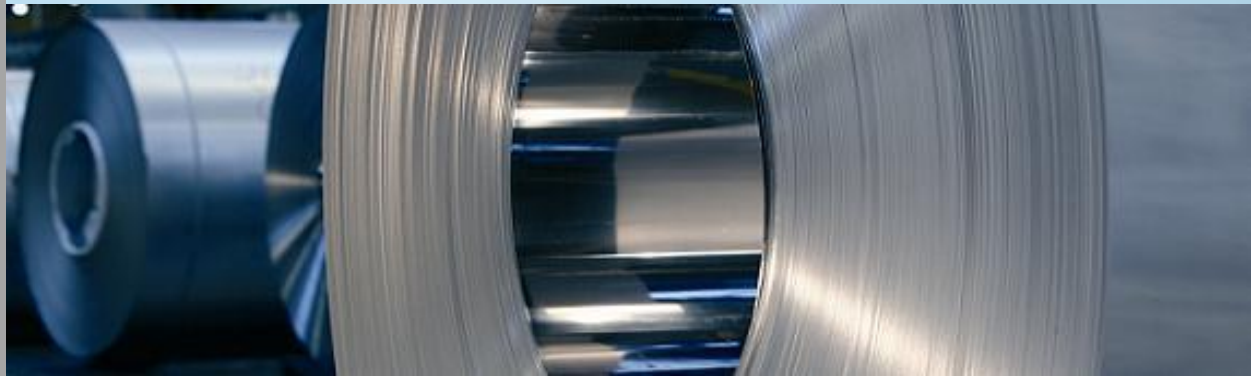


ThyssenKrupp Stainless International GmbH

Solutions for waste water management

2011



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Definition of stainless steel



Requirements for stainless steels in waste water systems



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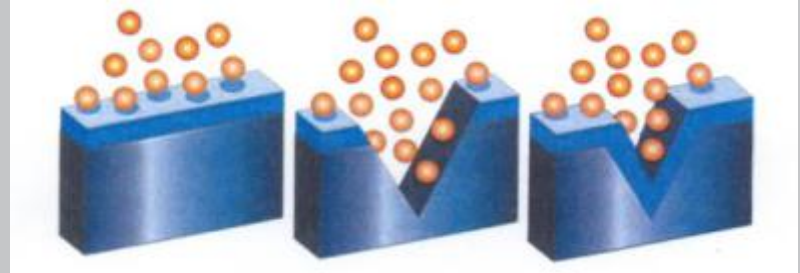


Definition of stainless steel

Self repair mechanism



SELF REPAIR MECHANISM OF STAINLESS STEEL



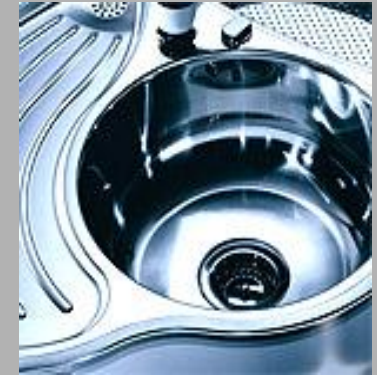
- stainless steel consists of at least **12% CHROMIUM**
- a transparent **PASSIV LAYER** on the surface seals stainless steel from the environment
- if damage occurs – **OXYGEN + CHROMIUM** build a new passive layer in a split of a second
- any kind of coatings or other forms of external corrosion protection are **NOT REQUIRED**

