extruflex

Racing ahead for safety and environment

Are all doors hardware components the same?

focus on

STAINLESS STEEL GRADES & PERFORMANCES

Different stainless steel qualities are used for door hardware, such as AISI 201, 304, 316 or 430. How to be sure that this grade or the other is suitable for your application? The purpose of this guide is to help you to compare the different grades and explain why **extruflex** has chosen to make its door hardware components in the top quality stainless steel AISI 201.

Why use stainless steel?

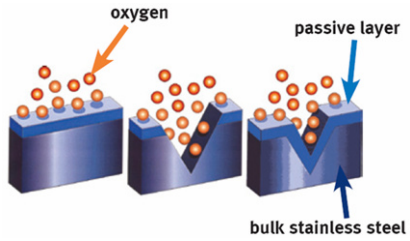
Corrosion decreases steel mechanical properties and gives it unacceptable aspect for many applications. Steel corrosion is an important factor in building systems failing. Industrial factories are usually aggressive environment where security, system reliability and durability are very important. In field such as food factories, rusty and non hygienic materials are not acceptable.

For those reasons, **extruflex** has chosen to use top quality stainless steel to make its door hardware components.

What is stainless steel?

Stainless steel is defined as an iron-carbon alloy with a maximum of 1,2% carbon and minimum of 10,5% chromium, necessary to ensure the build-up of a self-healing surface layer (passive layer) which provides the corrosion resistance and make it very durable.

But stainless steels are not all the same, different grades exist and have different mechanical properties and corrosion resistance.



Global comparison

The following table gives a general comparison of the different grades existing on the door hardware market:

	AISI 201	AISI 304	AISI 316	AISI 430
Corrosion resistance	++	++	+++	+
Mechanical resistance	+++	++	++	++

AISI 201: Due to its high corrosion resistance and mechanical properties, **extruflex** has naturally chosen to use the stainless steel AISI 201 which is the most appropriate grade for industrial doors.

AISI 304: Well known stainless steel grade, very close to the 201 grade but with lower mechanical properties.

AISI 316: Well known stainless steel as well, with very high corrosion resistance, it is usually reserved to very aggressive chloride environment such as swimming pools or seawater applications.

AISI 430: Not recommended for industrial doors application, should be used for decorative purpose in moderate aggressive environment.

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Why those grades have different properties?

Different structures

Stainless steels are classified mainly into 3 families based on their structures and depending of their composition:

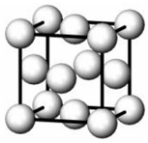
Main stainless steel families alloys content (Mass %)

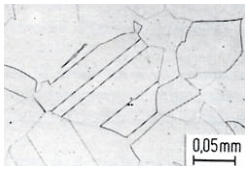
FAMILY	C min - max	Cr min - max	Ni min - max
Austenitic	0,15	16,5 - 28	3,5 - 32
Ferritic	0,025 - 0,08	10,5 - 30	
Martensitic	1,2	11,5 - 19	

(EN 10088 & Producers data)

C = Carbon – Increase mechanical properties but can decrease corrosion resistance if too abundant.
Cr = Chromium – Element the most responsible of the resistance to corrosion.
Ni = Nickel – Stabilizer allowing to keep austenitic structure at standard temperature.

Austenitic

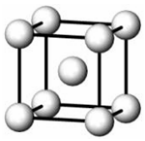

Atomic structure

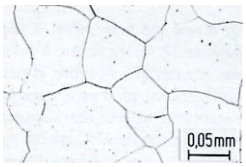


Micro structure

Comprise over 70% of total stainless steel production.
They contain sufficient nickel and/or manganese to retain an austenitic structure which gives them **high corrosion resistance**.
It is the only non-magnetic structure (easy to identify).
(AISI 201, 304, 316 are austenitic grades)

Ferritic

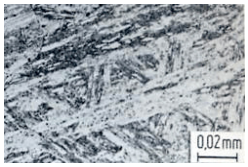

Atomic structure



Micro structure

They contain chromium to ensure corrosion resistance but no nickel or other stabilizer (or in very low quantity) and so do not retain the austenitic structure.
They are corrosion resistant, but less durable than austenitic grades.
(AISI 430 is a ferritic grade)

Martensitic



Micro structure

They contain a high percentage of carbon making them extremely strong and tough but less corrosion resistant. They are not as corrosion resistant as the other classes, manly due to their lower concentration of chromium.

