› **Our technology. Your success.**
Pumps ▪ Valves ▪ Service

Innovative and reliable:
KSB's expertise in materials

Demanding tasks, outstanding performance

Drawing on over 145 years of experience as a manufacturer of pumps, valves and services, we at KSB meet the continuously rising demands our customers place on high-performance products.

Where liquids are to be transported and controlled with pumps and valves, materials engineering requirements are often particularly high. Pump sets and their components have to be able to handle increasingly high operating pressures and temperatures to raise the profitability of processes and circuits. High expectations are also placed on abrasion and corrosion resistance or, in other words, the material's longevity. To meet our customers' continuously rising demands on products our staff in design and engineering, in the foundry, in production and in materials development work hand in hand.

Innovative developments and many years of experience in materials testing, chemical analyses, damage diagnosis, alloy development and casting technology as well as in corrosion and surface treatment technology enable us to offer an optimum solution tailored to each specific application. Our cast products are tested in KSB's own materials laboratory that is accredited to DIN EN ISO/IEC 17025. This is how we ensure the materials we produce and use are of a consistently high quality, meeting our customers' demands.

One-stop materials engineering

In-house materials laboratory with state-of-the-art technical equipment

KSB has got its own materials laboratory, equipped with all key instruments for chemical analyses as well as for metallographic examinations and mechanical materials testing. 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.

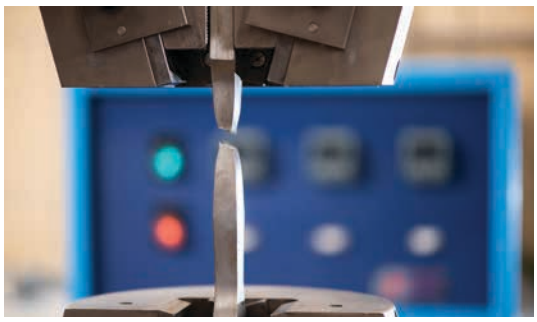
Accreditation

KSB's materials laboratory in Pegnitz is an accredited testing laboratory to DIN EN ISO/IEC 17025 (registration number D-PL-19609-01-00). It is further certified to ASME Code Section III NCA-3800.

Physical and chemical laboratory

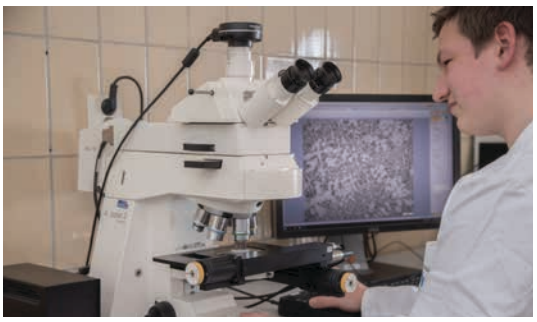
- Spectrographic analysis (ICP)
- Viscosity measurements
- Water analyses
- Various types of heat treatment

Mechanical test facilities



- Tensile testing, notched bar impact tests, bending and folding tests
- Hardness tests (Vickers, Brinell, Rockwell)
- Magnetic-inductive ferrite content measurements

Metallography

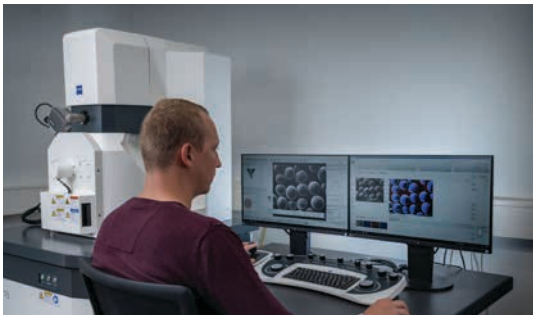


Qualitative analysis and evaluation of material surfaces and microstructures as well as quantitative metallography (stereo and reflected light microscopy, DIC)

Material analysis

- Optical emission spectroscopy (OES)
- X-ray fluorescence (XRF) analysis
- Mobile alloy analyser (e.g. for PMI testing)
- Elemental analysis of C, S, N and O

Scanning electron microscope



- Opto-electronic microscopy of material surfaces
- EDX analyses

Cavitation

- Characterisation of cavitation resistance using an ultrasonic transducer (direct measurement to ASTM G32-92)
- Weight loss and electrochemical measurements to determine corrosion resistance

Wear test stands

Analysis of the resistance of materials to hydroabrasive wear (e.g. using jet tribometry)

Digital data processing, storage and documentation system

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

Quality assurance

Providing our customers with first-class products and excellent service, that's the overall goal we focus all our activities on, in all our operations. Naturally, this also applies to KSB's foundry in Pegnitz.

Our awareness of quality shows. For example, in our continuous investments in quality-enhancing measures. This is where a lot of passion comes in, especially when optimising production processes and managing quality. Our standards are high, also when selecting and training personnel. Because only high-quality employees can make sure that the quality of our products and services is and remains outstanding.

Every material is subjected to the most stringent of quality checks:

- No matter whether it is cast iron, non-ferrous heavy metal, austenitic steel, duplex or triplex material – the chemical composition of every batch is monitored and optimised with computer assistance right from the melting process.
- After casting, the main analysis is conducted on material specimens. The components themselves are subjected to non-destructive materials testing (such as liquid penetrant and ultrasonic testing).
- Surface crack, radiographic and ultrasonic testing ensure that the cast components are free from cracks and shrinkage cavities.
- In addition to the above-mentioned quality assurance measures optical 3D measurement systems are available.

Casting expertise around the world

The KSB Group operates 9 highly modern foundries in 6 countries. Drawing on decades of experience, our experts apply their extensive know-how to all kinds of castings with single weights of up to 17 tonnes. A total volume of more than 35,000 tonnes of cast components for the most diverse of pumps and valves leaves our nine foundries each year.

Produced at the highest level of materials engineering and economic efficiency, the components are used for the company's product range worldwide. The Pegnitz foundry comprises state-of-the-art production facilities and machinery, which form the basis for its modern, high-precision manufacturing processes. The site employs the sand casting process to produce one-off components as well as small batch orders with component weights ranging from 10 to 4000 kg. The spectrum of materials that can be processed here reaches from simple grey cast iron through nodular cast iron and cast steel to cast bronze, duplex, super duplex and triplex.