Definition of stainless steel

General product properties

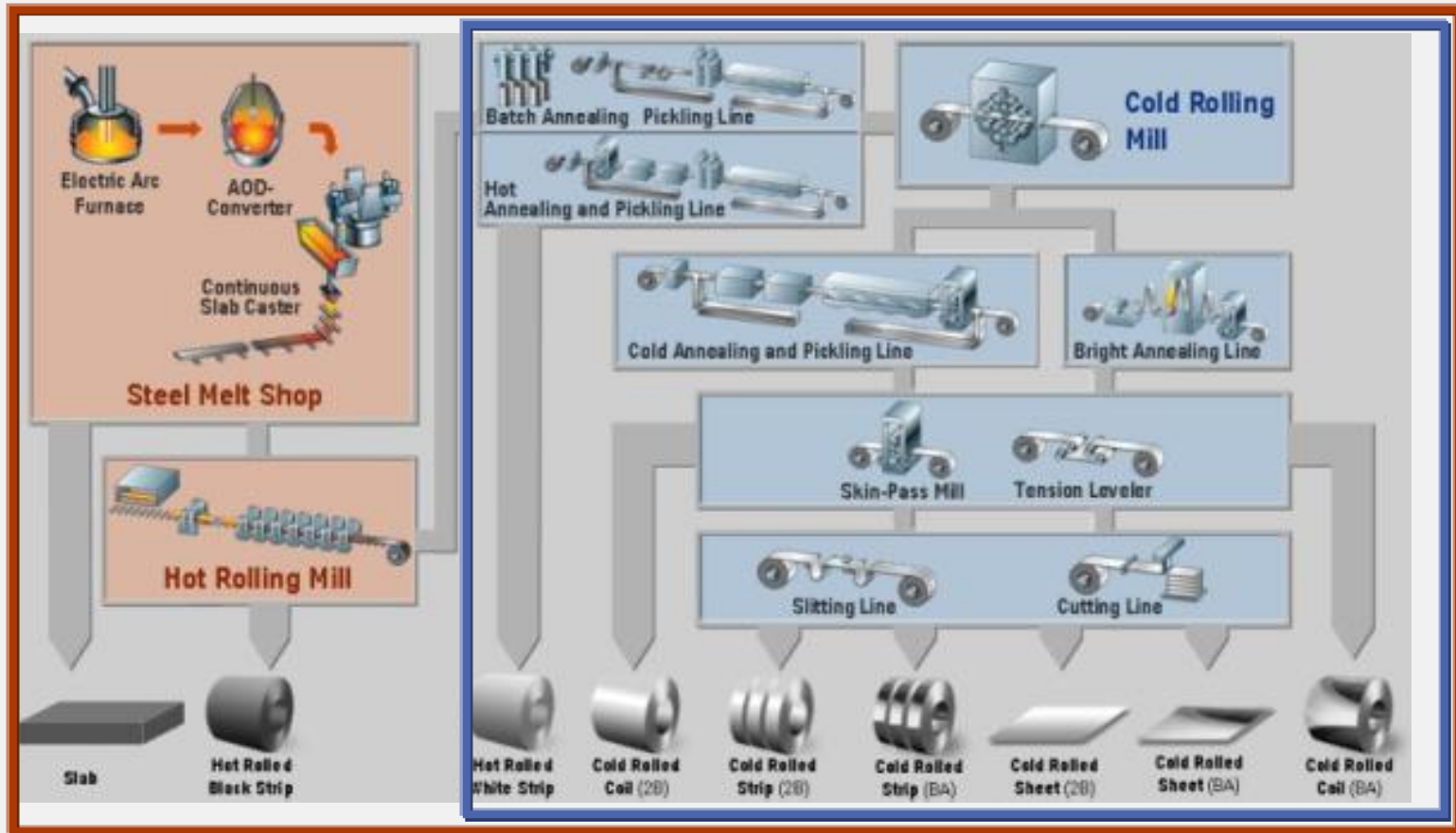
Stainless Steel

- Corrosion Resistance
- Heat Resistance
- Aesthetic Surface
- Easy-Care Properties
- Good Deformation Properties
- Good Strength to Weight Ratio
- High Weldability
- Long Service Life
- 100% Recyclable



Definition of stainless steel

Production cycle



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Agenda



Definition of stainless steel



Requirements for stainless steels in waste water systems



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Requirements for stainless steels in waste water systems

Considerations for choice of stainless steel grade

Possible influences to the material's surface

- Substances dissolved in waste water
- Chlorine as a disinfectant
- Gaseous products which may develop during waste water treatment
- Compatibility with other materials of construction
- Resistance to erosion



Requirements for stainless steels in waste water systems

Considerations for choice of stainless steel grade

ThyssenKrupp Stainless International recommends:

EN 10088	ASTM 240	Composition, % by mass				
No.	Type	C max.	Cr	Ni	Mo	other
1.4301	304	0.07	17.5 – 19.5	8.0 – 10.5	-	max. 0.11 N
1.4541	321	0.08	17.0 – 19.0	9.0 – 12.0	-	Ti: 5XC – 0.70
1.4404	316L	0.03	16.5 – 18.5	10.0 – 13.0	2.0 – 2.5	max. 0.11 N
1.4462	--	0.03	21.0 – 23.0	4.5 – 6.5	2.5 – 3.5	0.10 - 0.22N

Requirements for stainless steels in waste water systems

Considerations for choice of stainless steel grade

ThyssenKrupp Stainless International recommends:

EN 10088 No.	ASTM 240 Type	Proof Stress Y.P. _{0.2} in MPa	Tensile Strength T.S. in MPa	Elongation A ₈₀ in %
1.4301	304	≈ 285	≈ 635	≈ 58
1.4541	321	≈ 220	≈ 520	≈ 40
1.4404	316L	≈ 300	≈ 600	≈ 55
1.4462	--	≥ 480	680 - 880	≥ 25

