KRUPP THYSSEN NIROSTA

# Chemical resistance of NIROSTA® steels

New Companyname since February 2002

**ThyssenKrupp Nirosta GmbH**

# Chemical resistance of NIROSTA® steels



## General corrosion

Stainless steels are defined as being characterized by particularly high resistance to chemical attack by aqueous media. In general, they contain at least 12 % by weight of chrome and a maximum of 1.2 % carbon.

The reason for their high resistance to corrosion is a passive layer that forms on the surface. This consists of a metal oxide or hydroxide layer, rich in chrome, only a few Ångstrom units thick, separating the actual metal from the attacking medium.

After sufficient time has passed, the passive layer of a stainless steel exhibits a constant composition and remains in a state of equilibrium with the surrounding medium. Once formed, such a layer cannot therefore be transferred to another medium. Following any mechanical damage of the surface, a new layer can generally be expected to form spontaneously at that point.

If in some medium a satisfactory passive layer cannot form, or if an existing layer is locally damaged or completely destroyed, corrosion can occur.

The decisive element responsible for the formation of a passive layer is chrome. A chrome content above the quoted value of some 12 % inhibits rusting under normal atmospheric conditions. Further increases in the chrome content and, according to the application, the addition of molybdenum and other alloys permit corrosion resistance to be extended to much more agressive media.

Only those alloy contents dissolved in the metal are effective in achieving passivation. The highest resistance to corrosion is thus given with a segregation-free matrix whose chrome or molybdenum contents are not reduced by precipitations of the formation of non-metallic phases. The right heat treatment for achieving an ideal structure is described in the particular material sheets.

Stainless steels may suffer general corrosion or various types of localised corrosion. Resistance to general corrosion is usually classified as follows:

0 = resistant to general corrosion (mass loss rate < 0.1 g/h · m² corresponding to a corrosion rate < 0.11 mm thickness reduction/year)
1 = slight susceptibility to general corrosion, suitable for some applications (0.1 – 1.0 g/h · m² corresponding to 0.11 – 1.10 mm thickness reduction/year)
2 = low resistance to general corrosion, unsuitable for virtually all applications (1.0 – 10.0 g/h · m² corresponding to 1.1 – 11.0 mm thickness reduction/year)
3 = no resistance to general corrosion (> 10.0 g/h · m² corresponding to > 11.0 mm thickness reduction/year)

The following warning is provided for the major forms of localised corrosion
L = risk of pitting, crevice corrosion or stress-corrosion cracking, even in resistance class 0

General corrosion is to be expected primarily in acids and strong alkaline solutions. Pitting, crevice corrosion or stress-corrosion cracking are most frequently caused by chloride ions but they may also be induced by the rarer halides bromide and iodide, while stress-corrosion cracking can also occur in the presence of other species.

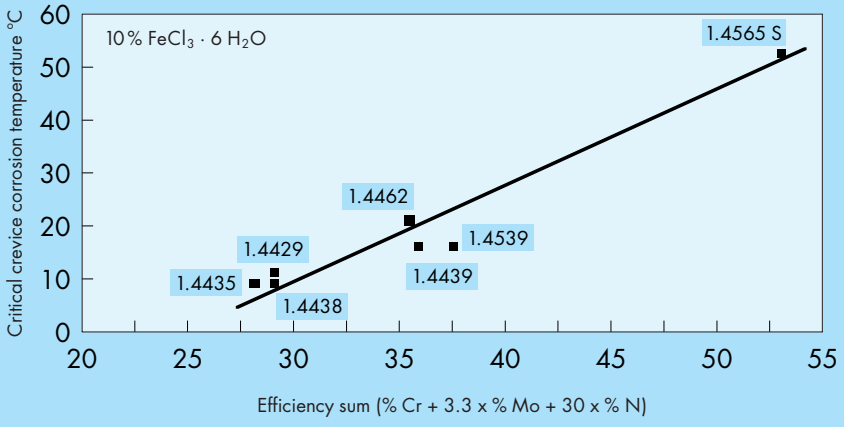
## Pitting and crevice corrosion

Pitting corrosion is initiated by interaction between halide ions and the passive film, the latter being locally punctured. Hollows the size of pin pricks are formed and grow into pit sites which can vary greatly in severity. The risk of pitting increases with

– increasing concentrations of halide ions
– increasing temperature
– an increase in the electrochemical potential of the steel in the relevant electrolyte, caused for example by the effects of an oxidising agent.

Crevice corrosion arises in crevices where fluid exchange with the surrounding environment is limited. Crevices of this nature are design or production related and occur e. g. on flanges, tube sheets, beneath seals or even under scale/deposits.

Critical crevice corrosion temperature as a factor of the efficiency sum



The corrosion mechanism is largely the same as for pitting, although crevice geometry and the type of materials forming the crevice exert an additional influence. Since crevice attack occurs under less serious corrosion conditions than pitting, attempts should be made to design out crevices in components to be used in chloride-bearing media.

Assuming a homogeneous distribution of alloying elements, a rough guide to the pitting and crevice corrosion resistance of stainless steel is the efficiency sum (W) of % Cr + 3.3 x % Mo + 30 x % N (see Fig.). The influence of nitrogen as an alloying element is, however, more complex than expressed by this equation. The high efficiency expressed in the factor of 30 will only apply in full in the case of high-alloy steels with increased molybdenum contents.

A material's inherent resistance to pitting and crevice corrosion can only be fully achieved if the surface quality of the material is pristine, i. e. bright metallic. It is therefore important to remove any heat tinting or scale left after welding, iron particles or rust from other sources, grinding residue etc.

### Stress-corrosion cracking

Stainless steels in media containing specific components – in particular chloride ions – and subjected at the same time to tensile stresses may suffer corrosion attack and cracking, even if the steel displays adequate resistance to the medium when not under mechanical load. This phenomenon is known as stress-corrosion cracking and is not caused exclusively by service stresses; the blame frequently lies with internal stresses applied during processing, e.g. welding, grinding or cold forming.

As with pitting and crevice corrosion, the risk of chloride-induced stress-corrosion cracking becomes greater as the temperature and chloride concentration increase. There are, however, other material-related variables. For example, austenitic steel grades 18/10-CrNi and 17/12/2-CrNiMo are at particular risk of chloride-induced stress-corrosion cracking when temperatures exceed 50 °C. Resistance can be distinctly enhanced by increasing the molybdenum and in particular the nickel content of the material. In comparison, ferritic and austenitic-ferritic stainless steels are relatively insensitive to corrosion of this type.

### How to use the table

Even though the figures provided in the following have been calculated in laboratory tests using pickled specimens with the best possible microstructure – annealed, tempered or quenched – they provide a basic guide to applicability.

It must however be emphasised that under practical conditions agents rarely occur in such pure form, and that even slight additions, e. g. of oxidising or reducing materials, can weaken or intensify corrosive attack. Deposits, such as those occasionally found on the walls above the bath surface or at other points, and condensation in the steam chamber of an enclosed apparatus can under certain circumstances greatly modify the conditions for corrosive attack.

Exact knowledge of corrosive conditions is thus vital in selecting the right grade of steel. The best (and sometimes only) way of gaining information on the resistance of a material in the corrosive medium in question is to carry out tests on a specimen under actual service conditions, taking into consideration not only the composition and concentration of the corrosive medium but also the temperature, the pH value and other variables.

We would be pleased to provide specimens of the relevant materials for test purposes.

**Classification of NIROSTA®-/ASTM grades by group**

| Gr. 1 | Gr. 2 | Gr. 3 | Gr. 4 | Gr. 5 | 4465 | 4539 | 4565 S |
|---|---|---|---|---|---|---|---|
| **4000/** 410 S | | | **4301/** 304 | | | | |
| **4002/** 405 | | | **4303/** (305) | **4401/** 316 | | | |
| **4003/** A240/ A240M | | | **4306/** 304 L | **4404/** 316 L | | | |
| **4006/** 410 | **4016/** 430 | | **4307/** 304 L | **4429/** 316 LN | | | |
| **4021/** (420) | **4057/** 431 | | **4310/** (301) | **4435/** 316 L | | | |
| **4024/** (410) | **4120** | | **4311/** 304 LN | **4436/** 316 | | | |
| **4028/** (420) | **4305/** 303 | | **4315/** 304 N | **4438/** 317 L | | | |
| **4031** (420) | **4427/** 316 F | | **4318/** 301 LN | **4439** | | | |
| **4034/** (420) | **4509/** 441 | | **4541/** 321 | **4462** | | | |
| **4313** | **4510/** 439 | **4113/** 434 | **4544** | **4501** | | | |
| **4512/** (409) | **4511** | **4521/** 444 | **4546** | **4561/** 316 Ti | | | |
| **4589** | **4520** | **4568** 631 | **4550/** 347 | **4571/** 316 Ti | **4465** | **4539** | **4565 S** |

# Table of steel grades



| NIROSTA® | Material no. | Abbreviation as per EN 10 088-2 | DIN/SEW | ASTM grade | UNS |
|---|---|---|---|---|---|
| 4000 | 1.4000 | X 6 Cr 13 | 17440 | 410 S | S 41008 |
| 4002 | 1.4002 | X 6 CrAl 13 | 17440 | 405 | S 40500 |
| 4003 | 1.4003 | X 2 CrNi 12 | SEW 400 | A 240/A 240 M | soon: S 40977 |
| 4006 | 1.4006 | X 12 Cr 13 | 17440 | 410 | S 41000 |
| 4016 | 1.4016 | X 6 Cr 17 | 17440/41 | 430 | S 43000 |
| 4021 | 1.4021 | X 20 Cr 13 | 17440 | (420) | (S 42000) |
| 4024 | 1.4024 | X 15 Cr 13 | | (410) | (S 41000) |
| 4028 | 1.4028 | X 30 Cr 13 | 17440/41 | (420) | (S 42000) |
| 4031 | 1.4031 | X 39 Cr 13 | | (420) | (S 42000) |
| 4034 | 1.4034 | X 46 Cr 13 | | (420) | (S 42000) |
| 4057 | 1.4057 | X 17 CrNi 16-2 | 17440 | 431 | S 43100 |
| 4113 | 1.4113 | X 6 CrMo 17-1 | | 434 | S 43400 |
| 4120 | 1.4120 | X 20 CrMo 13 | SEW 400 | | |
| 4301 | 1.4301 | X 5 CrNi 18-10 | 17440/41 | 304 | S 30400 |
| 4303 | 1.4303 | X 4 CrNi 18-12 | 17440 | (305) | (S 30500) |
| 4305 | 1.4305 | X 8 CrNiS 18-9 | 17440 | 303 | S 30300 |
| 4306 | 1.4306 | X 2 CrNi 19-11 | 17440/41 | 304 L | S 30403 |
| 4307 | 1.4307 | X 2 CrNi 18-9 | | 304 L | S 30403 |
| 4310 | 1.4310 | X 10 CrNi 18-8 | | (301) | (S 30100) |
| 4311 | 1.4311 | X 2 CrNiN 18-10 | 17440/41 | 304 LN | S 30453 |
| 4313 | 1.4313 | X 4 CrNi 13-4 | | | S 41500 |
| 4315 | 1.4315 | X 5 CrNiN 19-9 | SEW 400 | 304 N | S 30451 |
| 4318 | 1.4318 | X 2 CrNiN 18-7 | | 301 LN | |
| 4401 | 1.4401 | X 5 CrNiMo 17-12-2 | 17440/41 | 316 | S 31600 |
| 4404 | 1.4404 | X 2 CrNiMo 17-12-2 | 17440/41 | 316 L | S 31603 |
| 4427 | 1.4427 | X 4 CrNiMoS 18-11 | SE list | 316 F | S 31620 |

| NF | SIS | BS | CSN | JIS | GOST | NIROSTA® |
|---|---|---|---|---|---|---|
| Z 8 C 12 | 2301 | 403 S 17 | 17020 | SUS 410 S | 08 Ch 13 | 4000 |
| Z 8 CA 12 | | 405 S 17 | | SUS 405 | | 4002 |
| | | | | | | 4003 |
| Z 10 C 13 | 2302 | 410 S 21 | 17021 | SUS 410 | 12 Ch 13 | 4006 |
| Z 8 C 17 | 2320 | 430 S 17 | 17040 | SUS 430 | 12 Ch 17 | 4016 |
| Z 20 C 13 | 2303 | 420 S 37 | 17022 | SUS 420 J 1 | 20 Ch 13 | 4021 |
| | | 420 S 29 | | SUS 410 J 1 | 15 Ch 13 L | 4024 |
| Z 33 C 13 | 2304 | 420 S 45 | 17023 | SUS 420 J 2 | 30 Ch 13 | 4028 |
| Z 33 C 13 | 2304 | 420 S 45 | 17024 | SUS 420 J 2 | 40 Ch 13 | 4031 |
| Z 44 C 14 | | | 17024 | | 40 Ch 13 | 4034 |
| Z 15 CN 16-02 | 2321 | 431 S 29 | | SUS 431 | 20 Ch 17 N 2 | 4057 |
| Z 8 CD 17-01 | | 434 S 17 | | SUS 434 | | 4113 |
| Z 20 CD 14 | | | | | | 4120 |
| Z 7 CN 18-09 | 2332/33 | 304 S 31 | 17240 | SUS 304 | 08 Ch 18 N 10 | 4301 |
| Z 8 CN 18-12 | | 305 S 19 | | SUS 305 | 06 Ch 18 N 11 | 4303 |
| Z 10 CNF 18-09 | 2346 | 303 S 22 | | | | 4305 |
| Z 3 CN 18-10 | 2352 | 304 S 11 | 17249 | SUS 304 L | 03 Ch 18 N 11 | 4306 |
| | | | | | | 4307 |
| Z 11 CN 17-08 | 2331 | 301 S 21 | | SUS 301 | 07 Ch 16 N 6 | 4310 |
| Z 3 CN 18-10 AZ | 2371 | 304 S 61 | | SUS 304 L | | 4311 |
| Z 6 CN 13-04 | 2385 | 425 C 11 | | | | 4313 |
| Z 6 CN 19-09 AZ | | | | | | 4315 |
| Z 3 CN 18-07 AZ | | | | SUS 301 LN | | 4318 |
| Z 7 CND 17-11-02 | 2347 | 316 S 31 | 17346 | SUS 316 | 03 Ch 17 N 13 M 2 | 4401 |
| Z 3 CND 17-12-02 | 2348 | 316 S 11 | 17349 | SUS 316 L | 03 Ch 17 N 13 M 2 | 4404 |
| | | | | | | 4427 |