KSB SE & Co. KGaA certifications

KSB's foundry in Pegnitz

- Certified to ISO 9001 / ISO 14001 / ISO 45001
- TÜV-approved manufacturer according to AD-Merkblatt W0 and European Pressure Equipment Directive 2014/68/EU
- KTA 3211.1, KTA 1401 and AVS D100/50
- Lloyd's Register
- Bureau Veritas
- DNV-GL

KSB's additive manufacturing facilities

- TÜV-approved manufacturer according to European Pressure Equipment Directive 2014/68/EU

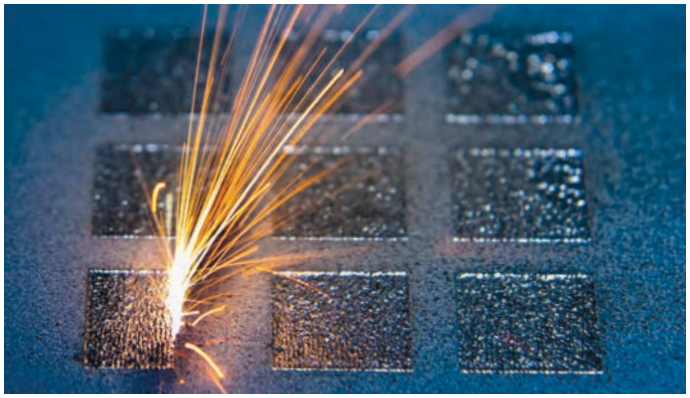
KSB's materials testing laboratory

- Accredited to DIN EN ISO/IEC 17025 (registration number D-PL-19609-01-00)
- Certified to ASME Code Section III NCA-3800

Additive manufacturing
for customised solutions

Where complex geometric shapes such as hollow bodies, undercuts, bionic structures or lattices are involved, conventional manufacturing processes soon reach the limits of feasibility. Providing components quickly or producing parts in small quantities is often uneconomical using conventional methods. For tasks of this kind, innovative 3D printing technology is the right choice.

Once a component has been redesigned, production can begin. In selective laser melting (SLM) a laser melts metal powder on a baseplate according to a given set of data, creating components layer by layer. Specific expertise and extensive experience with materials are necessary to ensure that the “printouts” are of the same quality as traditionally manufactured components.



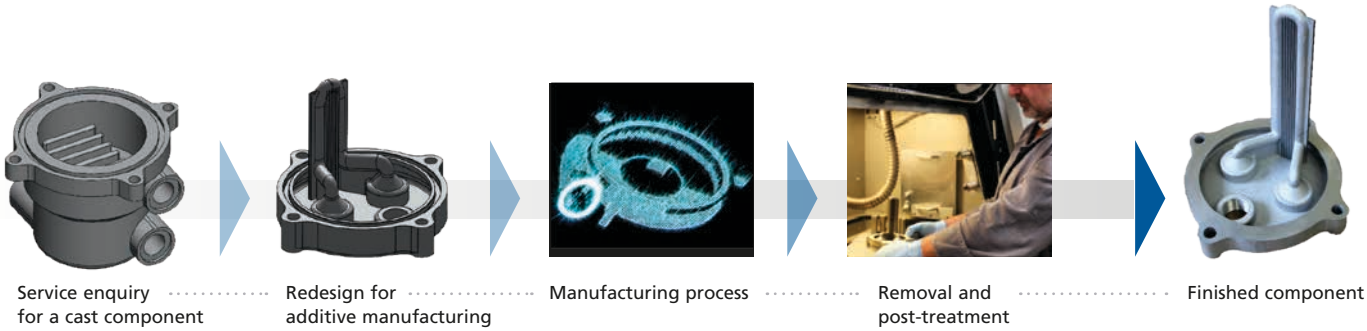
KSB has got its own materials testing laboratory accredited to DIN EN ISO/IEC 17025 and experienced specialists, ensuring compliance with quality assurance requirements.

Totally new design and manufacturing options

Fast delivery of complex components

Our production range comprises impellers, add-on parts, diffuser vanes, delicate small parts, seal components, prototypes, valve components, parts for quality inspection and testing, and specimens for mechanical testing and chemical analysis.

Process overview



Services provided:

- Reconstruction of components
- Optimisation for the specific production process or tailoring to customer requirements
- Production of components – including one-off parts
- Quality assurance
- Compatibility checks and advice on additive manufacturing

Benefits:

- Fast delivery of complex components
- Quality assurance thanks to extensive materials expertise
- Expert partner for all aspects of additive manufacturing