Requirements for stainless steels in waste water systems

Considerations for choice of stainless steel grade

Innovative Products of ThyssenKrupp Stainless International:

EN 10088	ASTM 240	Composition, % by mass				
No.	Type	C max.	Cr	Ni	Mo	other
1.4362	--	0.03	22.0 – 24.0	3.5 – 5.5	0.1 – 0.6	0.10 – 0.60 Cu
1.4521	444	0.025	17.0 – 20.0	-	1.8 – 2.5	Ti: min: [4x(C+N)+0,15]; max: 0,80
1.4613	470LI	0.03	24.0	-	-	Ti: <1.0; Nb: <1.0

Requirements for stainless steels in waste water systems

Considerations for choice of stainless steel grade

Innovative Products of ThyssenKrupp Stainless International:

EN 10088	ASTM 240	Proof Stress Y.P. $_{0.2}$ in MPa	Tensile Strength T.S. in MPa	Elongation A_{80} in %
No.	Type			
1.4362	--	≈ 350	≈ 700	≈ 35
1.4521	444	≈ 340	≈ 510	≈ 29
1.4613	470LI	≈ 310	≈ 470	≈ 30

Requirements for stainless steels in waste water systems

Considerations for choice of stainless steel grade

Corrosion resistance to waters

- Stainless Steels of the 304 group are generally resistant in waste waters down to pH of about 4.
- Risk of intergranular corrosion for heavier sections of ≥ 6 mm, max. 0.03 % C and/or Ti-stabilization is recommended:
 - 1.4307/ 304L ▪ 1.4541/ 321
 - 1.4404/ 316L ▪ 1.4571/ 316Ti
- Stress corrosion cracking of stainless steels is mostly no matter of concern at low temperatures.
- Pitting and crevice corrosion are more of a concern.



Requirements for stainless steels in waste water systems

Considerations for choice of stainless steel grade

Effect on the alloying concept

- The resistance to pitting and crevice corrosion can be estimated with the Pitting Resistance Equivalent Number (PREN):

$$\text{PREN} = \% \text{Cr} + 3.3 \times \% \text{Mo} [+ 16 \times \% \text{N}]^*$$

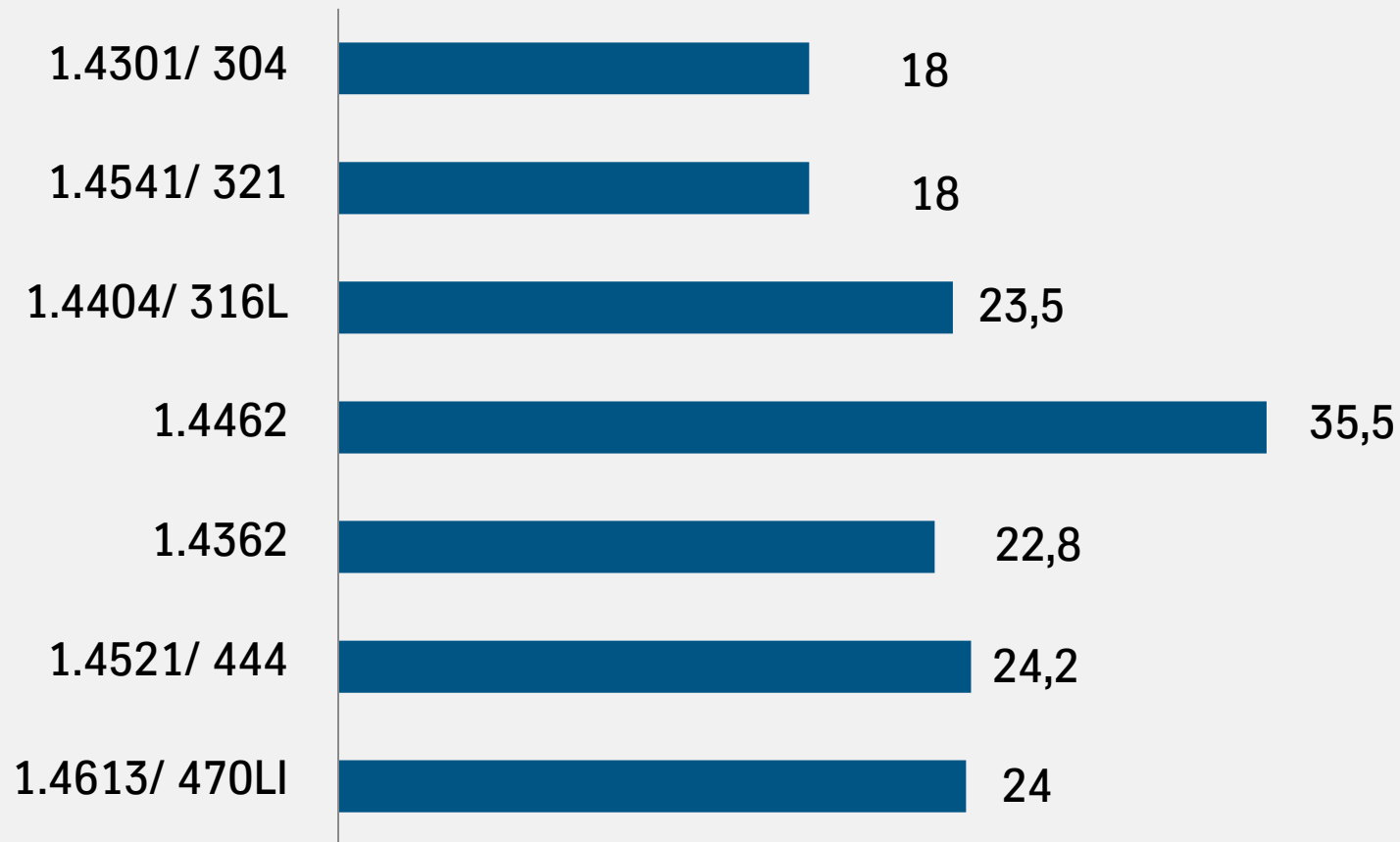
- Ti-stabilized grades 1.4541/ 321 and 1.4571/ 316Ti have a little lower resistance against pitting corrosion due to the presence of titanium