# Table of steel grades



| NIROSTA® | Material no. | Abbreviation as per EN 10 088-2 | DIN/SEW | ASTM grade | UNS |
|---|---|---|---|---|---|
| 4429 | 1.4429 | X 2 CrNiMoN 17-13-3 | 17440/41 | 316 LN | S 31653 |
| 4435 | 1.4435 | X 2 CrNiMo 18-14-3 | 17440/41 | 316 L | S 31603 |
| 4436 | 1.4436 | X 3 CrNiMo 17-13-3 | 17440/41 | 316 | S 31600 |
| 4438 | 1.4438 | X 2 CrNiMo 18-15-4 | 17440/41 | 317 L | S 31703 |
| 4439 | 1.4439 | X 2 CrNiMoN 17-13-5 | 17440/41 | | S 31726 |
| 4462 | 1.4462 | X 2 CrNiMoN 22-5-3 | SEW 400 | | S 31803<br>S 32205 |
| 4465 | 1.4465 | X 1 CrNiMoN 25-25-2 | SEW 400 | | |
| 4501 | 1.4501 | X 2 NiCrMoCuWN 25-7-4 | | | S 32760 |
| 4509 | 1.4509 | X 2 CrTiNb 18 | SE list | 441 | |
| 4510 | 1.4510 | X 3 CrTi 17 | 17440/41 | 439 | S 43900 |
| 4511 | 1.4511 | X 8 CrNb 17 | | | |
| 4512 | 1.4512 | X 2 CrTi 12 | | 409 | S 40900 |
| 4520 | 1.4520 | X 2 CrTi 17 | | | |
| 4521 | 1.4521 | X 2 CrMoTi 18-2 | | 444 | S 44400 |
| 4539 | 1.4539 | X 1 NiCrMoCuN 25-20-5 | | | N 08904 |
| 4541 | 1.4541 | X 6 CrNiTi 18-10 | 17440/41 | 321 | S 32100 |
| 4544 | 1.4544 | | | | |
| 4546 | 1.4546 | X 5 CrNiNb 18-10 | | | |
| 4550 | 1.4550 | X 6 CrNiNb 18-10 | 17440/41 | 347 | S 34700 |
| 4561 | 1.4561 | X 1 CrNiMoTi 18-13-2 | SEW 400 | 316 Ti/316 L | S 31603 |
| 4565 | 1.4565 | X 2 CrNiMnMoNbN 25-18-5-4 | SEW 400 | | S 34565 |
| 4568 | 1.4568 | X 7 CrNiAl 17-7 | 17224 | 631 | S 17700 |
| 4571 | 1.4571 | X 6 CrNiMoTi 17-12-2 | 17440/41 | 316 Ti | S 31635 |
| 4589 | 1.4589 | X 5 CrNiMoTi 15-2 | 5512 p.3 | | |

| NF | SIS | BS | CSN | JIS | GOST | NIROSTA® |
|---|---|---|---|---|---|---|
| Z 3 CND 17-12 AZ | 2375 | 316 S 63 | | SUS 316 LN | | 4429 |
| Z 3 CND 17-13-03 | 2353 | 316 S 13 | | SUS 316 L | 03 Ch 17 N 14 M 2 | 4435 |
| Z 6 CND 18-12-03 | 2343 | 316 S 33 | 17352 | SUS 316 | | 4436 |
| Z 3 CND 19-15-04 | 2367 | | | SUS 317 L | | 4438 |
| Z 3 CND 18-14-05 AZ | | | | SUS 317 | | 4439 |
| | | | | SUS 329 J 3 L | | 4462 |
| Z 2 CND 25-22 AZ | | | | | | 4465 |
| | | | | | | 4501 |
| Z 3 CTNb 18 | | | | | | 4509 |
| Z 4 CT 17 | | | 17041 | SUS 430 LX | 08 Ch 17 T | 4510 |
| Z 4 CNb 17 | | | | | | 4511 |
| Z 3 CT 12 | | 409 S 19 | | SUS 409 | | 4512 |
| | | | | | | 4520 |
| | | | | SUS 444 | | 4521 |
| Z 2 NCDU 25-20 | 2662 | 904 S 13 | | | | 4539 |
| Z 6 CNT 18-10 | 2337 | 321 S 31 | 17247 | SUS 321 | 08 Ch 18 N 10 T | 4541 |
| | | | | | | 4544 |
| | | | | | | 4546 |
| Z 6 CNNb 18-10 | 2338 | 347 S 31 | | SUS 347 | 08 Ch 18 N 12 B | 4550 |
| | | | | | | 4561 |
| | | | | | | 4565 |
| Z 9 CNA 17-07 | 2388 | | | SUS 631 | 09 Ch 17 N 7 Ju | 4568 |
| Z 6 CNDT 17-12 | 2350 | 320 S 31 | 17848 | SUS 316 Ti | 10 Ch 17 N 13 M 2 T | 4571 |
| | | | | | | 4589 |

# Chemical resistance of NIROSTA® steels



| Corrosive agent | Formula | Condition | Concentration |
|---|---|---|---|
| Acetic acid | $CH_3COOH$ | | 10 % |
| Acetic acid | $CH_3COOH$ | | 10 % |
| Acetic acid | $CH_3COOH$ | | 50 % |
| Acetic acid | $CH_3COOH$ | | 50 % |
| Acetic acid with hydrogen peroxide | $CH_3COOH + H_2O_2$ | | 10 % and 50 % |
| Acetic acid with hydrogen peroxide | $CH_3COOH + H_2O_2$ | | 10 % and 50 % |
| Acetic acid with hydrogen peroxide | $CH_3COOH + H_2O_2$ | | 10 % and 50 % |
| Acetic anhydride | $(CH_3CO)_2O$ | | |
| Acetic anhydride | $(CH_3CO)_2O$ | | |
| Acetochloride | $CH_3COCl$ | | |
| Acetone | $CH_3COCH_3$ | | all concentrations |
| Acetone | $CH_3COCH_3$ | | all concentrations |
| Acetosalicylic acid | $HOOCC_6H_4OCOCH_3$ | | |
| Activin | see p-toluene sulfonchloramide sodium | | |
| Alcohol | see methyl and ethyl alcohol | | |
| Alum | see potassium aluminium sulphate | | |
| Aluminium | Al | molten | |
| Aluminium acetate | $Al(CH_3COO)_3$ | cold saturated | |
| Aluminium acetate | $Al(CH_3COO)_3$ | cold and hot saturated | |
| Aluminium ammonium sulphate | $Al(NH_4)(SO_4)_2 \cdot 12H_2O$ | | all concentrations |
| Aluminium ammonium sulphate | $Al(NH_4)(SO_4)_2 \cdot 12H_2O$ | cold and hot saturated | |
| Aluminium chloride | $AlCl_3 \cdot 6H_2O$ | | 5 % |
| Aluminium chloride | $AlCl_3 \cdot 6H_2O$ | | 25 % |
| Aluminium nitrate | $Al(NO_3)_3 \cdot 9H_2O$ | | |
| Aluminium sulphate | $Al_2(SO_4)_3 \cdot 18H_2O$ | | 10 % |
| Aluminium sulphate | $Al_2(SO_4)_3 \cdot 18H_2O$ | | 10 % |
| Aluminium sulphate | $Al_2(SO_4)_3 \cdot 18H_2O$ | cold saturated | |
| Aluminium sulphate | $Al_2(SO_4)_3 \cdot 18H_2O$ | cold and hot saturated | |
| Ammonia | $NH_3$ | | |
| Ammonium alum | see aluminium ammonium sulphate | | |
| Ammonium bicarbonate | $NH_4HCO_3$ | | all concentrations |
| Ammonium bifluoride | $NH_4HF_2$ | cold saturated | |
| Ammonium carbonate | $(NH_4)_2CO_3 \cdot H_2O$ | cold saturated | |
| Ammonium carbonate | $(NH_4)_2CO_3 \cdot H_2O$ | hot saturated | |
| Ammonium chloride (sal ammoniac) | $NH_4Cl$ | | 10 % |
| Ammonium chloride (sal ammoniac) | $NH_4Cl$ | | 25 % |
| Ammonium chloride (sal ammoniac) | $NH_4Cl$ | | 50 % |
| Ammonium chloride (sal ammoniac) | $NH_4Cl$ | cold saturated | |
| Ammonium chloride (sal ammoniac) | $NH_4Cl$ | cold and hot saturated | |
| Ammonium chloride (sal ammoniac) | $NH_4Cl$ | cold saturated with copper and zinc chlorides | |

**Classification of NIROSTA®-/ASTM grades by group**

0 = resistant to general corrosion
1 = slight susceptibility to general corrosion
2 = low resistance to general corrosion
3 = no resistance to general corrosion
L = risk of pitting, crevice corrosion or stress-corrosion cracing

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **4000**/410 S | | | **4301**/304 | | | | |
| **4002**/405 | | | **4303**/(305) | **4401**/316 | | | |
| **4003**/A240… | | | **4306**/304 L | **4404**/316 L | | | |
| **4006**/410 | **4016**/430 | | **4307**/304 L | **4429**/316 LN | | | |
| **4021**/(420) | **4057**/431 | | **4310**/(301) | **4435**/316 L | | | |
| **4024**/(410) | **4120** | | **4311**/304 LN | **4436**/316 | | | |
| **4028**/(420) | **4305**/303 | | **4315**/304 N | **4438**/317 L | | | |
| **4031**/(420) | **4427**/316 F | | **4318**/301 LN | **4439** | | | |
| **4034**/(420) | **4509**/441 | | **4541**/321 | **4462** | | | |
| **4313** | **4510**/439 | **4113**/434 | **4544** | **4501** | | | |
| **4512**/409 | **4511** | **4521**/444 | **4546** | **4561**/316 Ti | | | |
| **4589** | **4520** | **4568**/631 | **4550**/347 | **4571**/316 Ti | **4465** | **4539** | **4565 S** |

| Temperature | Gr. 1 | Gr. 2 | Gr. 3 | Gr. 4 | Gr. 5 | 4465 | 4539 | 4565 S |
|---|---|---|---|---|---|---|---|---|
| 20 °C | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 3 | 2 | 1 | 1 | 0 | 0 | 0 | 0 |
| 20 °C | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 50 °C | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 90 °C | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 2 L | 1 L | 1 L | 1 L | 0 L | 0 L | 0 L | 0 |
| 20 °C | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | | | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| 750 °C | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| 20 °C | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | | | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | | | | 3 | 2 | 0 | 0 | 0 |
| 50 °C | | | | 2 L | 1 L | 0 L | 0 L | |
| 20 °C | | | | 3 L | 2 L | 2 L | 0 L | 0 |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 3 | 2 | 2 | 1 | 0 | 0 | 0 | 0 |
| 20 °C | 2 | 2 | 2 | 1 | 0 | 0 | 0 | 0 |
| boiling | 3 | 3 | 3 | 2 | 1 | 0 | 0 | 0 |
| 50 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 3 | 3 | 2 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 1 L | 0 L | 0 L | 0 L | 0 L | 0 L | 0 L | 0 L |
| boiling | 1 L | 1 L | 2 L | 1 L | 1 L | | | |
| boiling | | | | 2 L | 1 L | 1 L | 1 L | |
| 20 °C | | 0 L | 0 L | 0 L | 0 L | 0 L | 0 L | 0 |
| boiling | | | | 2 L | 1 L | 1 L | 1 L | |
| boiling | 3 L | 3 L | 3 L | 3 L | 3 L | | | |

# Chemical resistance of NIROSTA® steels



| Corrosive agent | Formula | Condition | Concentration |
|---|---|---|---|
| Ammonium hexachlorostannate (pink salt) | $(NH_4)_2(SnCl_6)$ | cold saturated | |
| Ammonium hexachlorostannate (pink salt) | $(NH_4)_2(SnCl_6)$ | | |
| Ammonium hydroxide | $NH_4OH$ | | all concentrations |
| Ammonium nitrate | $NH_4NO_3 \cdot 9H_2O$ | cold saturated | |
| Ammonium nitrate | $NH_4NO_3 \cdot 9H_2O$ | cold and hot saturated | |
| Ammonium oxalate | $(NH_4)_2C_2O_4 \cdot H_2O$ | cold and hot saturated | |
| Ammonium oxalate | $(NH_4)_2C_2O_4 \cdot H_2O$ | cold and hot saturated | |
| Ammonium perchlorate | $NH_4ClO_4$ | | 10 % |
| Ammonium perchlorate | $NH_4ClO_4$ | | |
| Ammonium sulphate | $(NH_4)_2SO_4$ | cold saturated | |
| Ammonium sulphate | $(NH_4)_2SO_4$ | cold saturated | |
| Ammonium sulphate | $(NH_4)_2SO_4$ | | with 5 % sulphuric acid |
| Ammonium sulphite | $(NH_4)_2SO_3$ | cold saturated | |
| Ammonium sulphite | $(NH_4)_2SO_3 \cdot H_2O$ | cold and hot saturated | |
| Aniline | $C_6H_5NH_2$ | | |
| Aniline hydrochloride | $C_6H_5NH_2HCl$ | | 5 % |
| Antichlor | see sodium thiosulphate, sodium perborate | | |
| Antimony | Sb | molten | |
| Antimony chloride | $SbCl_3$ | | |
| Aqua regia | $HCl + HNO_3$ | | |
| Aqueous ammonia | see ammonium hydroxide | | |
| Arsenic acid | $H_3AsO_4 \cdot 1/2H_2O$ | | all concentrations |
| Aspirin | see acetosalicylic acid | | |
| Atmosphere [1]) | | | |
| Barium chloride | $BaCl_2$ | fused | |
| Barium chloride | $BaCl_2 \cdot 2H_2O$ | saturated solution | |
| Barium chloride | $BaCl_2 \cdot 2H_2O$ | saturated solution | |
| Barium hydroxide | $Ba(OH)_2$ | cold saturated | |
| Barium hydroxide | $Ba(OH)_2$ | cold and hot saturated | |
| Barium nitrate | $Ba(NO_3)_2$ | | all concentrations |
| Beer [2]) | | | |
| Benzoic acid | $C_6H_5COOH$ | | all concentrations |
| Benzole | $C_6H_6$ | | |
| Bleach liquor | see sodium hypochlorite | | |
| Bleach solution | see chlorinated lime | | |
| Bleaching lye | see sodium hypochlorite | | |
| Blood [3]) | | | |
| Bonder's solution | see iron phosphate | | |
| Borax | see sodium tetraborate | | |
| Boric acid | $H_3BO_3$ | | all concentrations |
| Boric acid | $H_3BO_3$ | | all concentrations |

[1]) Corrosion by the atmosphere depends on the amounts of factory gases, sea water, volcanic gases etc. contained in the air. The corrosion rate will be higher in coastal areas or in the vicinity of factories than in non-industrial areas. The highest resistance to corrosion is only achieved with a polished surface and appropriate maintenance.