KSB Pegnitz foundry: selection of materials

Description	Designation / Trade name	Material No.	Chemical composition (reference analysis in weight %) C	Si	Mn	Cr	Ni	Mo	Cu	Other
Cast iron and cast steel grades										
Cast steel	GP240GH	1.0619	0.2	0.5	0.7	≤ 0.3	≤ 0.4	≤ 0.1	≤ 0.3	–
	G17CrMoV5-10	1.7706	0.2	≤ 0.6	0.8	1.4	≤ 0.4	1.0	≤ 0.3	–
Grey cast iron	EN-GJL-250	5.1301	–	≤ 0.6	0.7	–	–	–	–	–
Nodular cast iron	EN-GJS-400-18-LT	5.3103	–	–	–	–	–	–	–	–
Bainitic cast iron	ERN (GGL-NiMo7-7)	–	3.2	1.8	0.7	–	1.8	0.7	–	–
White cast iron	Norihard® NH 15 3 (GX250CrMo15-3)	–	2.6	0.6	0.7	15.0	–	2.6	–	–
	EN-GJN-HB555 (XCr14)	5.5608	1.8 – 3.6	≤ 1.0	1.0	14.0 – 18.0	≤ 2.0	≤ 3.0	≤ 1.2	–
	Noriloy® NL 25 2 (GX170CrMo25–2)	–	1.7	≤ 1.0	≤ 1.0	25.0	–	2.0	–	–
	Noricrom® (GX150CrNiMoCuN41-6-2)	1.4475	1.5	≤ 1.0	≤ 0.5	40.0	5.5	2.5	≤ 1.0	N: 0.1 - 0.2 %
Stainless and high-alloy cast steel										
Martensitic cast steel	GX7CrNiMo12-1	1.4008	≤ 0.10	≤ 1.0	≤ 1.0	13.0	1.5	≤ 0.5	≤ 0.3	–
	GX4CrNi13-4	1.4317	≤ 0.06	≤ 1.0	≤ 1.0	13.0	4.0	≤ 0.7	≤ 0.3	–
Austenitic cast steel	GX5CrNi19-10	1.4308	≤ 0.07	≤ 1.5	≤ 1.5	19.0	10.0	–	≤ 0.5	–
	GX2CrNi19-11	1.4309	≤ 0.03	≤ 1.5	≤ 2.0	19.0	11.0	–	≤ 0.5	–
	GX5CrNiMo19-11-2	1.4408	≤ 0.07	≤ 1.5	≤ 1.5	19.0	11.0	2.3	≤ 0.5	–
	GX2CrNiMo19-11-2	1.4409	≤ 0.03	≤ 1.5	≤ 2.0	19.0	11.0	2.3	≤ 0.5	–
	GX5CrNiNb19-11	1.4552	≤ 0.06	≤ 1.5	≤ 1.5	19.0	10.0	–	≤ 0.5	Nb ≤ 8x% C
	GX5CrNiMoNb19-11-2	1.4581	≤ 0.06	≤ 1.5	≤ 1.5	19.0	11.0	2.3	≤ 0.5	Nb ≤ 8x%C
	Noricid® (GX3CrNiSiN20-13)	9.4306	≤ 0.04	4.5	4.5	20.0	13.0	≤ 0.2	–	N: ≤ 0.15 %
Austenitic-ferritic cast steel (duplex / super duplex)	Noridur® (GX3CrNiMoCuN24-6-2-3)	1.4593	≤ 0.04	≤ 1.5	≤ 1.5	25.0	6.0	2.4	3.0	N: 0.10 - 0.20 %
	GX2CrNiMoCuN25-6-3-3	1.4517	≤ 0.03	≤ 1.0	≤ 1.5	25.5	6.0	3.0	3.1	N: 0.12 - 0.22 %
	Noriclor® (GX3CrNiMoCuN24-6-5)	1.4573	≤ 0.04	≤ 1.0	≤ 1.0	24.0	6.0	5.0	2.0	N: 0.15 - 0.25 %
	GX2CrNiMoN26-7-4	1.4469	≤ 0.03	≤ 1.0	≤ 1.0	26.0	7.0	4.0	≤1.3	N: 0.12 - 0.22 %
SLM (additive manufacturing of metal components)										
Austenitic stainless steel, 3D printing	Noribeam® 316L (X2CrNiMo17-12-2)	–	≤ 0.03	≤ 1.0	≤ 2.0	17.0	12.0	2.5	–	–

Description	Designation / Trade name	Material No.	Cu	Ni	Al	Sn	Fe	Si	Mn	Other
Cast copper-based alloys										
Tin bronze	CuSn10-C-GS	CC480K-GS	89.0	≤ 2.0	–	10.0	≤ 0.2	–	–	–
Aluminium bronze	CuAl10Fe5Ni5-C-GS	CC333G-GS	≥ 76.0	5.0	10.0	–	4.5	–	≤ 3.0	–

Standard	Comparable ASTM material	Hardness Reference values	0.2 yield strength in MPa	Tensile strength in MPa	Elongation at failure in %	Notch impact energy Kv_2 in J
DIN EN 10213	A216 WCB	–	≥ 240	≥ 420	≥ 22	≥ 27
DIN EN 10213	–	–	≥ 440	590 – 780	≥ 15	≥ 27
DIN EN 1561	A48–40B	–	–	≥ 250	–	–
DIN EN 1563	A536 Gr. 60–40–18	–	≥ 240	≥ 400	≥ 18	≥ 12
KSB MIC[1] 1930	–	≥ 260 HV	–	–	–	–
KSB MIC[1] 1941	–	≥ 750 HV	–	–	–	–
DIN EN 12513	A532 Class II B	≥ 550 HB	–	–	–	–
KSB MIC[1] 2878	–	≥ 400 HV	–	–	–	–
KSB MIC[1] 2711	–	≥ 350 HB	–	≥ 500	–	–
DIN EN 10283	CA15 (A217)	≥ 190 HB	≥ 440	≥ 590	≥ 15	≥ 27
DIN EN 10213/ DIN EN 10283	CA6NM (A352/A487/A743)	≥ 240 HB	≥ 550	760 – 960	≥ 15	≥ 50
DIN EN 10213/ DIN EN 10283	CF8 (A351/A743)	≥ 140 HB	≥ 175	440 – 640	≥ 30	≥ 60
DIN EN 10213/ DIN EN 10283	CF3 (A351/A743)	≥ 140 HB	≥ 185	440 – 640	≥ 30	≥ 80
DIN EN 10213/ DIN EN 10283	CF8M (A351/A743)	≥ 140 HB	≥ 185	440 – 640	≥ 30	≥ 60
DIN EN 10213/ DIN EN 10283	CF3M (A351/A743)	≥ 140 HB	≥ 195	440 – 640	≥ 30	≥ 70
DIN EN 10213/ DIN EN 10283	CF8C (A351/A743)	≥ 140 HB	≥ 175	440 – 640	≥ 25	≥ 40
DIN EN 10213/ DIN EN 10283	–	≥ 140 HB	≥ 185	440 – 640	≥ 25	≥ 40
KSB MIC[1] 2872	–	≥ 200 HB	≥ 300	≥ 600	≥ 30	≥ 80
KSB MIC[1] 2745/ SEW 410	Grade 1B (A890; A995)	≥ 200 HB	≥ 450	650 – 850	≥ 23	≥ 60
DIN EN 10213/ DIN EN 10283	Grade 1B (A890; A995)	≥ 200 HB	≥ 480	650 – 850	≥ 22	≥ 50
KSB MIC[1] 2747/ SEW 410	Grade 5A (A890; A995)	≥ 200 HB	≥ 480	690 – 890	≥ 22	≥ 50
DIN EN 10213/ DIN EN 10283	Grade 5A (A890; A995)	≥ 200 HB	≥ 480	650 – 850	≥ 22	≥ 50
KSB MIC[1] B309	–	≤ 200 HV	≥ 275	≥ 515	≥ 40	≥ 60

Standard	Comparable ASTM material	Hardness Reference values	0.2 yield strength in MPa	Tensile strength in MPa	Elongation at failure in %	Notch impact energy Kv_2 in J
DIN EN 1982	B 584, C 90 500	≥ 70 HB	≥ 130	≥ 250	≥ 18	–
DIN EN 1982	B 148 C 95 500	≥ 140 HB	≥ 270	≥ 600	≥ 13	–