* For the duplex steel grade 1.4462

Requirements for stainless steels in waste water systems

Considerations for choice of stainless steel grade

Pitting Resistance Equivalent Number (PREN) for recommended grades



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Agenda



Definition of stainless steel



Requirements for stainless steels in waste water systems



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Solutions of ThyssenKrupp Stainless International

Our recommendations



Source: ISSF



Source: ThyssenKrupp Nirosta

1.4301/ Type 304:

- It is by far the most commonly used austenitic, non-magnetic stainless steel grade, also suitable for many applications in waste water management.
- Combines good corrosion resistance with good mechanical properties.
- Due to its favorable formability the use in complex geometries is given.
- Can be welded by all standard processes
- At very high gauges $\geq 6\text{mm}$ the alternative use of the Ti-stabilized 1.4541/ Type 321 should be considered.

Solutions of ThyssenKrupp Stainless International

Our recommendations



Source: ISSF



Source: ISSF

1.4404/ Type 316L:

- This austenitic steel offers a very high corrosion resistance due to the alloying concept with chromium and molybdenum.
- The austenitic microstructure provides excellent formability for numerous applications
- The 1.4404/ Type 316L for applications like pipes, vessels and tanks in waste water management is widely used

Solutions of ThyssenKrupp Stainless International

Our recommendations



Source: ISSF



Source: ISSF

Duplex grade 1.4362:

- Substitution of the well known high-alloyed duplex steel 1.4462 and Type 316L.
- Comparable corrosion properties like Type 316L with higher strength and still reasonable elongation.
- Ferritic-austenitic microstructure
- Can be welded by all familiar processes (except gas welding).
- Combines good corrosion resistance with good mechanical properties.

Solutions of ThyssenKrupp Stainless International

Our recommendations



Source: ThyssenKrupp Nirosta



Source: ISSF

Duplex grade 1.4462:

- 1.4462 has a high strength and very good resistance to stress corrosion cracking, corrosion fatigue and erosion due to its ferritic-austenitic microstructure
- Can be welded by all familiar processes
- Its high chromium and molybdenum contents provide a very good resistance to general corrosion and local corrosion such as pitting, crevice corrosion and stress corrosion cracking.

Solutions of ThyssenKrupp Stainless International

Our recommendations



Source: EuroInox



Source: EuroInox

1.4521/ Type 444:

- High weldability due to stabilization with titanium and niobium
- The corrosion performance is comparable to the standard 1.4404/ Type 316L, containing also 2% molybdenum.
- Well known grade especially in drinking water sector used for pipes and for heat exchangers.

Solutions of ThyssenKrupp Stainless International

Our recommendations



Source: EuroInox



Source: ISSF

1.4613 / Type 470LI :

- Modern ferritic steel using the innovative VOD-technology for production
- High corrosion performance with 24% Cr
- Cost-efficient alternative to 1.4404/ Type 316L
- Excellent welding properties due to Ti/Nb stabilization
- Homologation by the Italian Ministry of Health for stainless steel including 1.4613/ 470LI (stainless steel in contact with food)

ThyssenKrupp Stainless International

Our support.



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