[2]) The taste of beer is not affected by contact with austenitic steels.

[3]) Pitting and crevice corrosion may occur in the presence of salt, especially with pigs' blood.

**Classification of NIROSTA®-/ASTM grades by group**

0 = resistant to general corrosion
1 = slight susceptibility to general corrosion
2 = low resistance to general corrosion
3 = no resistance to general corrosion
L = risk of pitting, crevice corrosion or stress-corrosion cracing

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **4000**/410 S | | | **4301**/304 | | | | |
| | **4002**/405 | | | **4303**/(305) | **4401**/316 | | | |
| | **4003**/A240... | | | **4306**/304 L | **4404**/316 L | | | |
| | **4006**/410 | **4016**/430 | | **4307**/304 L | **4429**/316 LN | | | |
| | **4021**/(420) | **4057**/431 | | **4310**/(301) | **4435**/316 L | | | |
| | **4024**/(410) | **4120** | | **4311**/304 LN | **4436**/316 | | | |
| | **4028**/(420) | **4305**/303 | | **4315**/304 N | **4438**/317 L | | | |
| | **4031**/(420) | **4427**/316 F | | **4318**/301 LN | **4439** | | | |
| | **4034**/(420) | **4509**/441 | | **4541**/321 | **4462** | | | |
| | **4313** | **4510**/439 | **4113**/434 | **4544** | **4501** | | | |
| | **4512**/409 | **4511** | **4521**/444 | **4546** | **4561**/316 Ti | | | |
| | **4589** | **4520** | **4568**/631 | **4550**/347 | **4571**/316 Ti | **4465** | **4539** | **4565 S** |
| Temperature | Gr. 1 | Gr. 2 | Gr. 3 | Gr. 4 | Gr. 5 | 4465 | 4539 | 4565 S |
| 20 °C | 2 L | 2 L | 1 L | 1 L | 0 L | | | |
| 60 °C | 3 L | 3 L | 3 L | 3 L | 3 L | | | |
| 20 °C and boiling | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 2 | 2 | 1 | 1 | 1 | 0 | 0 | 0 |
| 100 °C | 3 | 3 | 1 | 1 | 1 | 0 | 0 | 0 |
| 20 °C | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 3 L | 3 L | 3 L | 3 L | 3 L | 2 L | | |
| | | | | | | | | |
| 650 °C | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| 20 °C | 3 L | 3 L | 3 L | 3 L | 3 L | 3 L | | |
| 20 °C | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 |
| | | | | | | | | |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| fused | 3 | 3 | 3 | 3 | 3 | 3 | | |
| 20 °C | 1 L | 0 L | 0 L | 0 L | 0 L | 0 L | 0 L | 0 L |
| boiling | 2 L | 2 L | 1 L | 1 L | 0 L | 0 L | 0 L | 0 L |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C and 70 °C | | | | 0 | 0 | 0 | 0 | 0 |
| 20 °C and boiling | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C and boiling | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | 0 L | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| | | | | | | | | |
| 20 °C | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |

# Chemical resistance of NIROSTA® steels



| Corrosive agent | Formula | Condition | Concentration |
|---|---|---|---|
| Brandy [1]) | | | |
| Bromine | $Br_2$ | | |
| Bromine water | | | 0.03 % |
| Bromine water | | | 0.3 % |
| Bromine water | | | 1 % |
| Buttermilk | | | |
| Butyric acid | $C_3H_7COOH$ | | 100 % |
| Butyric acid | $C_3H_7COOH$ | | 100 % |
| Cadmium | Cd | | |
| Calcium bisulphite [2]) (sulphite lye) | $CaH_2(SO_3)_2$ | cold saturated | |
| Calcium bisulphite (sulphite lye) | $CaH_2(SO_3)_2$ | cold and hot saturated | |
| Calcium bisulphite (sulphite lye) | $CaH_2(SO_3)_2$ | 20 bar | |
| Calcium chloride | $CaCl_2 \cdot 6H_2O$ | cold saturated | |
| Calcium chloride | $CaCl_2 \cdot 6H_2O$ | cold saturated | |
| Calcium hydroxide (slaked lime) | $Ca(OH)_2$ | | |
| Calcium hydroxide (slaked lime) | $Ca(OH)_2$ | | |
| Calcium hypochloriste | $Ca(OCl)_2 \cdot 4H_2O$ | cold saturated | |
| Calcium sulphate | $CaSO_4$ | saturated | |
| Calcium sulphite | $CaSO_3$ | cold saturated | |
| Camphor | $C_{10}H_{16}O$ | | |
| Carbolic acid | see phenol | | |
| Carbon dioxide (carbonic acid) | $CO_2$ | dry | |
| Carbon dioxide (carbonic acid) | $CO_2$ | moist | |
| Carbon disulphide | $CS_2$ | | |
| Carbon tetrachloride [3]) | $CCl_4$ | anhydrous | |
| Carbon tetrachloride [3]) | $CCl_4$ | anhydrous | |
| Carnallite | $KClMgCl_2 \cdot 6H_2O$ | cold saturated | |
| Carnallite | $KClMgCl_2 \cdot 6H_2O$ | cold and hot saturated | |
| Caustic potash solution | see potassium hydroxide | | |
| Caustic soda solution | see sodium hydroxide | | |
| Cheese | | | |
| Chloramine-T | see p-toluene sodium sulfonchloramide | | |
| Chloric acid | $HClO_3$ | | concentrated |
| Chlorinated lime | $[3CaCl(OCl) \cdot Ca(OH)_2] \cdot 5H_2O$ | dry | |
| Chlorinated lime | $[3CaCl(OCl) \cdot Ca(OH)_2] \cdot 5H_2O$ | moist | |
| Chlorinated lime (bleach solution) | $[3CaCl(OCl) \cdot Ca(OH)_2] \cdot 5H_2O$ | | 2.5 g Cl/l |
| Chlorine (damp gas) | $Cl_2$ | | |
| Chlorine (damp gas) | $Cl_2$ | | |
| Chlorine (dry gas) | $Cl_2$ | | |
| Chlorine water | cold water saturated with chlorine | | |
| Chloroacetic acid | see mono-and trichloroacetic acid | | |

[1]) In individual cases of prolonged exposure, the taste may be affected.
[2]) Enhanced concentrations on condensation in steam rooms can lead to corrosive attack.
[3]) Even if only traces of hydrochloric acid (HCl) are formed by moisture, there is a danger of pitting, crevice and stress corrosion cracking.

**Classification of NIROSTA®-/ASTM grades by group**

0 = resistant to general corrosion
1 = slight susceptibility to general corrosion
2 = low resistance to general corrosion
3 = no resistance to general corrosion
L = risk of pitting, crevice corrosion or stress-corrosion cracing

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **4000**/410 S | | | **4301**/304 | | | | |
| **4002**/405 | | | **4303**/(305) | **4401**/316 | | | |
| **4003**/A240… | | | **4306**/304 L | **4404**/316 L | | | |
| **4006**/410 | **4016**/430 | | **4307**/304 L | **4429**/316 LN | | | |
| **4021**/(420) | **4057**/431 | | **4310**/(301) | **4435**/316 L | | | |
| **4024**/(410) | **4120** | | **4311**/304 LN | **4436**/316 | | | |
| **4028**/(420) | **4305**/303 | | **4315**/304 N | **4438**/317 L | | | |
| **4031**/(420) | **4427**/316 F | | **4318**/301 LN | **4439** | | | |
| **4034**/(420) | **4509**/441 | | **4541**/321 | **4462** | | | |
| **4313** | **4510**/439 | **4113**/434 | **4544** | **4501** | | | |
| **4512**/409 | **4511** | **4521**/444 | **4546** | **4561**/316 Ti | | | |
| **4589** | **4520** | **4568**/631 | **4550**/347 | **4571**/316 Ti | **4465** | **4539** | **4565 S** |

| Temperature | Gr. 1 | Gr. 2 | Gr. 3 | Gr. 4 | Gr. 5 | 4465 | 4539 | 4565 S |
|---|---|---|---|---|---|---|---|---|
| 20 °C and boiling | | | | 0 | 0 | 0 | 0 | 0 |
| 20 °C and boiling | 3 L | 3 L | 3 L | 3 L | 3 L | 3 L | 3 L | |
| 20 °C | | | | 0 L | 0 L | | | |
| 20 °C | | | | 1 L | 1 L | | | |
| 20 °C | | | | 3 L | 3 L | | | |
| 20 °C | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 2 | 2 | | 1 | 0 | 0 | 0 | 0 |
| molten | | | | 2 | 2 | | | |
| 20 °C | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 3 | 3 | 2 | 2 | 0 | 0 | 0 | 0 |
| 200 °C | 3 | 3 | 3 | 3 | 0 | 0 | 0 | 0 |
| 20 °C | | | | 0 L | 0 L | 0 L | 0 L | 0 |
| boiling | | | | 1 L | 1 L | 0 L | 0 L | 0 L |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | | | | 0 | 0 | 0 | 0 | 0 |
| up to 40 °C | | | | 2 L | 1 L | 0 L | 0 L | |
| 20 °C | | | | 0 | 0 | 0 | 0 | 0 |
| 20 °C | | | | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| hot | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| hot | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 2 L | 2 L | | | | 0 L | 0 L | 0 |
| boiling | 3 L | 3 L | 1 L | 1 L | 1 L | 0 L | 0 L | 0 L |
| | | | | | | | | |
| | | | | | | | | |
| 20 °C | | | | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| 20 °C | | | | 3 L | 3 L | 1 L | | |
| 20 °C | | | | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 3 L | 3 L | 2 L | 1 L | 1 L | 0 L | 0 L | |
| 20 °C | 3 L | 3 L | 2 L | 1 L | 0 L | 0 L | 0 L | |
| 20 °C | 3 L | 3 L | 3 L | 3 L | 3 L | | | |
| 100 °C | 3 L | 3 L | 3 L | 3 L | 3 L | | | |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 3 L | 3 L | 3 L | 1 L | 1 L | 0 L | 0 L | |
| | | | | | | | | |

# Chemical resistance of NIROSTA® steels



| Corrosive agent | Formula | Condition | Concentration |
|---|---|---|---|
| Chlorobenzene [1]) | $C_6H_5Cl$ | dry | |
| Chlorobenzene [1]) | $C_6H_5Cl$ | dry | |
| Chloroform [1]) | $CHCl_3$ | anhydrous | |
| Chlorosulphonic acid | $HSO_3Cl$ | | 10 % |
| Chlorosulphonic acid | $HSO_3Cl$ | | 100 % |
| Chocolate | | | |
| Chrome alum | see potassium chrome sulphate | | |
| Chrome sulphate | $Cr_2(SO_4)_3 \cdot 18H_2O$ | saturated | |
| Chromic acid | $CrO_3$ | | 10 % pure, free of $SO_3$ |
| Chromic acid | $CrO_3$ | | 10 % pure, free of $SO_3$ |
| Chromic acid | $CrO_3$ | | 50 % pure, free of $SO_3$ |
| Chromic acid | $CrO_3$ | | 50 % pure, free of $SO_3$ |
| Chromic acid | $CrO_3$ | | 50 % tech., containing $SO_3$ |
| Chromic acid | $CrO_3$ | | 50 % tech., containing $SO_3$ |
| Cider | | | |
| Citric acid | $HOC(CH_2COOH)_2COOH \cdot H_2O$ | | 1% |
| Citric acid | $HOC(CH_2COOH)_2COOH \cdot H_2O$ | | 1% |
| Citric acid | $HOC(CH_2COOH)_2COOH \cdot H_2O$ | | 10 % |
| Citric acid | $HOC(CH_2COOH)_2COOH \cdot H_2O$ | | 10 % |
| Citric acid | $HOC(CH_2COOH)_2COOH \cdot H_2O$ | | 25 % |
| Citric acid | $HOC(CH_2COOH)_2COOH \cdot H_2O$ | | 25 % |
| Citric acid | $HOC(CH_2COOH)_2COOH \cdot H_2O$ | | 50 % |
| Citric acid | $HOC(CH_2COOH)_2COOH \cdot H_2O$ | | 50 % |
| Citric acid | $HOC(CH_2COOH)_2COOH \cdot H_2O$ | 3 bar | 5 % |
| Coffee | | | |
| Copper acetate | $(CH_3COO)_2Cu \cdot H_2O$ | cold saturated | |
| Copper acetate | $(CH_3COO)_2Cu \cdot H_2O$ | cold and hot saturated | |
| Copper carbonate | $CuCO_3Cu(OH)_2$ | | all concentrations |
| Copper chloride | $CuCl_2 \cdot 2H_2O$ | cold saturated | |
| Copper cyanide | $Cu(CN)_2$ | hot saturated | |
| Copper nitrate | $Cu(NO_3)_2 \cdot 3H_2O$ | | 50 % |
| Copper nitrate | $Cu(NO_3)_2 \cdot 3H_2O$ | | 50 % |
| Copper sulphate | $CuSO_4 \cdot 5H_2O$ | | all concentrations |
| Copper sulphate (blue vitriol + 3% $H_2SO_4$) | $CuSO_4 \cdot 5H_2O$ | | |
| Copper sulphate (blue vitriol + 3% $H_2SO_4$) | $CuSO_4 \cdot 5H_2O$ | | |
| Creosote | | | |
| Creosote | | | |
| Cresol | $CH_3C_6H_4(OH)$ | | |
| Crude oil | | | |
| Developer | see photographic developer | | |
| Dichloroethane [1]) | $CH_2ClCH_2Cl$ | anhydrous | |

[1]) Even if only traces of hydrochloric acid (HCl) are formed by moisture, there is a danger of pitting, crevice and stress corrosion cracking.

