

# THE DIFFERENCE BETWEEN GRADES 304 AND 316

In this Whitepaper, we explain the difference, recognition and application of grades 304 and 316, among other aspects.





## INTRODUCTION

Dear Reader,

Welcome to our white paper on the difference between grades 304 and 316 stainless steel. In collaboration with an experienced metallurgist, we have put together this whitepaper not only to share our knowledge, but also to inspire and inform you about the intriguing world of stainless steel.

Stainless steel, also known as corrosion-resistant steel, is a fascinating alloy of iron with added elements that make it resistant to corrosion.

But what makes one type of stainless steel different from another?

How do these differences affect its performance and applications?

In this white paper, we dive deeper into the world of crystal structures and chemical compositions. We examine the essential differences between grades 304 and 316, covering not only the technical aspects, but also the practical implications for various applications.

Whether you are an industry professional or simply interested in these materials that shape our daily lives, this white paper is designed to provide you with a deep understanding of the world of stainless steel.

Let's take this journey together and discover what the difference is between 304 and 316 stainless steel and how this knowledge can enrich your projects and decisions.

Enjoy reading!

Team Arcus Group.

## WHAT IS STAINLESS STEEL?

Stainless steel, also known as corrosion-resistant steel, is a type of metal specially formulated to resist corrosion even under challenging conditions.

Stainless steel is an alloy of Iron (Fe), Chrome (Cr), and Nickel (Ni). In the molten bath, the elements Nickel and Chromium are dissolved, similar to how sugar dissolves in water.

Together, these metals have corrosion-resistant properties.

Stainless steel abbreviated as stainless steel, typically contains about 70% iron, with the elements chromium and nickel added, and sometimes molybdenum. Each of these individual elements has unique characteristics that contribute to the properties of the metal.

Nickel mainly contributes to the toughness of the steel, making it more deformable. Chromium plays a crucial role in forming a protective layer (oxide skin) on the surface of the metal, acting as a barrier against corrosion even in aggressive environments.

Molybdenum gives additional strength to metal, which is especially important in applications where high mechanical loads are expected. It also provides improved corrosion resistance to chlorides.

Together, these elements work in synergy to give stainless steel its durable and diverse properties, making it a favorite choice in a variety of industrial and commercial applications.





## HOW DOES ALLOYING WORK?

The metal is composed of atoms arranged in crystals, a collection of atoms. If we were able to see the atoms as balls in front of us, we can see that the ball stacking allows enough space between the atoms for other elements.

The way the balls are arranged can vary. For the most common grades 304 and 316, the atoms are arranged according to a cubic planes centered grid (see Figure 1).

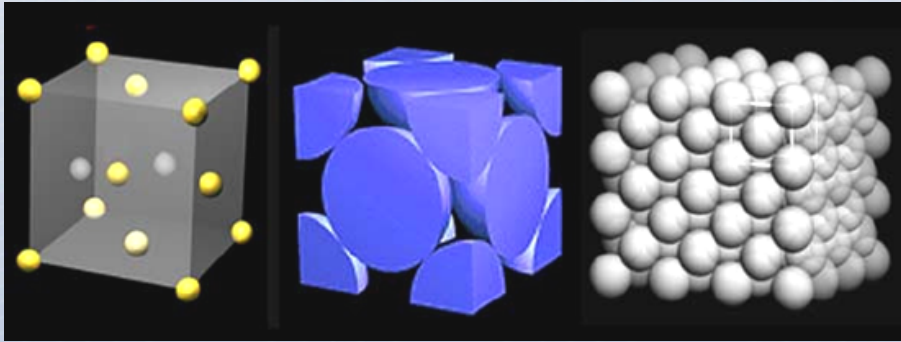


Figure 1.

This structure of crystals is called "austenite." Elements such as chromium, nickel and molybdenum, which have different properties from the steel itself, are dissolved and fit into the crystal structure of the metal.

## MINIMUM AND MAXIMUM ALLOY

Corrosion resistance, which is mainly caused by chromium is not a linear line based on its addition.

In other words, corrosion resistance does not begin to increase with the first addition of this element. A minimum of about 12% chromium is needed to achieve a degree of corrosion resistance.

A chromium oxide skin is formed on the surface of the steel that protects the steel. With too few or unevenly distributed chromium atoms, this oxide skin will not be completely closed, allowing general rust to form.

In addition to the possibility that too little of an element has been added to the steel, too much can also be added. Sometimes this is done deliberately to promote certain properties. The element will then no longer dissolve in its entirety, but will appear as a "free" element.



## HOW DO YOU ACTUALLY RECOGNIZE GRADES 304 AND 316?

Stainless steel now has about 1,500 different alloys, some with minimal differences. In the trade this is limited to about 50 common qualities. If we count this down further and ask the average dealer, the 304 and 316 grades are at the top of the list. So we find this quality at almost all dealers. This quickly makes the availability of all products in plate, tube or fitting possible. Below we explain where this designation 304 and 316 come from and what the difference is.