[1] MIC = material identification code

Overview of KSB materials for typical applications

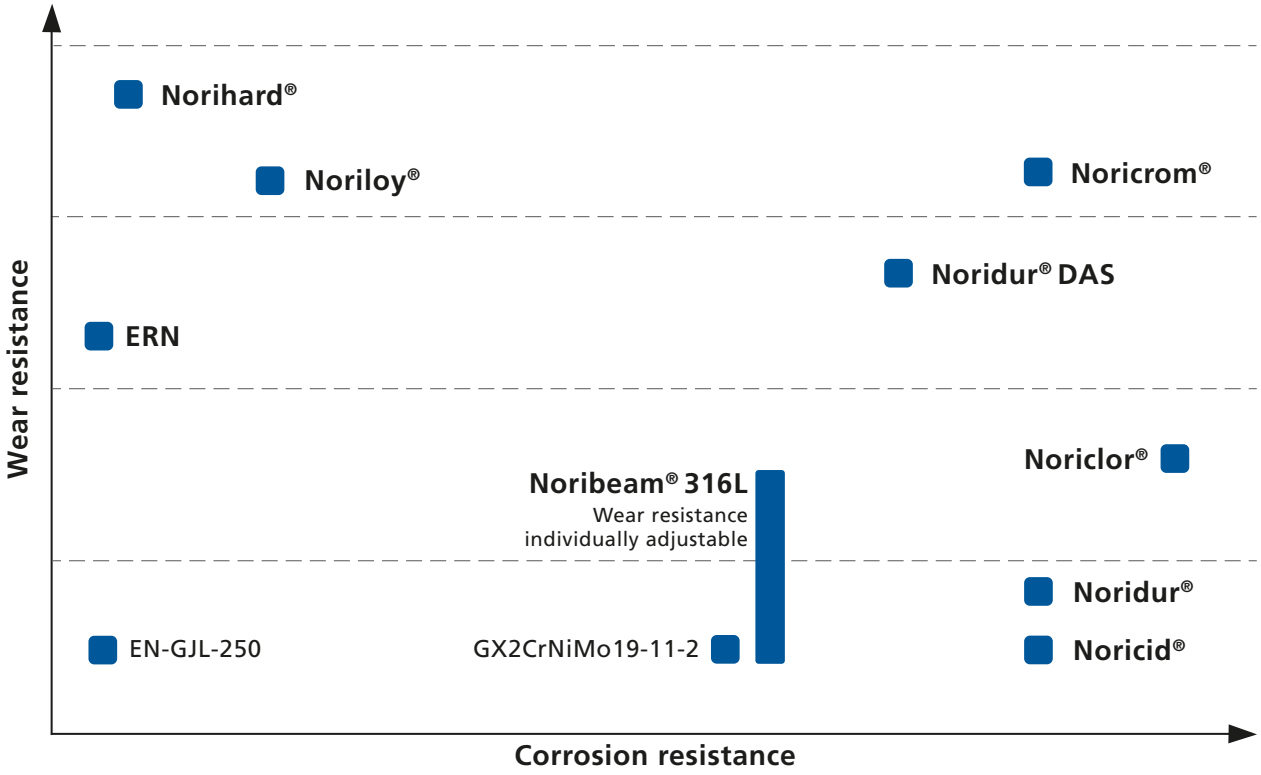
KSB's research has resulted in the development of the Nori® series, a group of wear- and/or corrosion-resistant materials. Pumps and valves made of these special materials perform well even under the most severe service conditions.

	Corrosion-resistant				Wear- and corrosion-resistant		Wear-resistant		
	Noridur®	Noriclor®	Noricid®	Noribeam® 316L	Noridur® DAS	Noricrom®	ERN	Norihard®	Noriloy®
Chemical and process industry	●	●		●		●			
High-concentration nitric and chromic acid			●						
Sulphuric and phosphoric acid	●	●				●			
Salt extraction and processing	●	●			●	●			
Petrochemical industry	●			●					
Coking plants	●	●		●	●	●			
Textile and pulp industries	●	●		●					
Food and sugar industries	●			●				●	●
Aluminium oxide industry / Solids transport								●	●
Steel and metal-working industries				●			●	●	
Mining industry / Coal mining and extraction	●							●	
Flue gas desulphurisation plant	●	●		●	●	●		●	●
Limestone and milk of lime suspensions								●	●
Acidic chloride-containing scrubber suspensions	●	●			●	●			
Acidic process water	●			●					
Waste water treatment plants	●	●		●		●	●	●	
Offshore and marine engineering	●	●		●		●			

KSB materials in detail

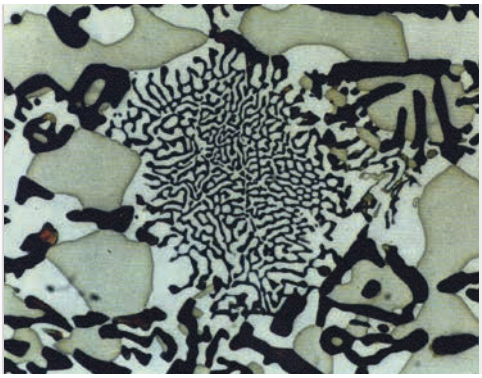
On the following pages you will find detailed information about our materials, for example their chemical composition, mechanical properties, specific applications and areas of use.

KSB materials portfolio



KSB Nori® materials

Noricrom®



Designation:
GX150CrNiMoCuN41-6-2 (material number: 1.4475)

Chemical composition (reference analysis in weight %)

C	1.4 – 1.6	Ni	5.0 – 7.0
Si	≤ 1.0	Mo	2.0 – 2.7
Mn	≤ 0.5	Cu	0.5 – 1.5
Cr	38.5 – 41.5	N	0.1 – 0.2

Microstructure: ferritic-austenitic matrix with primary carbides

Mechanical properties:

Reference values at room temperature

Tensile strength R_m in MPa	≥ 500
Yield strength $R_{p0.2}$ in MPa	–
Elongation at failure A_5 in %	–
Reduction of area Z in %	–
Notch impact energy Kv_2 in J	–
Fracture toughness K_{IC} N/mm$^{3/2}$	≥ 30
Hardness HB	≥ 350

Description:

- Noricrom® is a cast 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 fluids.
- No need for special component design or configuration

Weldability:

Components made of Noricrom® cannot be welded.