**Classification of NIROSTA®-/ASTM grades by group**

0 = resistant to general corrosion
1 = slight susceptibility to general corrosion
2 = low resistance to general corrosion
3 = no resistance to general corrosion
L = risk of pitting, crevice corrosion or stress-corrosion cracing

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **4000**/410 S | | | **4301**/304 | | | | |
| **4002**/405 | | | **4303**/(305) | **4401**/316 | | | |
| **4003**/A240… | | | **4306**/304 L | **4404**/316 L | | | |
| **4006**/410 | **4016**/430 | | **4307**/304 L | **4429**/316 LN | | | |
| **4021**/(420) | **4057**/431 | | **4310**/(301) | **4435**/316 L | | | |
| **4024**/(410) | **4120** | | **4311**/304 LN | **4436**/316 | | | |
| **4028**/(420) | **4305**/303 | | **4315**/304 N | **4438**/317 L | | | |
| **4031**/(420) | **4427**/316 F | | **4318**/301 LN | **4439** | | | |
| **4034**/(420) | **4509**/441 | | **4541**/321 | **4462** | | | |
| **4313** | **4510**/439 | **4113**/434 | **4544** | **4501** | | | |
| **4512**/409 | **4511** | **4521**/444 | **4546** | **4561**/316 Ti | | | |
| **4589** | **4520** | **4568**/631 | **4550**/347 | **4571**/316 Ti | **4465** | **4539** | **4565 S** |

| Temperature | Gr. 1 | Gr. 2 | Gr. 3 | Gr. 4 | Gr. 5 | 4465 | 4539 | 4565 S |
|---|---|---|---|---|---|---|---|---|
| 20 °C | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 3 | 2 | 2 | 0 | 0 | 0 | 0 | 0 |
| 20 °C and boiling | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 3 L | 3 L | 3 L | 3 L | 3 L | | | |
| 20 °C | 3 L | 3 L | | 0 L | 0 L | | | |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| 20 °C | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 3 | 3 | | 1 | 1 | 0 | | |
| 20 °C | 3 | 3 | 2 | 1 | 1 | 0 | | |
| boiling | 3 | 3 | 3 | 2 | 2 | 2 | 2 | |
| 20 °C | 3 | 3 | 2 | 1 | 1 | | | |
| boiling | 3 | 3 | 3 | 3 | 3 | 2 | 2 | |
| 20 °C | | | | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 3 | 3 | 2 | 2 | 0 | 0 | 0 | 0 |
| 20 °C | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 3 | 3 | 2 | 2 | 1 | 0 | 0 | 0 |
| 140 °C | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| 20 °C and boiling | | | | 0 | 0 | 0 | 0 | 0 |
| 20 °C | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 3 L | 3 L | 3 L | 3 L | 3 L | 2 L | 2 L | 0 L |
| boiling | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C and boiling | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| 20 °C | | | | 0 | 0 | 0 | 0 | 0 |

# Chemical resistance of NIROSTA® steels



| Corrosive agent | Formula | Condition | Concentration |
|---|---|---|---|
| Dichloroethylene [1]) | CHClCHCl | anhydrous | |
| Disulphur dichloride [1]) | $S_2Cl_2$ | anhydrous | |
| Disulphur dichloride [1]) | $S_2Cl_2$ | anhydrous | |
| Dripping | | | |
| Dye bath (alkaline or neutral) | | | |
| Dye bath (organic acid) | | | |
| Dye bath (organic acid) | | | |
| Dye bath (strong sulphuric acid or organic + strong sulphuric acid) ($H_2SO_4$ more than 1%) | | | |
| Dye bath (strong sulphuric acid or organic + strong sulphuric acid) ($H_2SO_4$ more than 1%) | | | |
| Dye bath (weak sulphuric acid or organic + sulphuric acid) ($H_2SO_4$ less than 1%) | | | |
| Dye bath (weak sulphuric acid or organic + sulphuric acid) ($H_2SO_4$ less than 1%) | | | |
| Epsom salts | see magnesium sulphate | | |
| Ethyl chloride [1]) | $C_2H_5Cl$ | anhydrous | |
| Ethyl ether | $(C_2H_5)_2O$ | | |
| Ethyl glycol | $CH_2OHCH_2OH$ | | |
| Ethylalcohol (spirit) | $C_2H_5OH$ | | all concentrations |
| Ethylene chloride | see dichloroethane | | |
| Fatty acid (oleic acid) + traces of $H_2SO_4$ | $C_{17}H_{33}COOH$ | | |
| Fatty acid (oleic acid) | $C_{17}H_{33}COOH$ | 30 bar | technical |
| Fatty acid (oleic acid) | $C_{17}H_{33}COOH$ | 30 bar | technical |
| Fatty acid (oleic acid) | $C_{17}H_{33}COOH$ | 30 bar | technical |
| Fatty acid (oleic acid) | $C_{17}H_{33}COOH$ | 30 bar | technical |
| Ferric chloride | $FeCl_3$ | | 30 % |
| Ferric chloride | $FeCl_3$ | | 50 % |
| Ferric nitrate | $Fe(NO_3)_3 \cdot 9H_2O$ | | all concentrations |
| Ferric sulphate [2]) | $Fe_2(SO_4)_3$ | | 10 % |
| Ferric sulphate [2]) | $Fe_2(SO_4)_3$ | | 10 % |
| Ferrous sulphate | $FeSO_4 \cdot 7H_2O$ | | all concentrations |
| Fixing salt | see photographic fixing bath | | |
| Fluosilicic acid | $H_2SiF_6$ | vapours | |
| Formaldehyde (formalin = methyl aldehyde) | HCHO | | 40 % |
| Formic acid | HCOOH | | 10 % |
| Formic acid | HCOOH | | 10 % |
| Formic acid | HCOOH | | 10 % |
| Formic acid | HCOOH | | 50 % |
| Formic acid | HCOOH | | 50 % |
| Formic acid | HCOOH | | 50 % |

[1]) Even if only traces of hydrochloric acid (HCl) are formed by moisture, there is a danger of pitting, crevice and stress corrosion cracking.
[2]) Can sometimes prevent austenitic chrome-nickel steels from being attacked by sulphuric acid.

**Classification of NIROSTA®-/ASTM grades by group**

0 = resistant to general corrosion
1 = slight susceptibility to general corrosion
2 = low resistance to general corrosion
3 = no resistance to general corrosion
L = risk of pitting, crevice corrosion or stress-corrosion cracing

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **4000**/410 S | | | **4301**/304 | | | | |
| | **4002**/405 | | | **4303**/(305) | **4401**/316 | | | |
| | **4003**/A240... | | | **4306**/304 L | **4404**/316 L | | | |
| | **4006**/410 | **4016**/430 | | **4307**/304 L | **4429**/316 LN | | | |
| | **4021**/(420) | **4057**/431 | | **4310**/(301) | **4435**/316 L | | | |
| | **4024**/(410) | **4120** | | **4311**/304 LN | **4436**/316 | | | |
| | **4028**/(420) | **4305**/303 | | **4315**/304 N | **4438**/317 L | | | |
| | **4031**/(420) | **4427**/316 F | | **4318**/301 LN | **4439** | | | |
| | **4034**/(420) | **4509**/441 | | **4541**/321 | **4462** | | | |
| | **4313** | **4510**/439 | **4113**/434 | **4544** | **4501** | | | |
| | **4512**/409 | **4511** | **4521**/444 | **4546** | **4561**/316 Ti | | | |
| | **4589** | **4520** | **4568**/631 | **4550**/347 | **4571**/316 Ti | **4465** | **4539** | **4565 S** |
| Temperature | Gr. 1 | Gr. 2 | Gr. 3 | Gr. 4 | Gr. 5 | 4465 | 4539 | 4565 S |
| boiling | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 2 | 2 | 2 | 0 | 0 | | | |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C and boiling | | | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | | | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | | | 1 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | | | 1 | 1 | 0 | 0 | 0 | 0 |
| boiling | | | 1 | 1 | 1 | 0 | 0 | 0 |
| 20 °C | | | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | | | 1 | 1 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| boiling | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C and boiling | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| hot | | | 3 | 2 | 1 | 0 | 0 | 0 |
| 150 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 180 °C | 2 | 2 | 1 | 1 | 0 | 0 | 0 | 0 |
| 235 °C | 3 | 2 | 2 | 1 | 0 | 0 | 0 | 0 |
| 300 °C | 3 | 3 | 2 | 2 | 0 | 0 | 0 | 0 |
| 20 °C | 3 L | 3 L | 3 L | 3 L | 2 L | 1 L | 1 L | 0 |
| 50 °C | 3 L | 3 L | 3 L | 3 L | 3 L | | | |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| 100 °C | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 |
| 20 °C and boiling | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 70 °C | 3 | 2 | 1 | 1 | 0 | 0 | 0 | 0 |
| boiling | 3 | 3 | 2 | 2 | 1 | 0 | 0 | 0 |
| 20 °C | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 70 °C | 3 | 2 | 1 | 2 | 1 | 0 | 0 | 0 |
| boiling | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 |

# Chemical resistance of NIROSTA® steels



| Corrosive agent | Formula | Condition | Concentration |
|---|---|---|---|
| Formic acid | HCOOH | | 80 % |
| Formic acid | HCOOH | | 80 % |
| Formic acid | HCOOH | | 100 % |
| Formic acid | HCOOH | | 100 % |
| Fruit juices and fruit acids | | | |
| Fruit pulp (containing $SO_2$) | | | |
| Gallic acid | $C_6H_2(OH)_3COOH$ | saturated | |
| Gallic acid | $C_6H_2(OH)_3COOH$ | hot saturated | |
| Glacial acetic acid | | | 100 % |
| Glacial acetic acid | | | 100 % |
| Glauber's salt | see sodium sulphate | | |
| Glue (also acid) | | | |
| Glycerine | $C_3H_5(OH)_3$ | concentrated | |
| Hydrazine sulphate | $(NH_2)_2 \cdot H_2SO_4$ | | 10 % |
| Hydrochloric acid | gas, see hydrogen chloride gas | | |
| Hydrochloric acid | HCl | | 0.50 % |
| Hydrochloric acid | HCl | | 0.50 % |
| Hydrocyanic acid | HCN | | |
| Hydrofluoric acid | HF | | 40 % |
| Hydrogen chloride gas | HCl | | |
| Hydrogen chloride gas | HCl | | |
| Hydrogen chloride gas | HCl | | |
| Hydrogen chloride gas | HCl | | |
| Hydrogen fluoride | HF | dry gaseous | |
| Hydrogen peroxide [2]) | $H_2O_2$ | | |
| Hydrogen sulphide | $H_2S$ | dry | < 4 % |
| Hydrogen sulphide | $H_2S$ | | < 4 % |
| Hydrogen sulphide | $H_2S$ | | < 4 % |
| Hydrogen sulphide | $H_2S$ | moist | < 4 % |
| Hydroxylamine sulphate | $(NH_2OH)_2 \cdot H_2SO_4$ | | 10 % |
| Industrial air | see atmosphere | | |
| Ink | see iron gallate ink | | |
| Iodine | $J_2$ | dry | |
| Iodine | $J_2$ | moist | |
| Iodoform [3]) | $CHI_3$ | vapour | |
| Iron gallate ink [4]) | | | |
| Iron phosphate [5]) | | | |
| Lactic acid | $CH_3CH(OH)COOH$ | | 2 % |
| Lactic acid | $CH_3CH(OH)COOH$ | | 2 % |
| Lactic acid | $CH_3CH(OH)COOH$ | | 10 % |
| Lactic acid | $CH_3CH(OH)COOH$ | | 10 % |

[1]) Discolouring of the pulp.
[2]) At 20 °C there is no corrosive, catalytic influence. This starts at temperatures above 80 °C.
[3]) Even if only traces of hydrogen iodide (HI) are formned by moisture, there is a danger of pitting and crevice corrosion.
[4]) Take care with inks containing salts.
[5]) Solution by Bonder's process.

**Classification of NIROSTA®-/ASTM grades by group**

0 = resistant to general corrosion
1 = slight susceptibility to general corrosion
2 = low resistance to general corrosion
3 = no resistance to general corrosion
L = risk of pitting, crevice corrosion or stress-corrosion cracing

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **4000**/410 S | | | **4301**/304 | | | | |
| **4002**/405 | | | **4303**/(305) | **4401**/316 | | | |
| **4003**/A240... | | | **4306**/304 L | **4404**/316 L | | | |
| **4006**/410 | **4016**/430 | | **4307**/304 L | **4429**/316 LN | | | |
| **4021**/(420) | **4057**/431 | | **4310**/(301) | **4435**/316 L | | | |
| **4024**/(410) | **4120** | | **4311**/304 LN | **4436**/316 | | | |
| **4028**/(420) | **4305**/303 | | **4315**/304 N | **4438**/317 L | | | |
| **4031**/(420) | **4427**/316 F | | **4318**/301 LN | **4439** | | | |
| **4034**/(420) | **4509**/441 | | **4541**/321 | **4462** | | | |
| **4313** | **4510**/439 | **4113**/434 | **4544** | **4501** | | | |
| **4512**/409 | **4511** | **4521**/444 | **4546** | **4561**/316 Ti | | | |
| **4589** | **4520** | **4568**/631 | **4550**/347 | **4571**/316 Ti | **4465** | **4539** | **4565 S** |
| Temperature | Gr. 1 | Gr. 2 | Gr. 3 | Gr. 4 | Gr. 5 | 4465 | 4539 | 4565 S |
| 20 °C | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 |
| 20 °C | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 3 | 3 | 2 | 2 | 1 | 0 | 0 | 0 |
| 20 °C and boiling | | | | 0 | 0 | 0 | 0 | 0 |
| | | 1 [1]) | | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 3 | 2 | 2 | 1 | 1 | 0 | 0 | 0 |
| | | | | | | | | |
| boiling | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C and boiling | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | | | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| 20 °C | 3 L | 2 L | 2 L | 1 L | 1 L | 0 L | 0 L | 0 |
| boiling | 3 L | 3 L | 3 L | 3 L | 3 L | 1 L | 1 L | 1 L |
| 20 °C | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 3 | 3 | 3 | 3 | 3 | | | |
| 20 °C | 3 L | 2 L | | 1 L | 1 L | | | |
| 50 °C | 3 L | 2 L | 1 L | 1 L | 1 L | | | |
| 100 °C | 3 L | 3 L | 2 L | 2 L | 1 L | | | |
| 400 °C | 3 | 3 | 3 | 3 | 3 | | | |
| 100 °C | 3 | 3 | 1 | 1 | 1 | | | |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 100 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| < 400 °C | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 0 |
| | 3 | 3 | 1 | 0 | 0 | 0 | 0 | 0 |
| 20 °C and boiling | | | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| | | | | | | | | |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 2 L | 2 L | 1 L | 1 L | 0 L | 0 L | 0 L | 0 L |
| 20 °C and 60 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 1 L | 0 L | 0 L | 0 L | 0 | 0 | 0 | 0 |
| 98 °C | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 3 | 3 | 2 | 1 | 0 | 0 | 0 | 0 |