Different compositions

Each stainless steel families regroup different grades, which have different composition leading to different properties.

Stainless steel grades alloys content (Mass %)

AISI	C min - max	Cr min - max	Ni min - max	Mn min - max	N min - max	Mo min - max	Structure
201	0,15	16,00 - 18,00	3,50 - 5,50	5,50 - 7,50	0,05 - 0,25		Austenitic
304	0,08	18,00 - 20,00	8,00 - 10,50	2,00	0,10		Austenitic
316	0,08	16,00 - 18,00	10,00 - 14,00	2,00	0,10	2,00 - 3,00	Austenitic
430	0,12	16,00 - 18,00		1,00			Ferritic

(ASTM A 240 & Producers data)

Mn = Manganese – Austenitic stabilizer which can replace nickel with a specific ratio.
N = Nitrogen – Increase significantly corrosion resistance in Austenitic structures.
Mo = Molybdenum – Increase significantly corrosion resistance.

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Different corrosion resistances

Even stainless steel can corrode under certain conditions. Because these modes of corrosion are more exotic and their immediate results are less visible than rust, they often escape notice and cause problems among those who are not familiar with them. Pitting corrosion is the most common and damaging forms of stainless steel corrosion.

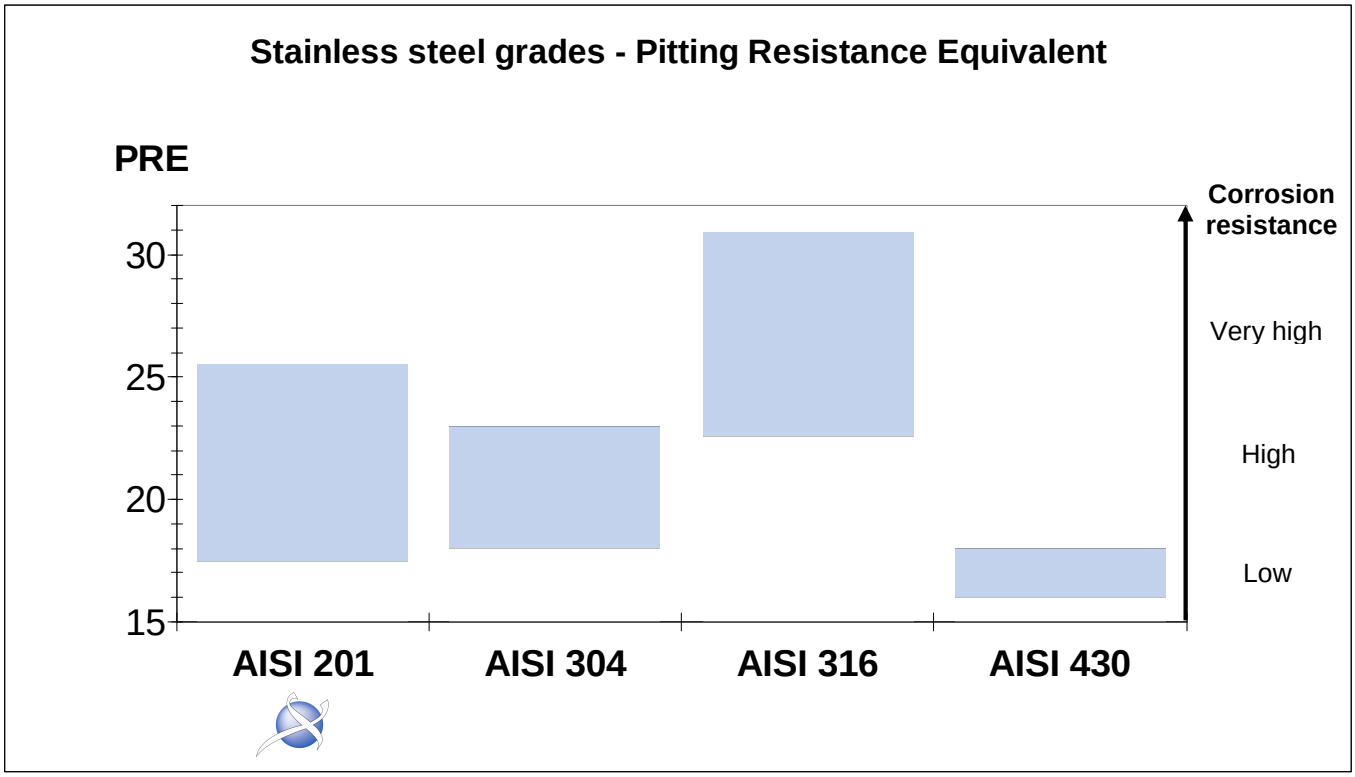
Pitting corrosion

Pitting corrosion: When deprived of oxygen or when a salt such as chloride competes as an ion, stainless steel lacks the ability to re-form its passive film. The film is degraded in few critical points. Corrosion at those points is amplified. They can continue to grow even when conditions return to normal if the interior of the pit is deprived of oxygen. Pitting corrosion can occur when stainless steel is subjected to high concentration of chloride ions (for example, seawater) and moderately high temperatures.

How to compare stainless steel grades corrosion resistances?

Stainless steel pitting resistance depends on its structure and composition. The three elements which have a significant beneficial effect are chromium, molybdenum, and nitrogen.

The **P**itting **R**esistance **E**quivalent: PRE = (%Cr) + (3,3 x %Mo) + (A x %N) is the most used indicator to compare stainless steel corrosion resistance due to its correlation with pitting corrosion tests results.
Structure influence on PRE coefficients: For Austenitic structure A = 30. For Ferritic structure A = 0.
The following graph gives the PRE of the different grades calculated according to their structure and minimum and maximum chromium, molybdenum, and nitrogen contents. (See table on the previous page)



AISI 201 & 304 have comparable high corrosion resistance. They can be used in aggressive environment and are suitable for food process plant. Their corrosion resistances are perfectly adapted for industrial doors application.

AISI 316 which contain molybdenum is very high corrosion resistant. It is made for very aggressive chloride environment such as swimming pool or seawater applications.

AISI 430 which has a Ferritic structure and does not content other anti corrosion elements than chromium has a lower corrosion resistance. It is mainly used for decorative purpose in moderate aggressive environment.