Application:

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

Corrosion resistance:

Material	Corrosion rate in mm/a
Noridur® 1.4593	< 0.01
Noricrom® 1.4475	< 0.01
Noridur® DAS	0.08
1.4464 (GX40CrNiMo27-5)	0.3

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

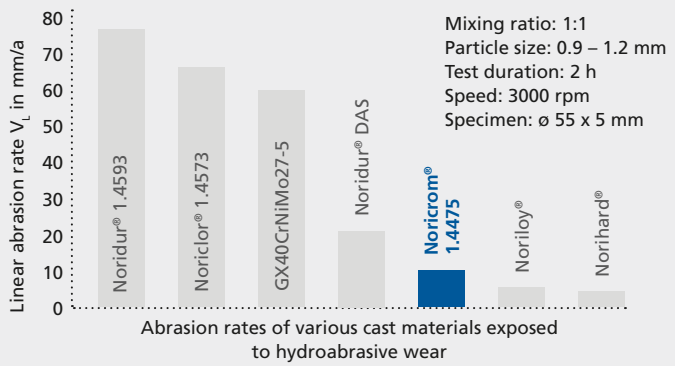
Field test results:

Service life depending on the material

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 rpm)	Impeller KWP K 600-823 (n = 740 rpm)	
			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

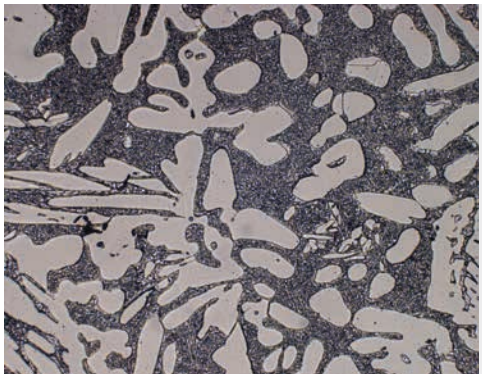
[1] Projection based on practical experience

Wear resistance:



Abrasion rates of various cast materials exposed to hydroabrasive wear

Noridur® DAS



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

Chemical composition (reference analysis in weight %)

C	≤ 0.04	Ni	5.0 – 8.0
Si	≤ 1.0	Mo	2.0 – 3.0
Mn	≤ 1.5	Cu	2.75 – 3.5
Cr	23.0 – 26.0	N	0.10 – 0.15

Microstructure: austenitic matrix containing intermetallic phases and residual ferrite

Mechanical properties:

Reference values at room temperature

Tensile strength R_m in MPa	≥ 500
Yield strength $R_{p0.2}$ in MPa	–
Elongation at failure A_5 in %	–
Reduction of area Z in %	–
Notch impact energy Kv_2 in J	–
Hardness HB	≥ 260

Description:

- Noridur® DAS is a wear-resistant cast duplex stainless steel with a precipitation-hardened microstructure characterised by an austenitic matrix containing intermetallic phases as well as some residual ferrite.
- Its chemical composition is identical to that of Noridur® duplex stainless steel.
- Additional special heat treatment results in the precipitation of hard, wear-resistant phases.
- It offers better resistance to hydroabrasive wear than Noridur® and at the same time good corrosion resistance in acidic chloride-containing fluids.

Application:
The applications of Noridur® DAS are manifold: It is suitable for handling corrosive and heavily solids-laden fluids in industry and process engineering as well as in waste water and environmental engineering. Noridur® DAS is mainly used for pump components subject to hydraulic loads and in contact with gypsum and scrubber suspensions in flue gas desulphurisation plants. It is the material of choice where long warranty periods and longevity are required.

Weldability:
Components made of Noridur® DAS cannot be welded.

Corrosion resistance:

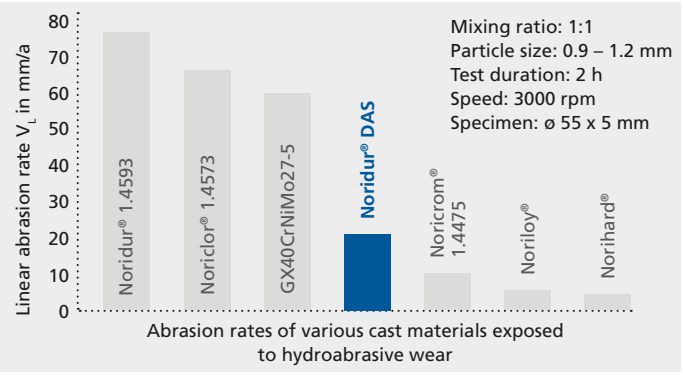
Material	Corrosion rate in mm/a
Noridur® 1.4593	< 0.01
Noricrom® 1.4475	< 0.01
Noridur® DAS	0.08
1.4464 (GX40CrNiMo27-5)	0.3

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

Field test results:

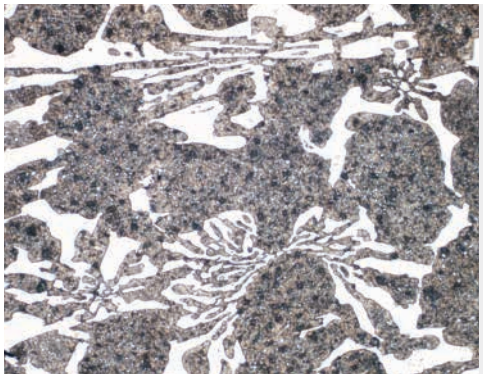
Material	Gypsum suspension Chloride content: up to 80,000 ppm pH: 3 – 6, T: 70 °C Solids content: 15 – 20 % by weight KWP 600-803
Cast duplex stainless steel	approx. 10,000 h
Noridur® DAS	45,000 – 50,000 h

Wear resistance:



Abrasion rates of various cast materials exposed to hydroabrasive wear

Norihard®



Designation:
GX250CrMo15-3

Chemical composition (reference analysis in weight %)

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

Microstructure: martensitic matrix containing primary and secondary carbides

Mechanical properties:

Reference values at room temperature

Tensile strength R_m in MPa	≥ 500
Yield strength $R_{p0.2}$ in MPa	–
Elongation at failure A_5 in %	–
Reduction of area Z in %	–
Notch impact energy Kv_2 in J	–
Hardness HV	≥ 750

Description:

- Norihard® is a martensitic white cast iron alloyed with chromium and molybdenum.
- Soft-annealing after casting makes the material suitable for any type of machining, including drilling and thread cutting.
- Finish-machined parts are subsequently hardened by further heat treatment.
- Contrary to self-hardening materials, such as Ni-Hard alloys, Norihard® is suitable for components of any configuration or design.