# Chemical resistance of NIROSTA® steels



| Corrosive agent | Formula | Condition | Concentration |
|---|---|---|---|
| Lactic acid | $CH_3CH(OH)COOH$ | | 80 % |
| Lactic acid | $CH_3CH(OH)COOH$ | | 80 % |
| Lactic acid | $CH_3CH(OH)COOH$ | | concentrated |
| Lactic acid | $CH_3CH(OH)COOH$ | | concentrated |
| Lead [1]) | Pb | | molten |
| Lead acetate (sugar of lead) | $Pb(CH_3COO)_2 \cdot 3H_2O$ | | all concentrations |
| Lead acetate (sugar of lead) | $Pb(CH_3COO)_2 \cdot 3H_2O$ | | all concentrations |
| Lead nitrate | $Pb(NO_3)_2$ | | |
| Lemon juice | | | |
| Linseed oil (+3% $H_2SO_4$) | | | |
| Linseed oil (+3% $H_2SO_4$) | | | |
| Liqueurs | | | |
| Lubricating oils | see oil | | |
| Lysoform | | | |
| Lysol | | | |
| Magnesium carbonate | $MgCO_3$ | | all concentrations |
| Magnesium chloride | $MgCl_2 \cdot 6H_2O$ | | 10 % |
| Magnesium chloride | $MgCl_2 \cdot 6H_2O$ | | 30 % |
| Magnesium sulphate (Epsom salts) | $MgSO_4 \cdot 7H_2O$ | cold saturated | |
| Magnesium sulphate (Epsom salts) | $MgSO_4 \cdot 7H_2O$ | cold and hot saturated | |
| Maleic acid | $(CHCOOH)_2$ | | 50 % |
| Malic acid | $COOHCH_2CHOHCOOH$ | | up to 50 % |
| Malic acid | $COOHCH_2CHOHCOOH$ | | up to 50 % |
| Malic acid | $COOHCH_2CHOHCOOH$ | | up to 50 % |
| Manganese chloride | $MnCl_2 \cdot 4H_2O$ | | 10 % |
| Manganese chloride | $MnCl_2 \cdot 4H_2O$ | | 50 % |
| Manganese sulphate | $MnSO_4 \cdot 7H_2O$ | | |
| Meat | | | |
| Mercuric acetate | $Hg(CH_3COO)_2$ | cold saturated | |
| Mercuric acetate | $Hg(CH_3COO)_2$ | hot saturated | |
| Mercuric chloride | $HgCl_2$ (sublimate) | | 0.10 % |
| Mercuric chloride | $HgCl_2$ (sublimate) | | 0.10 % |
| Mercuric chloride | $HgCl_2$ (sublimate) | | 0.70 % |
| Mercuric chloride | $HgCl_2$ (sublimate) | | 0.70 % |
| Mercurous nitrate | $(HgNO_3)_2 \cdot 2H_2O$ | | all concentrations |
| Mercury | Hg | | |
| Mercury cyanide | $Hg(CN)_2$ | | all concentrations |
| Methyl alcohol | $CH_3OH$ | | all concentrations |
| Methyl aldehyde | see formaldehyde | | |
| Methyl chloride [2]) | $CH_3Cl$ | anhydrous | |
| Methylene chloride [2]) | $CH_2Cl_2$ | anhydrous | |

[1]) Iron or iron alloys are not attacked by lead. Even high-alloy steels are, however, attacked by lead oxide at points exposed to the atmoshere.
[2]) Even if only traces of hydrochloric acid (HCl) are formed by moisture, there is a danger of pitting, crevice and stress corrosion cracking.

**Classification of NIROSTA®-/ASTM grades by group**

0 = resistant to general corrosion
1 = slight susceptibility to general corrosion
2 = low resistance to general corrosion
3 = no resistance to general corrosion
L = risk of pitting, crevice corrosion or stress-corrosion cracing

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **4000**/410 S | | | **4301**/304 | | | | |
| | **4002**/405 | | | **4303**/(305) | **4401**/316 | | | |
| | **4003**/A240… | | | **4306**/304 L | **4404**/316 L | | | |
| | **4006**/410 | **4016**/430 | | **4307**/304 L | **4429**/316 LN | | | |
| | **4021**/(420) | **4057**/431 | | **4310**/(301) | **4435**/316 L | | | |
| | **4024**/(410) | **4120** | | **4311**/304 LN | **4436**/316 | | | |
| | **4028**/(420) | **4305**/303 | | **4315**/304 N | **4438**/317 L | | | |
| | **4031**/(420) | **4427**/316 F | | **4318**/301 LN | **4439** | | | |
| | **4034**/(420) | **4509**/441 | | **4541**/321 | **4462** | | | |
| | **4313** | **4510**/439 | **4113**/434 | **4544** | **4501** | | | |
| | **4512**/409 | **4511** | **4521**/444 | **4546** | **4561**/316 Ti | | | |
| | **4589** | **4520** | **4568**/631 | **4550**/347 | **4571**/316 Ti | **4465** | **4539** | **4565 S** |
| Temperature | Gr. 1 | Gr. 2 | Gr. 3 | Gr. 4 | Gr. 5 | 4465 | 4539 | 4565 S |
| 20 °C | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |
| 20 °C | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |
| 600 °C | | | | 1 | | | | |
| 20 °C | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | | | | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 200 °C | | | 1 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| boiling | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 2 L | 1 L | 0 L | 0 L | 0 L | 0 L | 0 L | 0 |
| 20 °C | 2 L | 1 L | 0 L | 0 L | 0 L | 0 L | 0 L | 0 |
| 20 °C | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | | | | 0 | 0 | 0 | 0 | 0 |
| 100 °C | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 60 °C | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 0 |
| 100 °C | 3 | 3 | 2 | 1 | 0 | 0 | 0 | 0 |
| boiling | | | | 0 L | 0 L | 0 L | 0 L | 0 L |
| boiling | | | | 0 | 0 L | 0 L | 0 L | 0 L |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 2 L | 1 L | 0 L | 0 L | 0 L | 0 | 0 | 0 |
| boiling | 3 L | 2 L | 1 L | 1 L | 0 L | 0 L | 0 L | 0 |
| 20 °C | 2 L | 2 L | 1 L | 1 L | 1 L | 0 | 0 | 0 |
| boiling | 3 L | 3 L | 2 L | 2 L | 2 L | 1 L | 0 L | 0 L |
| boiling | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C and 50 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 2 | 2 | | 0 | 0 | 0 | 0 | 0 |
| 20 °C and 65 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| boiling | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

# Chemical resistance of NIROSTA® steels



| Corrosive agent | Formula | Condition | Concentration |
|---|---|---|---|
| Milk | | fresh | |
| Milk | | sour | |
| Milk of lime | see calcium hydroxide | | |
| Mixed acids (nitrating acids) | | | 50 % $H_2SO_4$ + 50 % $HNO_3$ |
| Mixed acids (nitrating acids) | | | 50 % $H_2SO_4$ + 50 % $HNO_3$ |
| Mixed acids (nitrating acids) | | | 50 % $H_2SO_4$ + 50 % $HNO_3$ |
| Mixed acids (nitrating acids) | | | 75 % $H_2SO_4$ + 25 % $HNO_3$ |
| Mixed acids (nitrating acids) | | | 75 % $H_2SO_4$ + 25 % $HNO_3$ |
| Mixed acids (nitrating acids) | | | 75 % $H_2SO_4$ + 25 % $HNO_3$ |
| Mixed acids (nitrating acids) | | | 20 % $H_2SO_4$ + 15 % $HNO_3$ |
| Mixed acids (nitrating acids) | | | 20 % $H_2SO_4$ + 15 % $HNO_3$ |
| Mixed acids (nitrating acids) | | | 70 % $H_2SO_4$ + 10 % $HNO_3$ |
| Mixed acids (nitrating acids) | | | 70 % $H_2SO_4$ + 10 % $HNO_3$ |
| Mixed acids (nitrating acids) | | | 70 % $H_2SO_4$ + 10 % $HNO_3$ |
| Mixed acids (nitrating acids) | | | 30 % $H_2SO_4$ + 5 % $HNO_3$ |
| Mixed acids (nitrating acids) | | | 30 % $H_2SO_4$ + 5 % $HNO_3$ |
| Mixed acids (nitrating acids) | | | 15 % $H_2SO_4$ + 5 % $HNO_3$ |
| Mixed acids (nitrating acids) | | | 2 % $H_2SO_4$ + 1 % $HNO_3$ |
| Monochloracetic acid | $CH_2ClCOOH$ | | 50 % |
| Mustard | | | |
| Nickel chloride | $NiCl_2 \cdot 6H_2O$ | cold saturated | |
| Nickel nitrate | $Ni(NO_3)_2 \cdot 6H_2O$ | cold saturated | |
| Nickel sulphate | $NiSO_4 \cdot 7H_2O$ | cold saturated | |
| Nitrating acid | see mixed acids | | |
| Nitric acid | $HNO_3$ | | 7 % |
| Nitric acid | $HNO_3$ | | 7 % |
| Nitric acid | $HNO_3$ | | 10 % |
| Nitric acid | $HNO_3$ | | 10 % |
| Nitric acid | $HNO_3$ | | 25 % |
| Nitric acid | $HNO_3$ | | 25 % |
| Nitric acid | $HNO_3$ | | 37 % |
| Nitric acid | $HNO_3$ | | 37 % |
| Nitric acid | $HNO_3$ | | 50 % |
| Nitric acid | $HNO_3$ | | 50 % |
| Nitric acid | $HNO_3$ | | 66 % |
| Nitric acid | $HNO_3$ | | 66 % |
| Nitric acid | $HNO_3$ | | 99 % (high concentration) |
| Nitric acid | $HNO_3$ | | 99 % (high concentration) |
| Nitrosylsulphuric acid 60° Bé with 4 – 5 % nitro content | | | |
| Nitrosylsulphuric acid 60° Bé with 4 – 5 % nitro content | | | |
| Nitrous acid | $HNO_2$ | | concentrated |

**Classification of NIROSTA®-/ASTM grades by group**

0 = resistant to general corrosion
1 = slight susceptibility to general corrosion
2 = low resistance to general corrosion
3 = no resistance to general corrosion
L = risk of pitting, crevice corrosion or stress-corrosion cracing

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **4000**/410 S | | | **4301**/304 | | | | |
| **4002**/405 | | | **4303**/(305) | **4401**/316 | | | |
| **4003**/A240... | | | **4306**/304 L | **4404**/316 L | | | |
| **4006**/410 | **4016**/430 | | **4307**/304 L | **4429**/316 LN | | | |
| **4021**/(420) | **4057**/431 | | **4310**/(301) | **4435**/316 L | | | |
| **4024**/(410) | **4120** | | **4311**/304 LN | **4436**/316 | | | |
| **4028**/(420) | **4305**/303 | | **4315**/304 N | **4438**/317 L | | | |
| **4031**/(420) | **4427**/316 F | | **4318**/301 LN | **4439** | | | |
| **4034**/(420) | **4509**/441 | | **4541**/321 | **4462** | | | |
| **4313** | **4510**/439 | **4113**/434 | **4544** | **4501** | | | |
| **4512**/409 | **4511** | **4521**/444 | **4546** | **4561**/316 Ti | | | |
| **4589** | **4520** | **4568**/631 | **4550**/347 | **4571**/316 Ti | **4465** | **4539** | **4565 S** |

| Temperature | Gr. 1 | Gr. 2 | Gr. 3 | Gr. 4 | Gr. 5 | 4465 | 4539 | 4565 S |
|---|---|---|---|---|---|---|---|---|
| up to 70 °C | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| up to 70 °C | | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| 50 °C | 3 | 2 | 1 | 0 | 0 | 0 | 0 | 0 |
| 90 °C | 3 | 3 | 2 | 1 | 1 | | | |
| 120 °C | 3 | 3 | 3 | 2 | 2 | | | |
| 50 °C | 3 | 2 | 1 | 1 | 0 | 0 | 0 | 0 |
| 90 °C | 3 | 3 | 1 | 1 | 1 | | | |
| 157 °C | 3 | 3 | 3 | 3 | 3 | | | |
| 50 °C | 3 | 3 | 1 | 0 | 0 | 0 | 0 | 0 |
| 80 °C | 3 | 3 | 2 | 1 | 0 | 0 | 0 | 0 |
| 50 °C | 3 | 3 | 1 | 0 | 0 | 0 | 0 | 0 |
| 90 °C | 3 | 3 | 3 | 1 | 0 | 0 | 0 | 0 |
| 168 °C | 3 | 3 | 3 | 3 | 3 | | | |
| 90 °C | 3 | 3 | 1 | 0 | 0 | 0 | 0 | 0 |
| 110 °C | 3 | 3 | 2 | 1 | 0 | 0 | 0 | 0 |
| 134 °C | 3 | 3 | 2 | 1 | 1 | | | |
| boiling | 3 | 3 | 2 | 2 | 0 | 0 | 0 | 0 |
| 20 °C | 3 L | 3 L | 2 L | 1 L | 1 L | 0 L | 0 L | |
| 20 °C | 2 L | 0 L | 0 L | 0 L | 0 L | 0 | 0 | 0 |
| 20 °C | | | | 1 L | 1 L | 0 L | 0 L | 0 |
| 20 °C | 0 | | | 0 | 0 | 0 | 0 | 0 |
| 20 °C and boiling | | | | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 2 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 |
| 20 °C | 2 | 1 | 1 | 1 | 2 | 1 | 1 | 1 |
| boiling | 3 | 3 | 3 | 2 | 2 | | | |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 75 °C | | | | | 1 | 1 | | |
| 20 °C | | | 0 | 0 | 0 | 0 | 0 | 0 |