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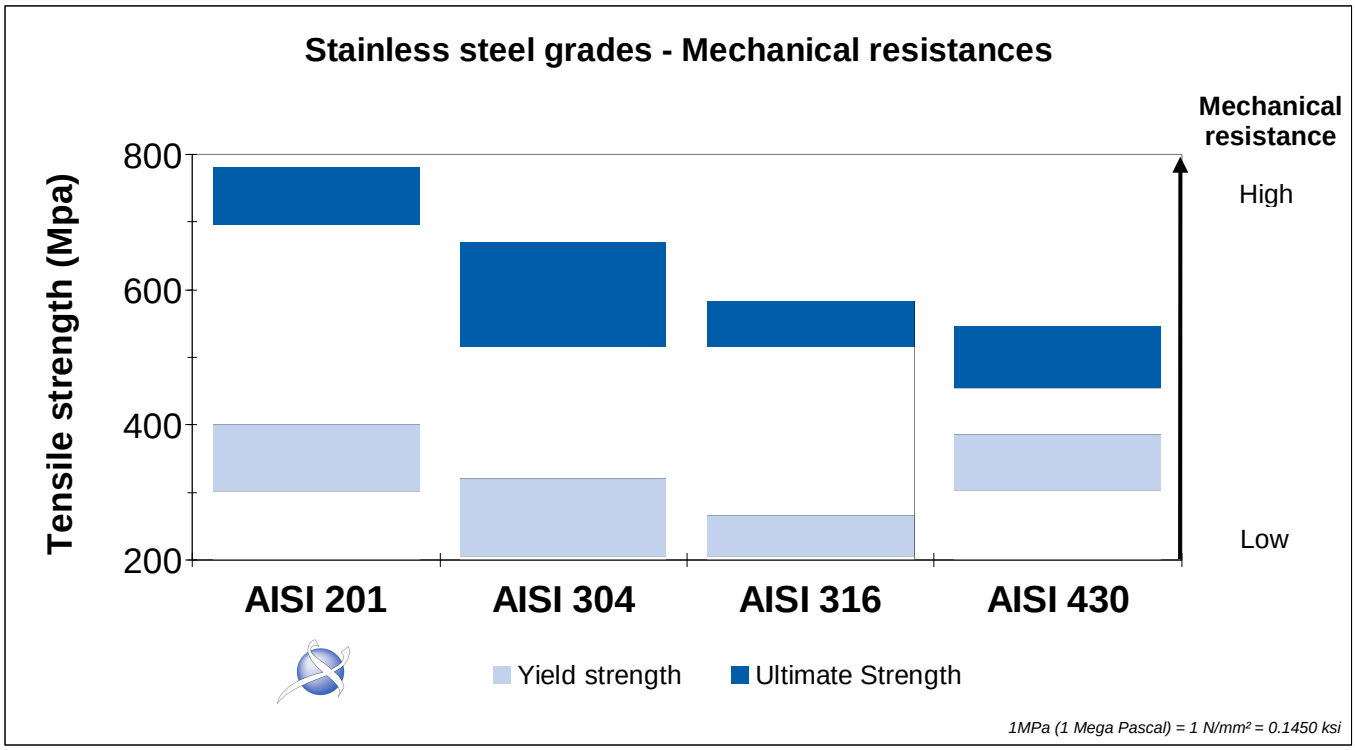
Different mechanical resistances

Due to their structure and chemical composition, stainless steel grades have different mechanical resistances, such as yield and ultimate strength. Carbon content is one of the most influencing parameter.

Yield strength: Stress at which material strain changes from elastic to plastic deformation causing permanent bend.

Ultimate strength: Maximum stress that material can withstand before fail.



(ASTM A 240 & Producers data)

AISI 201: Due to its higher carbon content, AISI 201 has a very high mechanical resistance (hard to bend and break) which make it the perfect grade for industrial doors applications where high mechanical resistance is advised.

AISI 304 & 316: With less carbon content than AISI 201, they are less resistant and durable (easier to bend and break).

AISI 430: Contain a high carbon percentage as AISI 201. It is hard to bend but as most of Ferritic stainless steel grades, its ultimate strength is low and it is easier to break even than 304 & 316 grades.

Resources:

Arcelor Stainless International - Arcelor Group www.arcelor-stainless.com
ATI - Allegheny Ludlum Corporation www.alleghenyludlum.com
Outokumpu - International Stainless Steel Company www.outokumpu.com
Corrosion and Energy storage materials Laboratory http://corrosion.kaist.ac.kr
Euro inox - European Stainless Steel Development Association www.euro-inox.org
MAFSI - Manufacturers' Agents Association for the Foodservice Industry www.mafsi.org
Arcelor Mittal - Stainless www.iup-stainless.com
Id inox - Institut de développement de l'inox www.idinox.com
SSINA - Specialty Steel Industry of North America www.ssina.com
IMOA - International Molybdenum Association www.imoa.info

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