Application:
Norihard® is used for abrasive fluids containing large amounts of solids such as bauxite and sinter slurries, milk of lime and limestone suspensions, as well as wash water and waste water with a high sand content. Using Norihard® for handling bauxite and aluminium oxide suspensions significantly increases the service life of pump components.

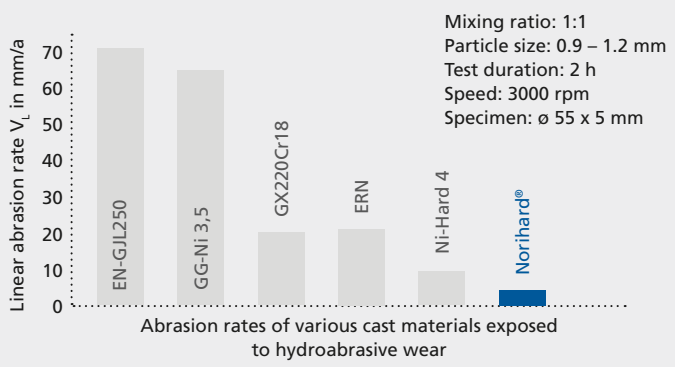
Weldability:
Components made of Norihard® cannot be welded.

Field test results:

Service life depending on the material

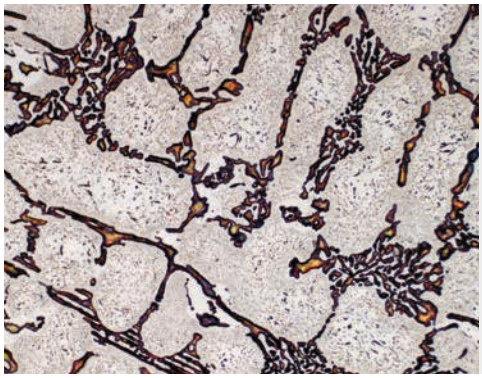
Material	Bauxite suspension Solids content 600–700 g/l KWP 150–400	Aluminium oxide suspension Solids content 300–400 g/l KWP 150–315
EN-GJL250	1,500 h	1,000 h
Ni-Hard 4	5,000 h	5,500 h
Norihard®	> 7,000 h	> 10,000 h

Wear resistance:



Abrasion rates of various cast materials exposed to hydroabrasive wear

Noriloy®



Designation:
GX170CrMo25-2

Chemical composition (reference analysis in weight %)

C	1.5 – 1.8	Cr	24.0 – 26.0
Si	≥ 1.0	Mo	1.5 – 2.5
Mn	≥ 1.0		

Microstructure: ferritic matrix containing primary and secondary carbides

Mechanical properties:

Reference values at room temperature

Tensile strength R_m in MPa	≥ 400
Yield strength $R_{p0.2}$ in MPa	–
Elongation at failure A_5 in %	–
Reduction of area Z in %	–
Notch impact energy Kv_2 in J	–
Hardness HV	≥ 400

Description:

- Noriloy® is a chromium- and molybdenum-alloyed white cast iron with a ferritic matrix.
- Soft-annealing after casting makes 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 fluids.

Application:
Noriloy® is specifically used for slightly corrosive fluids with a high solids content such as the raw products of semi-dry processes in waste incineration plants, 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.

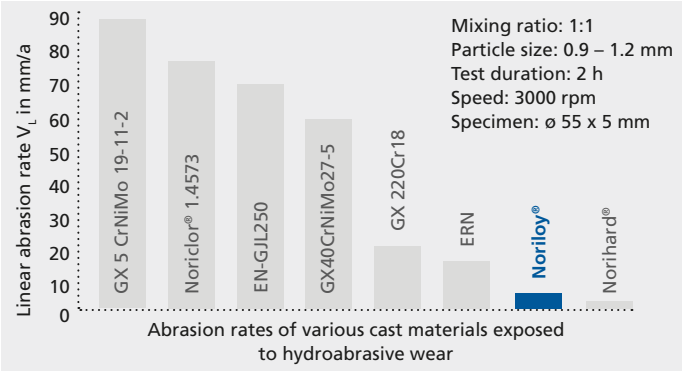
Weldability:
Components made of Noriloy® cannot be welded.

Field test results:

Service life depending on the material

Material	Milk of lime containing $CaSO_3$ Chloride content: 1000-5000 ppm pH: 6–10, T: 60 °C Solids content: 20-45 % b.w. KWP 80–500	Limestone suspension Chloride content: 1000-7000 ppm pH: 6.5–9, T: 40 °C Solids content: 40-65 % b.w. KWP 250–50
GX40CrNiMo27-5	approx. 10,000 h	approx. 1,500 h
Noriloy®	40,000 – 50,000 h	30,000 – 40,000 h

Wear resistance:



Abrasion rates of various cast materials exposed to hydroabrasive wear

ERN

Designation:
GGL-NiMo7-7

Chemical composition (reference analysis in weight %)

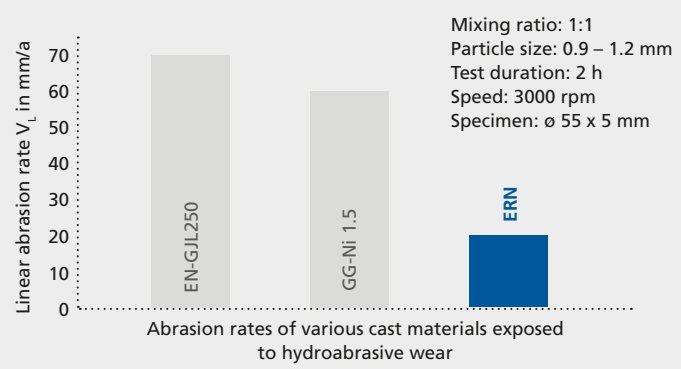
C	3.0 – 3.5	Ni	1.8 – 2.2
Si	1.2 – 2.0	Mo	0.6 – 0.9
Mn	0.7 – 1.0		

Microstructure: bainitic matrix containing lamellar graphite

Mechanical properties:
Reference values at room temperature

Tensile strength R_m in MPa	–
Yield strength $R_{p0.2}$ in MPa	–
Elongation at failure A_5 in %	–
Reduction of area Z in %	–
Notch impact energy Kv_2 in J	–
Hardness HV	≥ 260

Wear resistance:



Abrasion rates of various cast materials exposed to hydroabrasive wear

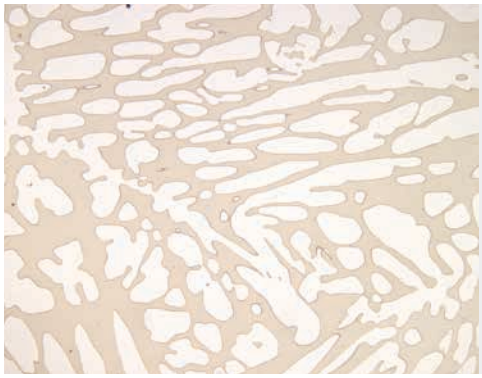
Description:

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

Weldability:
The material ERN cannot be welded.