# Chemical resistance of NIROSTA® steels



| Corrosive agent | Formula | Condition | Concentration |
|---|---|---|---|
| Novocain | | | |
| Oil (lubricating oil) | | | |
| Oil (vegetable oil) | | | |
| Oleic acid | see fatty acids | | |
| Oxalic acid | $(COOH)_2 \cdot 2H_2O$ | | 5 % |
| Oxalic acid | $(COOH)_2 \cdot 2H_2O$ | | 5 % |
| Oxalic acid | $(COOH)_2 \cdot 2H_2O$ | | 10 % |
| Oxalic acid | $(COOH)_2 \cdot 2H_2O$ | | 10 % |
| Oxalic acid | $(COOH)_2 \cdot 2H_2O$ | | 25 % |
| Oxalic acid | $(COOH)_2 \cdot 2H_2O$ | | 50 % |
| P-toluene sulfonchloramide sodium (chloramin T) | $CH_3C_6H_4SO_2NClNa \cdot 3H_2O$ | cold saturated | |
| P-toluene sulfonchloramide sodium (chloramin T) | $CH_3C_6H_4SO_2NClNa \cdot 3H_2O$ | | cold and hot concentrated |
| Paraffin | | | |
| Persil | | | |
| Petrol | | | all concentrations |
| Petroleum | | | |
| Petroleum ether | | | |
| Phenol (carbolic acid) | $C_6H_5OH$ | | pure |
| Phenol (carbolic acid) | $C_6H_5OH$ | | with 10 % $H_2O$ |
| Phenol (carbolic acid) | $C_6H_5OH$ | | raw 90 % phenol |
| Phosphate detergents | | | |
| Phosphoric acid | $H_3PO_4$ chem. pure | | 1% |
| Phosphoric acid | $H_3PO_4$ chem. pure | | 1% |
| Phosphoric acid | $H_3PO_4$ chem. pure | | 10 % |
| Phosphoric acid | $H_3PO_4$ chem. pure | | 10 % |
| Phosphoric acid | $H_3PO_4$ chem. pure | | 45 % |
| Phosphoric acid | $H_3PO_4$ chem. pure | | 45 % |
| Phosphoric acid | $H_3PO_4$ chem. pure | | 60 % |
| Phosphoric acid | $H_3PO_4$ chem. pure | | 60 % |
| Phosphoric acid | $H_3PO_4$ chem. pure | | 70 % |
| Phosphoric acid | $H_3PO_4$ chem. pure | | 70 % |
| Phosphoric acid | $H_3PO_4$ chem. pure | | 80 % |
| Phosphoric acid | $H_3PO_4$ chem. pure | | 80 % |
| Phosphoric acid | $H_3PO_4$ chem. pure | | concentrated |
| Phosphoric acid | $H_3PO_4$ chem. pure | | concentrated |
| Phosphoric acid anhydride (phosphorus pentoxide, dry or moist) | $P_2O_5$ | | |
| Photographic developer (Agfa-glycine developer) | | | |

**Classification of NIROSTA®-/ASTM grades by group**

0 = resistant to general corrosion
1 = slight susceptibility to general corrosion
2 = low resistance to general corrosion
3 = no resistance to general corrosion
L = risk of pitting, crevice corrosion or stress-corrosion cracing

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **4000**/410 S | | | **4301**/304 | | | | |
| | **4002**/405 | | | **4303**/(305) | **4401**/316 | | | |
| | **4003**/A240... | | | **4306**/304 L | **4404**/316 L | | | |
| | **4006**/410 | **4016**/430 | | **4307**/304 L | **4429**/316 LN | | | |
| | **4021**/(420) | **4057**/431 | | **4310**/(301) | **4435**/316 L | | | |
| | **4024**/(410) | **4120** | | **4311**/304 LN | **4436**/316 | | | |
| | **4028**/(420) | **4305**/303 | | **4315**/304 N | **4438**/317 L | | | |
| | **4031**/(420) | **4427**/316 F | | **4318**/301 LN | **4439** | | | |
| | **4034**/(420) | **4509**/441 | | **4541**/321 | **4462** | | | |
| | **4313** | **4510**/439 | **4113**/434 | **4544** | **4501** | | | |
| | **4512**/409 | **4511** | **4521**/444 | **4546** | **4561**/316 Ti | | | |
| | **4589** | **4520** | **4568**/631 | **4550**/347 | **4571**/316 Ti | **4465** | **4539** | **4565 S** |
| Temperature | Gr. 1 | Gr. 2 | Gr. 3 | Gr. 4 | Gr. 5 | 4465 | 4539 | 4565 S |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C and boiling | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C and boiling | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| 20 °C | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | | 3 | 3 | 1 | 1 | 0 | 0 | 0 |
| 20 °C | | 1 | 2 | 1 | 0 | 0 | 0 | 0 |
| boiling | | | 3 | 2 | 2 | 1 | 1 | 1 |
| boiling | | | 3 | 2 | 2 | 1 | 1 | 1 |
| boiling | | | 3 | 2 | 2 | 1 | 1 | 1 |
| 20 °C | | | | 1 L | 0 L | 0 L | 0 L | 0 |
| boiling | | | | 1 L | 0 L | 0 L | 0 L | 0 L |
| 20 °C and molten | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C and boiling | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C and boiling | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| boiling | 3 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| boiling | 3 | 3 | 1 | 1 | 0 | 0 | 0 | 0 |
| 95 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 0 |
| boiling | 3 | 2 | 2 | 2 | 1 | 0 | 0 | 0 |
| 20 °C | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 0 |
| boiling | 3 | 3 | 2 | 2 | 1 | 0 | 0 | 0 |
| 20 °C | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 0 |
| boiling | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 1 |
| 20 °C | 2 | 2 | 1 | 1 | 0 | 0 | 0 | 0 |
| boiling | 3 | 3 | 3 | 3 | 2 | | | |
| 20 °C | 2 | 2 | 1 | 1 | 0 | 0 | 0 | 0 |
| boiling | 3 | 3 | 3 | 3 | 3 | | | |
| 20 °C | | | 1 | 1 | 0 | 0 | 0 | 0 |
| 20 °C | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

# Chemical resistance of NIROSTA® steels



| Corrosive agent | Formula | Condition | Concentration |
|---|---|---|---|
| Photographic fixing bath [1]) | | | |
| Pickling liquid | | | |
| Picric acid | $C_6H_2(NO_2)_3OH$ | | all concentrations |
| Pink salt | see ammonium hexachlorostannate | | |
| Potash | see potassium carbonate | | |
| Potassium acetate | $CH_3COOK$ | molten | |
| Potassium aluminium sulphate (alum) | $KAl(SO_4)_2 \cdot 12H_2O$ | | 10 % |
| Potassium aluminium sulphate (alum) | $KAl(SO_4)_2 \cdot 12H_2O$ | | 10 % |
| Potassium aluminium sulphate (alum) | $KAl(SO_4)_2 \cdot 12H_2O$ | cold saturated | |
| Potassium aluminium sulphate (alum) | $KAl(SO_4)_2 \cdot 12H_2O$ | cold and hot saturated | |
| Potassium bifluoride | $KHF_2$ | cold saturated | |
| Potassium bisulphate | $KHSO_4$ | | 2 % |
| Potassium bisulphate | $KHSO_4$ | | 5 % |
| Potassium bisulphate | $KHSO_4$ | | 5 % |
| Potassium bisulphate | $KHSO_4$ | | 15 % |
| Potassium bitartrate (tartar) | $KHC_4H_4O_6$ | cold saturated | |
| Potassium bitartrate (tartar) | $KHC_4H_4O_6$ | cold and hot saturated | |
| Potassium bromide | KBr | | |
| Potassium carbonate (potash) | $K_2CO_3$ | cold saturated | |
| Potassium carbonate (potash) | $K_2CO_3$ | cold and hot saturated | |
| Potassium chlorate | $KClO_3$ | hot saturated | |
| Potassium chloride | KCl | | |
| Potassium chloride | KCl | cold and hot saturated | |
| Potassium chrome sulphate (chrome alum) | $KCr(SO_4)_2 \cdot 12H_2O$ | cold saturated | |
| Potassium chrome sulphate (chrome alum) | $KCr(SO_4)_2 \cdot 12H_2O$ | cold and hot saturated | |
| Potassium cyanate | KOCN | | |
| Potassium cyanide | KCN | | 5 % |
| Potassium dichromate | $K_2Cr_2O_7$ | | 25 % |
| Potassium dichromate | $K_2Cr_2O_7$ | | 25 % |
| Potassium ferricyanide | $K_3[Fe(CN)_6]$ | cold saturated | |
| Potassium ferricyanide | $K_3[Fe(CN)_6]$ | hot saturated | |
| Potassium ferrocyanide | $K_4[Fe(CN)_6] \cdot 3H_2O$ | cold and hot saturated | |
| Potassium hydroxide (caustic potash solution) | KOH | | 20 % |
| Potassium hydroxide (caustic potash solution) | KOH | | 20 % |
| Potassium hydroxide (caustic potash solution) | KOH | | 50 % |
| Potassium hydroxide (caustic potash solution) | KOH | | 50 % |
| Potassium hydroxide (caustic potash solution) | KOH | hot saturated | |
| Potassium hydroxide (caustic potash) | KOH | fused | |
| Potassium hypochlorite | KClO | | approx. 15 % free chlorine |
| Potassium hypochlorite | KClO | | |
| Potassium iodide | KI | cold saturated | |

[1]) Even corrosion-resistant steels must be handled and cleaned carefully.
No fixing salt may be allowed to dry anywhere on the surface, since pitting could easily occur at these points.

**Classification of NIROSTA®-/ASTM grades by group**

0 = resistant to general corrosion
1 = slight susceptibility to general corrosion
2 = low resistance to general corrosion
3 = no resistance to general corrosion
L = risk of pitting, crevice corrosion or stress-corrosion cracing

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **4000**/410 S | | | **4301**/304 | | | | |
| **4002**/405 | | | **4303**/(305) | **4401**/316 | | | |
| **4003**/A240… | | | **4306**/304 L | **4404**/316 L | | | |
| **4006**/410 | **4016**/430 | | **4307**/304 L | **4429**/316 LN | | | |
| **4021**/(420) | **4057**/431 | | **4310**/(301) | **4435**/316 L | | | |
| **4024**/(410) | **4120** | | **4311**/304 LN | **4436**/316 | | | |
| **4028**/(420) | **4305**/303 | | **4315**/304 N | **4438**/317 L | | | |
| **4031**/(420) | **4427**/316 F | | **4318**/301 LN | **4439** | | | |
| **4034**/(420) | **4509**/441 | | **4541**/321 | **4462** | | | |
| **4313** | **4510**/439 | **4113**/434 | **4544** | **4501** | | | |
| **4512**/409 | **4511** | **4521**/444 | **4546** | **4561**/316 Ti | | | |
| **4589** | **4520** | **4568**/631 | **4550**/347 | **4571**/316 Ti | **4465** | **4539** | **4565 S** |

| Temperature | Gr. 1 | Gr. 2 | Gr. 3 | Gr. 4 | Gr. 5 | 4465 | 4539 | 4565 S |
|---|---|---|---|---|---|---|---|---|
| 20 °C | 3 L | 3 L | 3 L | 0 L | 0 L | | | |
| 20 °C | 1 L | 0 L | 0 L | 0 L | 0 L | 0 L | 0 L | 0 L |
| 20 °C | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| | | | | | | | | |
| | | | | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 2 | 2 | 1 | 1 | 0 | 0 | 0 | 0 |
| 20 °C | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 0 |
| boiling | 3 | 3 | 3 | 1 | 0 | 0 | 0 | 0 |
| 20 °C | 3 | 2 | 1 | 0 | 0 | 0 | 0 | 0 |
| 90 °C | | | | 3 | 2 | 0 | 0 | 0 |
| 20 °C | | | 1 | 1 | 0 | 0 | 0 | 0 |
| 90 °C | | | | 3 | 2 | 0 | 0 | |
| 90 °C | | | | 3 | 2 | 1 | 1 | |
| cold | | | | 0 | 0 | 0 | 0 | 0 |
| boiling | | | 2 | 2 | 1 | 0 | 0 | 0 |
| 20 °C | | 0 L | 0 L | 0 L | 0 L | 0 L | 0 L | 0 L |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 1 L | 0 L | 0 L | 0 L | 0 L | 0 L | 0 L | 0 L |
| boiling | 3 L | 1 L | 0 L | 0 L | 0 L | 0 L | 0 L | 0 L |
| 20 °C | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 0 |
| boiling | 3 | 3 | 3 | 3 | 3 | 1 | 1 | |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C and boiling | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| boiling | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| 360 °C | 3 | 3 | 3 | 3 | 3 | | | |
| 20 °C | | | | 2 L | 1 L | 0 L | 0 L | |
| 150 °C | | | | 2 L | 1 L | 0 L | 0 L | 0 L |
| 20 °C | 2 L | 1 L | 0 L | 0 | 0 L | 0 L | 0 L | |

# Chemical resistance of NIROSTA® steels



| Corrosive agent | Formula | Condition | Concentration |
|---|---|---|---|
| Potassium nitrate (saltpetre) | $KNO_3$ | | 25 % |
| Potassium nitrate (saltpetre) | $KNO_3$ | | 25 % |
| Potassium nitrate (saltpetre) | $KNO_3$ | | 50 % |
| Potassium nitrate (saltpetre) | $KNO_3$ | | 50 % |
| Potassium nitrate (saltpetre) | $KNO_3$ | molten | |
| Potassium oxalate | $K_2C_2O_4 \cdot H_2O$ | | all concentrations |
| Potassium oxalate | $K_2C_2O_4 \cdot H_2O$ | | all concentrations |
| Potassium permanganate | $KMnO_4$ | | all concentrations |
| Potassium permanganate | $KMnO_4$ | | all concentrations |
| Potassium sulphate | $K_2SO_4$ | cold and hot saturated | |
| Precipitation bath | see spinning bath | | |
| Prussic acid | see hydrocyanic acid | | |
| Pulp | see fruit pulp | | |
| Pyrogallic acid (pyrogallol) | $C_6H_3(OH)_3$ | | all concentrations |
| Quinine sulphate | | | |
| Sal ammoniac | see ammonium chloride | | |
| Salicylic acid | $HOC_6H_4COOH$ | | all concentrations |
| Salt of hartshorn | $NH_4HCO_3 + (NH_4)_2CO_3$ | cold saturated | |
| Salt/acid mixtures | 10 % $H_2SO_4$ + 10 % copper sulphate | | |
| Salt/acid mixtures | 10 % $H_2SO_4$ + 2 % ferrous sulphate | | |
| Saltpetre | see potassium nitrate/sodium nitrate | | |
| Sauerkraut liquor | | | |
| Schweinfurt green | $Cu(CH_3COO)_2 \cdot 3Cu(AsO_2)_2$ | | |
| Seawater [1]) | | | |
| Seawater [1]) | | | |
| Silver bromide | AgBr | saturated | |
| Silver chloride | AgCl | saturated | |
| Silver nitrate | $AgNO_3$ | | 10 % |
| Silver nitrate | $AgNO_3$ | fused | |
| Slaked lime | see calcium hydroxide | | |
| Soap | | | |
| Soda | see sodium carbonate | | |
| Sodium acetate | $CH_3COONa \cdot 3H_2O$ | saturated | |
| Sodium bicarbonate | $NaHCO_3$ | | all concentrations |
| Sodium bisulphate | $NaHSO_4 \cdot H_2O$ | | 10 % |
| Sodium bisulphite | $NaHSO_3$ | | 50 % |
| Sodium bromide | NaBr | | 20 % |
| Sodium carbonate (soda) | $Na_2CO_3 \cdot 10H_2O$ | | 10 % |
| Sodium carbonate (soda) | $Na_2CO_3 \cdot 10H_2O$ | fused | |
| Sodium carbonate (soda) | $Na_2CO_3 \cdot 10H_2O$ | fused | |
| Sodium chlorate | $NaClO_3$ | | 30 % |

[1]) Depending on operating conditions.