### NORMING

The composition of stainless steel is defined in various standards. In the past, each country had its own standard describing a quality. Nowadays, more European and international standards are available. Such a standard describes a steel grade with all its elements and mechanical properties. What can and should I expect from a selected steel grade and what is it suitable for. The most common standards are the American Iron and Steel Institute the AISI and the German grade system. In addition, stainless steel is sometimes referred to by its chemical composition.





## AISI

The American Iron and Steel Institute, AISI for short, describes grades 304 and 316, among others. A chosen number behind which is the chemical composition. This is an international organization that regulates standards. 304 is one specific alloy, variations on this are certainly possible. We then see 304 with certain letter additions. The chemical composition is then slightly modified.

## GRADE

With the German origin, "Stahlschlüssel" is presented in which all stahl alloys are bundled. The system in this "Stahlschlüssel" is based on a 5-digit number combination with a separator after the first digit. As an example, 304 is designated as 1.4301 within this system. With a small variation, a new Werkstoff number is selected. This makes searching or recognition a bit more complicated. For example, a 304L is then 1.4306 or 1.4307.

## CHEMICAL

The chemical composition is also still shown as an indication of quality. For the processor, this is the clearest indication because you can immediately see what is in the steel.

We know a 304 in this form as an X5CrNi18-10 or even shortened to 18/10 quality.

The X indicates that the numbers after the alloying elements are added as a percentage. The "5" refers to the percentage of carbon in 1/100 indicated. So in this example, a 304 has 18% Chrome and 10% Nickel added to the steel.

## VARIANTS

In addition to the previously mentioned qualities, other elements can be added, creating new variants.

These then have a different chemical composition, different mechanical properties, (higher) corrosion resistance or are more resistant to higher temperatures.

Examples are:

- > 304L and 316L with a lower carbon percentage than 304 and 316;
- > The opposite is also possible: 304H and 316H;
- > 321 is created by adding Titanium (Ti) to 304 quality;
- > The addition of silicon (Si), among other things, results in heat-resistant grade 310.

## DIFFERENCES

We have now looked primarily at the designations and variations on these. If we look specifically at the two most common types of 304 and 316, two things immediately stand out. This becomes most obvious when we present the chemical composition in the following way: 304 as X5CrNi18-10 and 316 as X5CrNiMo17-12-2.

What stands out is the addition of 2% Molybdenum and the increase in the Nickel percentage of also 2%. Here is also directly the explanation of the large price difference, because Nickel and Molybdenum are 2 relatively expensive elements.

More important is to know why these differences are there and the effect on corrosion resistance and mechanical properties.

The addition of the Nickel makes the steel tougher and thus more deformable. The Molybdenum increases the strength of the metal, allowing for lighter construction.

Corrosion resistance has increased significantly with the addition of these elements.

## APPLICATION

Due to the chemical differences between 304 and 316, there is a great distinction in physical and mechanical properties that we find in the table below. This clearly defines the area of application. Despite the fact that 304 is a good and widely used stainless steel, its corrosion resistance is more limited than that of 316. We find the application of 304 mostly in dry, non-aggressive environments and a lot in constructions. It is less suitable for applications in acidic soils or marine environments.

Nevertheless, given its more favorable price and availability, 304 is widely used and its limiting corrosion resistance is sometimes taken at face value.

## PRICE EFFECT

As indicated, nickel and molybdenum are strong price drivers. The price of nickel can be tracked on the London Metal Exchange site: [www.lme.com](http://www.lme.com).

UNS	GRADE	CHEMICAL	%C	%Cr	%Ni	%Mo	MIN. STRETCH LIMIT [N/MM2]	MIN. PULL STRENGTH [N/MM2]	STRETCH [%]
304	1.4301	X5CrNi18 9	<0,05	17-18	8-9	0	140	240	40
316	1.4401	X5CrNiMo 17 12 2	<0,05	17-18	10-12	2-3	145	245	45



## CONCLUSION

304 and 316 are two of the most widely used types of stainless steel, each with specific properties and applications. 304 is cost-effective and multipurpose, suitable for general construction in non-aggressive environments. 316 offers higher corrosion resistance and mechanical strength, making it more suitable for aggressive and marine environments. Choosing between 304 and 316 depends on the specific requirements of the application, with corrosion resistance and mechanical properties being key considerations.

Whether you are looking for the right stainless steel grade for your next project or have a question about the availability of 304 and 316, we are here to help. Our experts can provide you with detailed information and guidance to ensure you make the most cost-effective and durable choice. Contact us today for a consultation and find out how we can support you in achieving your goals with high-quality stainless steel.

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