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

Noridur®



Designation:
GX3CrNiMoCuN24-6-2-3 (material number: 1.4593)

Chemical composition (reference analysis in weight %)

C	≤ 0.04	Ni	5.0 – 8.0
Si	≤ 1.5	Mo	2.0 – 3.0
Mn	≤ 1.5	Cu	2.75 – 3.5
Cr	23.0 – 26.0	N	0.10 – 0.20

Microstructure: ferritic-austenitic, containing approximately 50 % austenite

Mechanical properties:

Reference values at room temperature

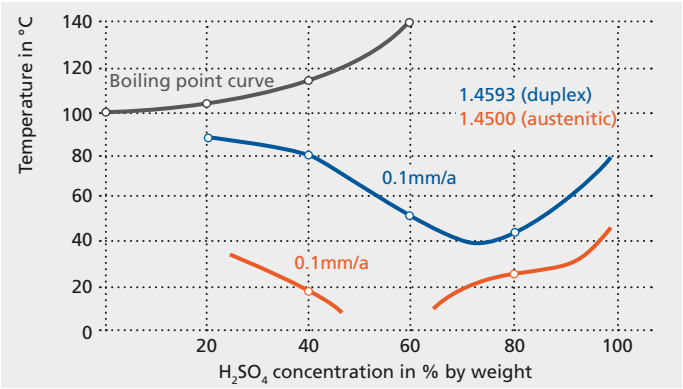
Tensile strength R_m in MPa	≥ 650
Yield strength $R_{p0.2}$ in MPa	≥ 450
Elongation at failure A_5 in %	≥ 23
Reduction of area Z in %	≥ 50
Notch impact energy Kv_2 in J	≥ 60
Hardness HB	≥ 200

Description:

- Noridur® is a cast 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.
- Higher resistance to cavitation and wear than austenitic steels.
- Excellent resistance to uniform corrosion in highly acidic fluids and to localised corrosion in chloride-containing fluids.
- The mean pitting resistance equivalent (PREN) (%Cr+3.3%Mo+16%N) is 35.2.
- Noridur® offers higher resistance to stress corrosion cracking and is less susceptible to corrosion fatigue in chloride-containing fluids than austenitic steels.
- Its maximum application temperature is 290 °C.

Weldability:
If compatible filler metals and an appropriate welding process are used, components made of Noridur® can be easily welded.

Corrosion resistance (at the example of H_2SO_4)



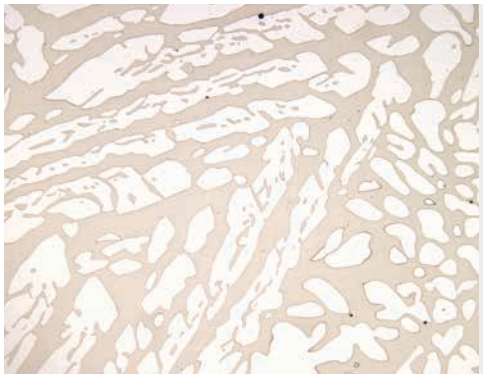
Test conditions: flowing sulphuric acid (10 m/s)

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

Comparable materials:

- 1.4517 to DIN EN 10213 and DIN EN 10283
- UNS J93372 (Grade 1B/CD4MCuN to ASTM A890 and ASTM A995)

Noriclor®



Designation:
GX3CrNiMoCuN24-6-5 (material number: 1.4573)

Chemical composition (reference analysis in weight %)

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

Microstructure: ferritic-austenitic, containing approximately 50 % austenite

Mechanical properties:

Reference values at room temperature

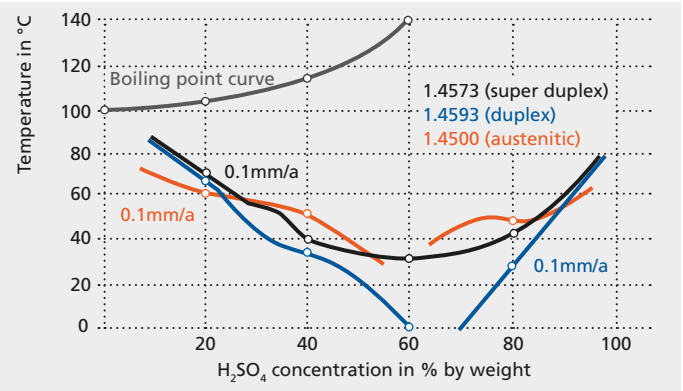
Tensile strength R_m in MPa	≥ 690
Yield strength $R_{p0.2}$ in MPa	≥ 480
Elongation at failure A_5 in %	≥ 22
Reduction of area Z in %	≥ 50
Notch impact energy Kv_2 in J	≥ 50
Hardness HB	≥ 200

Description:

- Noriclor® is a cast 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.
- Higher resistance to cavitation and wear than austenitic steels.
- Excellent resistance to uniform corrosion in highly acidic fluids and to localised 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 at least 40.
- Compared with cast austenitic stainless steels, Noriclor® is more resistant to stress corrosion cracking and less susceptible to corrosion fatigue in chloride-containing fluids.
- Compared with other stainless steels, Noriclor® is more resistant to hydroabrasive wear.
- Its maximum application temperature is 290 °C.

Weldability:
If compatible filler metals and an appropriate welding process are used, components made of Noriclor® can be easily welded.

Corrosion resistance (at the example of H_2SO_4)



Test conditions: static sulphuric acid

Application:
Noriclor® is used for acids with critical concentrations and for fluids with a high chloride content, in particular at elevated temperatures, where the corrosion resistance of Noridur® would be insufficient. Noriclor® is typically employed for handling aggressive fluids in chemical process engineering, in waste water transport, in environmental engineering as well as in the marine and offshore sectors.