**Classification of NIROSTA®-/ASTM grades by group**

0 = resistant to general corrosion
1 = slight susceptibility to general corrosion
2 = low resistance to general corrosion
3 = no resistance to general corrosion
L = risk of pitting, crevice corrosion or stress-corrosion cracing

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **4000**/410 S | | | **4301**/304 | | | | |
| **4002**/405 | | | **4303**/(305) | **4401**/316 | | | |
| **4003**/A240… | | | **4306**/304 L | **4404**/316 L | | | |
| **4006**/410 | **4016**/430 | | **4307**/304 L | **4429**/316 LN | | | |
| **4021**/(420) | **4057**/431 | | **4310**/(301) | **4435**/316 L | | | |
| **4024**/(410) | **4120** | | **4311**/304 LN | **4436**/316 | | | |
| **4028**/(420) | **4305**/303 | | **4315**/304 N | **4438**/317 L | | | |
| **4031**/(420) | **4427**/316 F | | **4318**/301 LN | **4439** | | | |
| **4034**/(420) | **4509**/441 | | **4541**/321 | **4462** | | | |
| **4313** | **4510**/439 | **4113**/434 | **4544** | **4501** | | | |
| **4512**/409 | **4511** | **4521**/444 | **4546** | **4561**/316 Ti | | | |
| **4589** | **4520** | **4568**/631 | **4550**/347 | **4571**/316 Ti | **4465** | **4539** | **4565 S** |

| Temperature | Gr. 1 | Gr. 2 | Gr. 3 | Gr. 4 | Gr. 5 | 4465 | 4539 | 4565 S |
|---|---|---|---|---|---|---|---|---|
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 550 °C | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 3 | 2 | 2 | 1 | 0 | 0 | 0 | 0 |
| 20 °C and boiling | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| 20 °C | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| 20 °C | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C and boiling | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| boiling | 3 | 2 | 2 | 1 | 1 | 0 | 0 | 0 |
| | | | | | | | | |
| 20 °C | | | | 2 L | 1 L | 0 | 0 | 0 |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | | 0 L | 0 L | 0 L | 0 L | 0 L | 0 L | 0 |
| boiling | | | | 2 L | 1 L | 0 L | 0 L | 0 L |
| 20 °C | | 0 L | 0 L | 0 L | 0 L | | | |
| | | 1 L | | 1 L | 1 L | 0 L | 0 L | 0 L |
| boiling | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 250 °C | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| boiling | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | | | 1 | 1 | 0 | 0 | 0 | 0 |
| boiling | | | 1 | 0 | 0 | 0 | 0 | 0 |
| 80 °C | | | | | | 0 L | 0 L | |
| boiling | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 100 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 900 °C | 3 | 3 | 3 | 3 | 3 | | | |
| 20 °C and boiling | | | | 0 | 0 | 0 | 0 | 0 |

# Chemical resistance of NIROSTA® steels



| Corrosive agent | Formula | Condition | Concentration |
|---|---|---|---|
| Sodium chloride (table salt) | NaCl | cold saturated | |
| Sodium chloride (table salt) | NaCl | hot saturated | |
| Sodium chlorite | $NaClO_2$ | | 5 % |
| Sodium chlorite | $NaClO_2$ | | 5 % |
| Sodium fluoride | NaF | | 5 % |
| Sodium hydrogen phosphate | $Na_2HPO_4 \cdot 12H_2O$ | | |
| Sodium hydroxide(caustic soda solution) | NaOH | | 25 % |
| Sodium hydroxide(caustic soda solution) | NaOH | | 25 % |
| Sodium hydroxide(caustic soda solution) | NaOH | | 50 % |
| Sodium hydroxide(caustic soda) | NaOH | fused | |
| Sodium hypochlorite (bleaching liquor) | NaClO | | 5 % |
| Sodium hypochlorite (bleaching liquor) | NaClO | | 5 % |
| Sodium nitrate (Chile saltpetre) | $NaNO_3$ | | |
| Sodium nitrate (Chile saltpetre) | $NaNO_3$ | | |
| Sodium nitrate (Chile saltpetre) | $NaNO_3$ | fused | |
| Sodium nitrite | $NaNO_2$ | hot saturated | |
| Sodium perborate | $NaBO_3 \cdot 4H_2O$ | cold saturated | |
| Sodium perchlorate | $NaClO_4 \cdot 4H_2O$ | | 10 % |
| Sodium peroxide (sodium superoxide) | $Na_2O_2$ | | 10 % |
| Sodium peroxide (sodium superoxide) | $Na_2O_2$ | | 10 % |
| Sodium peroxide (sodium superoxide) | $Na_2O_2$ | | 10 % stabilised with sodium silicate |
| Sodium phosphate sec. | $Na_2HPO_4 \cdot 12H_2O$ | cold saturated | |
| Sodium phosphate tert. | $Na_3PO_4 \cdot 12H_2O$ | cold saturated | |
| Sodium salicylate | $HOC_6H_4COONa$ | cold saturated | |
| Sodium silicate | $Na_2SiO_3$ | | |
| Sodium sulphate (Glauber's salt) | $Na_2SO_4 \cdot 10H_2O$ | cold saturated | |
| Sodium sulphate (Glauber's salt) | $Na_2SO_4 \cdot 10H_2O$ | cold saturated | |
| Sodium sulphide | $Na_2S \cdot 9H_2O$ | | 25 % |
| Sodium sulphide | $Na_2S \cdot 9H_2O$ | | sat. solution |
| Sodium sulphite | $Na_2SO_3 \cdot 7H_2O$ | | 50 % |
| Sodium tetraborate (borax) | $Na_2B_4O_7 \cdot 10H_2O$ | saturated | |
| Sodium tetraborate (borax) | $Na_2B_4O_7 \cdot 10H_2O$ | saturated | |
| Sodium tetraborate (borax) | $Na_2B_4O_7 \cdot 10H_2O$ | molten | |
| Sodium thiosulphate (anti-chlorine) | $Na_2S_2O_3 \cdot 5H_2O$ | | 25 % |
| Sodium thiosulphate (anti-chlorine) | $Na_2S_2O_3 \cdot 5H_2O$ | | 25 % |
| Soft soap | | | |
| Spinning bath (viscose bath) | | | up to 10 % $H_2SO_4$ |
| Spinning bath (viscose bath) | | | over 10 % $H_2SO_4$ |
| Spirit | see ethyl alcohol | | |
| Stannic chloride | $SnCl_4$ | | |
| Stannic chloride | $SnCl_4$ | | |

**Classification of NIROSTA®-/ASTM grades by group**

0 = resistant to general corrosion
1 = slight susceptibility to general corrosion
2 = low resistance to general corrosion
3 = no resistance to general corrosion
L = risk of pitting, crevice corrosion or stress-corrosion cracing

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **4000**/410 S | | | **4301**/304 | | | | |
| **4002**/405 | | | **4303**/(305) | **4401**/316 | | | |
| **4003**/A240… | | | **4306**/304 L | **4404**/316 L | | | |
| **4006**/410 | **4016**/430 | | **4307**/304 L | **4429**/316 LN | | | |
| **4021**/(420) | **4057**/431 | | **4310**/(301) | **4435**/316 L | | | |
| **4024**/(410) | **4120** | | **4311**/304 LN | **4436**/316 | | | |
| **4028**/(420) | **4305**/303 | | **4315**/304 N | **4438**/317 L | | | |
| **4031**/(420) | **4427**/316 F | | **4318**/301 LN | **4439** | | | |
| **4034**/(420) | **4509**/441 | | **4541**/321 | **4462** | | | |
| **4313** | **4510**/439 | **4113**/434 | **4544** | **4501** | | | |
| **4512**/409 | **4511** | **4521**/444 | **4546** | **4561**/316 Ti | | | |
| **4589** | **4520** | **4568**/631 | **4550**/347 | **4571**/316 Ti | **4465** | **4539** | **4565 S** |

| Temperature | Gr. 1 | Gr. 2 | Gr. 3 | Gr. 4 | Gr. 5 | 4465 | 4539 | 4565 S |
|---|---|---|---|---|---|---|---|---|
| 20 °C | 1 L | 0 L | 0 L | 0 L | 0 L | 0 L | 0 L | 0 |
| 100 °C | 3 L | 2 L | 1 L | 1 L | 1 L | 0 L | 0 L | 0 L |
| 20 °C | | | | 2 L | 2 L | 1 L | 0 L | |
| boiling | | | | 3 | 2 | 2 L | 1 L | 1 L |
| 20 °C | | | | | 0 | 0 | 0 | 0 |
| boiling | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 2 | 2 | 2 | 1 | 1 | 0 | 0 | 0 |
| boiling | 3 | 2 | 2 | 1 | 1 | 0 | 0 | 0 |
| 320 °C | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 |
| 20 °C | 3 L | 2 L | 2 L | 1 L | 1 L | 0 L | 0 L | |
| boiling | 3 L | 3 L | 2 L | 1 L | 1 L | 1 L | 1 L | 1 L |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 360 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| up to 80 °C | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C and boiling | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C and boiling | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C and boiling | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | | 2 | 1 | 0 | 0 | 0 | 0 | 0 |
| 100 °C | | | | 1 | 1 | | | |
| boiling | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 |
| 20 °C | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 70 °C | 3 | 3 | 2 | 2 | 1 | 0 | 0 | 0 |
| 70 °C | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 |
| | | | | | | | | |
| 20 °C | 3 L | 3 L | 3 L | 3 L | 2 L | | | |
| boiling | 3 L | 3 L | 3 L | 3 L | 3 L | | | |

# Chemical resistance of NIROSTA® steels



| Corrosive agent | Formula | Condition | Concentration |
|---|---|---|---|
| Stannous chloride | $SnCl_2 \cdot 2H_2O$ | hot saturated | |
| Stannous chloride | $SnCl_2 \cdot 2H_2O$ | hot saturated | |
| Steam | | | |
| Stearic acid | $C_{17}H_{35}COOH$ | | |
| Stearic acid | $C_{17}H_{35}COOH$ | | |
| Sublimate | see mercuric chloride | | |
| Sugar of lead | see lead acetate | | |
| Sugar solution | | | |
| Sulphite liquor | see calcium bisulphite | | |
| Sulphur chloride | see disulphur dichloride | | |
| Sulphur dioxide | see sulphurous acid (gas) | | |
| Sulphur, dry | | molten | |
| Sulphur, dry | | boiling | |
| Sulphur, wet | | | |
| Sulphuric acid [1]) | $H_2SO_4$ | | 1% |
| Sulphuric acid [1]) | $H_2SO_4$ | | 1% |
| Sulphuric acid [1]) | $H_2SO_4$ | | 1% |
| Sulphuric acid [1]) | $H_2SO_4$ | | 2.5% |
| Sulphuric acid [1]) | $H_2SO_4$ | | 2.5% |
| Sulphuric acid [1]) | $H_2SO_4$ | | 2.5% |
| Sulphuric acid [1]) | $H_2SO_4$ | | 5% |
| Sulphuric acid [1]) | $H_2SO_4$ | | 5% |
| Sulphuric acid [1]) | $H_2SO_4$ | | 5% |
| Sulphuric acid [1]) | $H_2SO_4$ | | 7.5% |
| Sulphuric acid [1]) | $H_2SO_4$ | | 7.5% |
| Sulphuric acid [1]) | $H_2SO_4$ | | 7.5% |
| Sulphuric acid [1]) | $H_2SO_4$ | | 10% |
| Sulphuric acid [1]) | $H_2SO_4$ | | 10% |
| Sulphuric acid [1]) | $H_2SO_4$ | | 10% |
| Sulphuric acid [1]) | $H_2SO_4$ | | 20% |
| Sulphuric acid [1]) | $H_2SO_4$ | | 20% |
| Sulphuric acid [1]) | $H_2SO_4$ | | 20% |
| Sulphuric acid [1]) | $H_2SO_4$ | | 40% |
| Sulphuric acid [1]) | $H_2SO_4$ | | 40% |
| Sulphuric acid [1]) | $H_2SO_4$ | | 40% |
| Sulphuric acid [1]) | $H_2SO_4$ | | 60% |
| Sulphuric acid [1]) | $H_2SO_4$ | | 60% |
| Sulphuric acid [1]) | $H_2SO_4$ | | 60% |
| Sulphuric acid [1]) | $H_2SO_4$ | | 80% |
| Sulphuric acid [1]) | $H_2SO_4$ | | 80% |
| Sulphuric acid [1]) | $H_2SO_4$ | | 80% |

[1]) Oxidising conditions can considerably expand the applications of stainless steels. Please enquire with the manufacturers.

