mechanical loading the components will be exposed to and how aggressive the medium pumped is. Making the right choices is even more difficult when dealing with new products or processes. Although there is a mass of empirical values available on the corrosion behaviour of materials, these are normally based on uniform corrosion in unadulterated, static fluids. In real life, however, products are often contaminated, and contaminants tend to speed up corrosion processes. This has to be kept in mind when selecting the materials for the principal pump components. Noridur® has proven to be an excellent choice for pump casings and impellers, which is why our pump units - compared with the life cycle costs of competitive products - are among the best the market has to offer. The combination of corrosion resistance and wear resistance make Noridur® the choice material for a great variety of applications.

Seawater Desalination

In the largest seawater desalination station ever built, our pumps play a major part in securing the supply of potable water. At a flow rate of 20,000 cubic metres per hour each, the nine giant-sized tubular casing pumps transport warm (35 °C), highly aggressive seawater to the station. Thousands of cubic metres of concentrated brine are pumped through the various evaporation stations and finally back into the sea by enormous brine recirculation pumps weighing up to 90 tons. The pumps' efficiency figures, which are not just high but remain steady over long periods of time, and their long services lives are of paramount importance for a reliable drinking water supply to the population and for the economically sensible utilization of energy resources. Impellers and pump casings of Noridur® are capable of meeting the high demands made on primary pump components in such crucial installations.

The Pump and Valve Specialist KSB Offers Worldwide ...

Competence and Experience

Looking back on more than 130 years of experience, we can offer state-of-the-art pump and valve technology for a great variety of applications. These range from building services to industrial processes, water engineering, power generation and mining.

Service Around the Clock

KSB service is guaranteed worldwide and around the clock. With our installation and inspection, servicing, maintenance and repair services, as well as our comprehensive service packages, we set standards.

Intelligent Integrated Systems Solutions

KSB's hydraulics experts provide turnkey water and waste water transfer systems.

On-the-spot Advice

With 27 manufacturing sites as well as sales branches and agencies, KSB is on hand in 100 countries. Wherever you need us.

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KSB

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