Comparable materials:

- 1.4469 to DIN EN 10213 and DIN EN 10283
- UNS J93404 (Grade 5A/CE3MN to ASTM A890 and ASTM A995)

Noricid®

Designation:
GX3CrNiSiN2013 (material number: Noricid® 9.4306)

Chemical composition (reference analysis in weight %)

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

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

Mechanical properties:

Reference values at room temperature

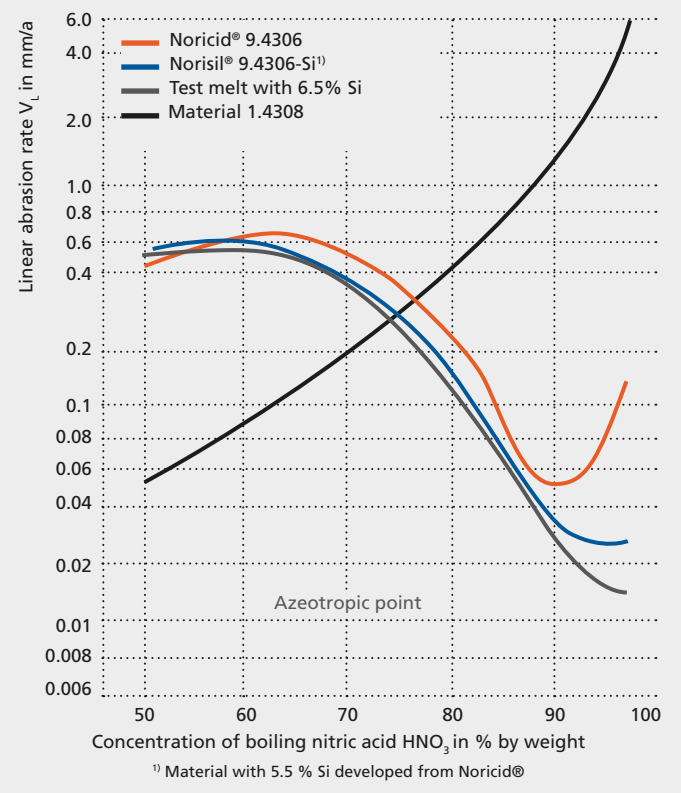
Tensile strength R_m in MPa	≥ 600
Yield strength $R_{p0.2}$ in MPa	≥ 300
Elongation at failure A_5 in %	≥ 30
Reduction of area Z in %	≥ 30
Notch impact energy Kv_2 in J	≥ 80
Hardness HB	≥ 200

Description:

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

Weldability:
If compatible filler metals and an appropriate welding process are used, 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.

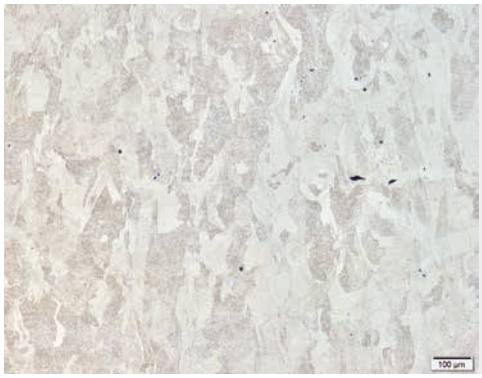
Corrosion resistance:



1) Material with 5.5 % Si developed from Noricid®

Application:
Noricid® is used as a material for pumps and valves handling highly oxidising acids such as concentrated nitric, chromic or sulphuric acid.

Noribeam® 316L



Designation:
X2CrNiMo17-12-2, low-carbon CrNiMo steel comparable with 1.4404 and 316L

Chemical composition (reference analysis in weight %)

C	≤ 0.03	S	≤ 0.03
Si	≤ 1.0	Cr	16.0 – 18.0
Mn	≤ 2.0	Mo	2.00 – 3.00
P	≤ 0.045	Ni	10.0 – 14.0

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

Mechanical properties:

Reference values at room temperature

Tensile strength R_m in MPa	≥ 515
Yield strength $R_{p0.2}$ in MPa	≥ 275
Elongation at failure A_5 in %	≥ 40
Reduction of area Z in %	–
Notch impact energy Kv_2 in J	≥ 60
Hardness HV	≤ 200

Description:

- Austenitic stainless steel, produced in selective laser melting (SLM)
- Comparable with forged materials 1.4404 and 316L (UNS: S31603)
- High molybdenum content provides excellent resistance against non-oxidising acids and halogen-containing fluids.
- Its low carbon content enhances its resistance to intergranular corrosion.

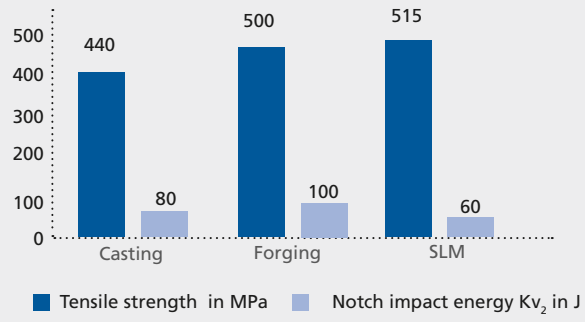
Component size:

Components with maximum dimensions of 400 mm x 400 mm x 380 mm can be manufactured.

Application:

- The components are used in solution-annealed condition in order to meet the specified mechanical properties.
- Solution annealing is employed for targeted matrix transformation.
- Primarily used in the chemical industry and in mechanical and apparatus engineering.

Material properties of 316L (reference values)



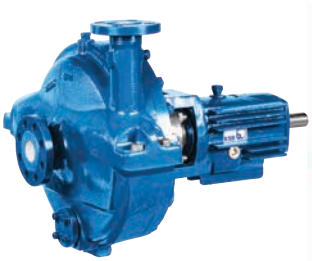
Applications of our cast products

Our cast products are especially used for:

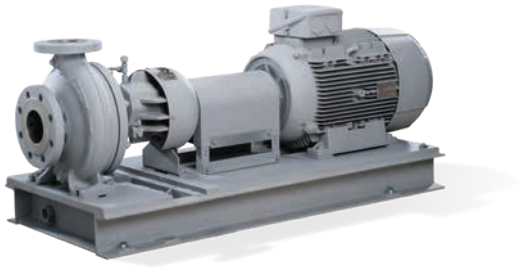
- Industry and process engineering
- Seawater desalination
- Drinking water supply
- Waste water disposal
- Sugar production

Standardised chemical pumps

Centrifugal pumps with channel impellers



Pumps for refineries, petrochemical processes



Hot water pumps

Canned motor pumps

Mag-drive pumps

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