**Classification of NIROSTA®-/ASTM grades by group**

0 = resistant to general corrosion
1 = slight susceptibility to general corrosion
2 = low resistance to general corrosion
3 = no resistance to general corrosion
L = risk of pitting, crevice corrosion or stress-corrosion cracing

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **4000**/410 S | | | **4301**/304 | | | | |
| **4002**/405 | | | **4303**/(305) | **4401**/316 | | | |
| **4003**/A240... | | | **4306**/304 L | **4404**/316 L | | | |
| **4006**/410 | **4016**/430 | | **4307**/304 L | **4429**/316 LN | | | |
| **4021**/(420) | **4057**/431 | | **4310**/(301) | **4435**/316 L | | | |
| **4024**/(410) | **4120** | | **4311**/304 LN | **4436**/316 | | | |
| **4028**/(420) | **4305**/303 | | **4315**/304 N | **4438**/317 L | | | |
| **4031**/(420) | **4427**/316 F | | **4318**/301 LN | **4439** | | | |
| **4034**/(420) | **4509**/441 | | **4541**/321 | **4462** | | | |
| **4313** | **4510**/439 | **4113**/434 | **4544** | **4501** | | | |
| **4512**/409 | **4511** | **4521**/444 | **4546** | **4561**/316 Ti | | | |
| **4589** | **4520** | **4568**/631 | **4550**/347 | **4571**/316 Ti | **4465** | **4539** | **4565 S** |

| Temperature | Gr. 1 | Gr. 2 | Gr. 3 | Gr. 4 | Gr. 5 | 4465 | 4539 | 4565 S |
|---|---|---|---|---|---|---|---|---|
| 50 °C | 3 L | 2 L | 2 L | 1 L | 0 L | | | |
| boiling | 3 L | 3 L | 3 L | 3 L | 3 L | | | |
| 400 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 130 °C | | | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| | | | | | | | | |
| 20 °C and boiling | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| 130 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 445 °C | 3 | 3 | 3 | 2 | 2 | | | |
| 20 °C | | 1 | | 1 | 0 | 0 | 0 | 0 |
| 20 °C | 3 | 3 | 2 | 1 | 0 | 0 | 0 | 0 |
| 70 °C | 3 | 3 | 2 | 1 | 0 | 0 | 0 | 0 |
| boiling | 3 | 3 | 3 | 1 | 1 | 0 | 0 | 0 |
| 20 °C | 3 | 3 | 3 | 1 | 0 | 0 | 0 | 0 |
| 70 °C | 3 | 3 | 3 | 1 | 0 | 0 | 0 | 0 |
| boiling | 3 | 3 | 3 | 2 | 2 | 0 | 0 | 0 |
| 20 °C | 3 | 3 | 3 | 1 | 0 | 0 | 0 | 0 |
| 70 °C | 3 | 3 | 3 | 1 | 1 | 0 | 0 | 0 |
| boiling | 3 | 3 | 3 | 3 | 2 | 1 | 1 | 1 |
| 20 °C | 3 | 3 | 3 | 1 | 0 | 0 | 0 | 0 |
| 70 °C | 3 | 3 | 3 | 1 | 1 | 0 | 0 | 0 |
| boiling | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 |
| 20 °C | 3 | 3 | 3 | 2 | 1 | 0 | 0 | 0 |
| 70 °C | 3 | 3 | 3 | 2 | 2 | 0 | 0 | 0 |
| boiling | 3 | 3 | 3 | 3 | 2 | 1 | 1 | 1 |
| 20 °C | 3 | 3 | 3 | 1 | 1 | 0 | 0 | 0 |
| 70 °C | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 |
| boiling | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 |
| 20 °C | 3 | 3 | 3 | 1 | 1 | 0 | 0 | |
| 70 °C | 3 | 3 | 3 | 2 | 2 | 2 | 1 | 2 |
| boiling | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 |
| 20 °C | 3 | 3 | 3 | 3 | 2 | 0 | 0 | |
| 70 °C | 3 | 3 | 3 | 3 | 3 | | 1 | |
| boiling | 3 | 3 | 3 | 3 | 3 | | | |
| 20 °C | 3 | 3 | 3 | 1 | 1 | 1 | 1 | 1 |
| 70 °C | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 |
| boiling | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 |

# Chemical resistance of NIROSTA® steels



| Corrosive agent | Formula | Condition | Concentration |
|---|---|---|---|
| Sulphuric acid [1]) | $H_2SO_4$ | | 98 % (concentrated) |
| Sulphuric acid [1]) | $H_2SO_4$ | | 98 % (concentrated) |
| Sulphuric acid [1]) | $H_2SO_4$ | | 98 % (concentrated) |
| Sulphuric acid [1]) | $H_2SO_4$ | | 98 % (concentrated) |
| Sulphuric acid [1]) | fuming (11 % free $SO_3$) | | |
| Sulphuric acid [1]) | fuming (11 % free $SO_3$) | | |
| Sulphuric acid [1]) | fuming (60 % free $SO_3$) | | |
| Sulphuric acid [1]) | fuming (60 % free $SO_3$) | | |
| Sulphurous acid | $H_2SO_3$ | saturated | |
| Sulphurous acid | $H_2SO_3$ | 4 bar | |
| Sulphurous acid | $H_2SO_3$ | 5–8 bar | |
| Sulphurous acid | $H_2SO_3$ | 10–20 bar | |
| Sulphurous acid, gas ($SO_2$) | moist, free of $SO_3$ | | |
| Sulphurous acid, gas ($SO_2$) | moist, free of $SO_3$ | | |
| Sulphurous acid, gas ($SO_2$) | moist, free of $SO_3$ | | |
| Sulphurous acid, gas ($SO_2$) | moist, free of $SO_3$ | | |
| Super phosphate | $Ca(H_2PO_4)_2$ + $CaSO_4$ + 3 % $H_2SO_4$ | | |
| Tannic acid (tannin) | | | 5 % |
| Tannic acid (tannin) | | | 5 % |
| Tannic acid (tannin) | | | 10 % |
| Tannic acid (tannin) | | | 10 % |
| Tannic acid (tannin) | | | 50 % |
| Tannic acid (tannin) | | | 50 % |
| Tannin | see tannic acid | | |
| Tar, pure | | | |
| Tartar | see potassium bitartrate | | |
| Tartaric acid | $COOH(CHOH)_2COOH$ | | 10 % |
| Tartaric acid | $COOH(CHOH)_2COOH$ | | 10 % |
| Tartaric acid | $COOH(CHOH)_2COOH$ | | 50 % |
| Tartaric acid | $COOH(CHOH)_2COOH$ | | 50 % |
| Thioglycolic acid | $HSCH_2COOH$ | | |
| Thioglycolic acid | $HSCH_2COOH$ | | |
| Tin | Sn | molten | |
| Tin | Sn | molten | |
| Tin | Sn | molten | |
| Tincture of iodine | | | |
| Toluene | $C_6H_5CH_3$ | | |
| Trichloroacetic acid | $CCl_3COOH$ | | 80 % |
| Trichloroethylene [2]) | $C_2HCl_3$ | anhydrous | |
| Trisodium phosphate | see sodium phosphate tert. | | |
| Turpentine | | | |

[1]) Oxidising conditions can considerably expand the applications of stainless steels.
Please enquire with the manufacturers.

[2]) Even if only traces of hydrochloric acid (HCl) are formed by moisture, there is a danger of pitting, crevice and stress corrosion cracking.

**Classification of NIROSTA®-/ASTM grades by group**

0 = resistant to general corrosion
1 = slight susceptibility to general corrosion
2 = low resistance to general corrosion
3 = no resistance to general corrosion
L = risk of pitting, crevice corrosion or stress-corrosion cracing

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **4000**/410 S | | | **4301**/304 | | | | |
| | **4002**/405 | | | **4303**/(305) | **4401**/316 | | | |
| | **4003**/A240… | | | **4306**/304 L | **4404**/316 L | | | |
| | **4006**/410 | **4016**/430 | | **4307**/304 L | **4429**/316 LN | | | |
| | **4021**/(420) | **4057**/431 | | **4310**/(301) | **4435**/316 L | | | |
| | **4024**/(410) | **4120** | | **4311**/304 LN | **4436**/316 | | | |
| | **4028**/(420) | **4305**/303 | | **4315**/304 N | **4438**/317 L | | | |
| | **4031**/(420) | **4427**/316 F | | **4318**/301 LN | **4439** | | | |
| | **4034**/(420) | **4509**/441 | | **4541**/321 | **4462** | | | |
| | **4313** | **4510**/439 | **4113**/434 | **4544** | **4501** | | | |
| | **4512**/409 | **4511** | **4521**/444 | **4546** | **4561**/316 Ti | | | |
| | **4589** | **4520** | **4568**/631 | **4550**/347 | **4571**/316 Ti | **4465** | **4539** | **4565 S** |
| Temperature | Gr. 1 | Gr. 2 | Gr. 3 | Gr. 4 | Gr. 5 | 4465 | 4539 | 4565 S |
| 20 °C | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 70 °C | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |
| 150 °C | 3 | 3 | 3 | 2 | 2 | | | |
| boiling | 3 | 3 | 3 | 3 | 3 | | | |
| 20 °C | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 100 °C | 3 | 3 | 3 | 1 | 0 | 0 | 0 | 0 |
| 20 °C | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 80 °C | 3 | 3 | 3 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 135 °C | 3 | 2 | 0 | 1 | 0 | 0 | 0 | 0 |
| 160 °C | 3 | 3 | 1 | 2 | 1 | | | |
| 180–200 °C | 3 | 3 | 2 | 2 | 1 | | | |
| up to 100 °C | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| up to 300 °C | 3 | 3 | 1 | 1 | 0 | 0 | 0 | 0 |
| up to 500 °C | 3 | 3 | 3 | 1 | 1 | | | |
| 900 °C | 3 | 3 | 3 | 3 | 2 | | | |
| 20 °C | | | | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| 20 °C and hot | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| 20 °C | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 3 | 2 | 2 | 2 | 1 | 0 | 0 | 0 |
| 20 °C | | | | | 1 | 0 | 0 | 0 |
| boiling | | | | | 1 | 0 | 0 | 0 |
| 200 °C | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 400 °C | 3 | 3 | 1 | 1 | 1 | | | |
| 600 °C | 3 | 3 | 3 | 3 | 3 | | | |
| 20 °C | 2 L | 2 L | 1 L | 1 L | 1 L | 0 L | 0 L | 0 L |
| 20 °C and boiling | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | | | | 2 L | 1 L | 0 L | 0 L | |
| boiling | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| 20 °C and hot | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

# Chemical resistance of NIROSTA® steels



| Corrosive agent | Formula | Condition | Concentration |
|---|---|---|---|
| Urea | $CO(NH_2)_2$ | | |
| Urine | | | |
| Varnish (copal varnish) | | | |
| Vaseline | | | |
| Vaseline | | | |
| Vegetables | | | |
| Vinegar (wine vinegar) | | | |
| Vinegar (wine vinegar) | | | |
| Washing powder | | | |
| Water [1]) (tap water) | | | |
| Water [2]) [pit water (acid water)] | | | |
| Water glass | | | |
| Water glass | | | |
| Wine [3]) (white and red wines) | | | |
| Wine [3]) (white and red wines) | | | |
| Wine vinegar | see vinegar | | |
| Xylene | $C_6H_4(CH_3)_2$ | | |
| Zinc | Zn | molten | |
| Zinc chloride | $ZnCl_2$ | cold and hot saturated | |
| Zinc chloride | $ZnCl_2$ | cold saturated | |
| Zinc chloride | $ZnCl_2$ | cold and hot saturated | |
| Zinc sulphate | $ZnSO_4 \cdot 7H_2O$ | cold saturated | |
| Zinc sulphate | $ZnSO_4 \cdot 7H_2O$ | cold saturated | |
| Zinc sulphate | $ZnSO_4 \cdot 7H_2O$ | hot saturated | |
| Zink cyanide | $Zn(CN)_2$ moistened with water | | |

[1]) With tap water, the composition of the water (in particular the chloride content) has a decisive influence on the corrosion resistance of the steels. Enquiry recommended.
[2]) Pitting and crevice corrosion highly dependent on composition of pit water, in particular the chloride concentration.
[3]) Materials from Group 5 upwards have no effect on the taste.

**Classification of NIROSTA®-/ASTM grades by group**

0 = resistant to general corrosion
1 = slight susceptibility to general corrosion
2 = low resistance to general corrosion
3 = no resistance to general corrosion
L = risk of pitting, crevice corrosion or stress-corrosion cracing

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **4000**/410 S | | | **4301**/304 | | | | |
| **4002**/405 | | | **4303**/(305) | **4401**/316 | | | |
| **4003**/A240… | | | **4306**/304 L | **4404**/316 L | | | |
| **4006**/410 | **4016**/430 | | **4307**/304 L | **4429**/316 LN | | | |
| **4021**/(420) | **4057**/431 | | **4310**/(301) | **4435**/316 L | | | |
| **4024**/(410) | **4120** | | **4311**/304 LN | **4436**/316 | | | |
| **4028**/(420) | **4305**/303 | | **4315**/304 N | **4438**/317 L | | | |
| **4031**/(420) | **4427**/316 F | | **4318**/301 LN | **4439** | | | |
| **4034**/(420) | **4509**/441 | | **4541**/321 | **4462** | | | |
| **4313** | **4510**/439 | **4113**/434 | **4544** | **4501** | | | |
| **4512**/409 | **4511** | **4521**/444 | **4546** | **4561**/316 Ti | | | |
| **4589** | **4520** | **4568**/631 | **4550**/347 | **4571**/316 Ti | **4465** | **4539** | **4565 S** |

| Temperature | Gr. 1 | Gr. 2 | Gr. 3 | Gr. 4 | Gr. 5 | 4465 | 4539 | 4565 S |
|---|---|---|---|---|---|---|---|---|
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | | | 0 L | 0 L | 0 L | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| hot | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | | | | 0 | 0 | 0 | 0 | 0 |
| 20 °C | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | | | | |
| 20 °C | 0 L | 0 L | 0 L | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 1 L | 1 L | 0 L | 0 L | 0 L | 0 | 0 | 0 |
| 20 °C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| boiling | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | | | | 0 | 0 | 0 | 0 | 0 |
| hot | | | | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| 20 °C and boiling | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 500 °C | 3 | 3 | 3 | 3 | 3 | | | |
| 20 °C | 1 L | 1 L | 1 L | 0 L | 0 L | 0 L | 0 L | 0 L |
| 45 °C | | | | 2 L | 1 L | 0 L | 0 L | 0 L |
| boiling | 3 L | 3 L | 3 L | 3 L | 2 L | 1 L | 1 L | 1 L |
| 20 °C | | | | 0 | 0 | 0 | 0 | 0 |
| boiling | | | | 0 | 0 | 0 | 0 | 0 |
| boiling | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 °C | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |