

Technical

STAINLESS STEEL AND MAGNETISM

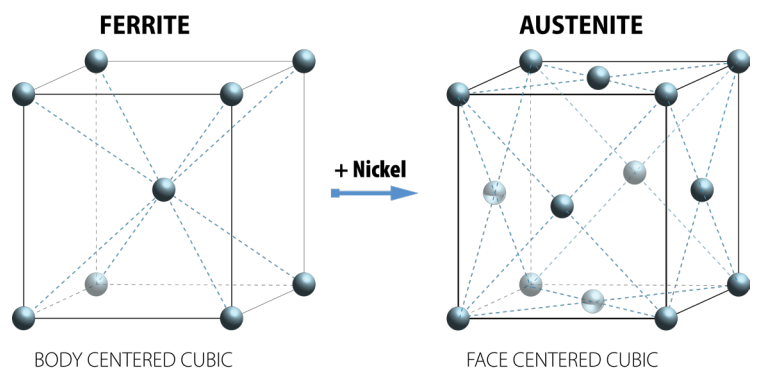
1 INTRODUCTION

Stainless steel is often associated with the idea of being “non-magnetic,” but this isn’t always true. In reality, there are different behaviors regarding magnets within the stainless steel family, and the reason lies in their internal structure.

Stainless steel is not a single material, but a family of alloys primarily composed of iron, chromium, and, in many cases, nickel. Depending on how these elements are combined, the atoms organize themselves in different ways, leading to crystalline structures that determine whether the material will be magnetic or not.

Austenitic stainless steels, such as the well-known 304 or 316, contain a higher proportion of nickel. This composition creates a crystalline structure in which the magnetic domains cannot align, making them practically non-magnetic. This is why they are most commonly used in kitchen utensils, sinks, or applications where interaction with magnetic fields must be avoided.

In contrast, ferritic and martensitic stainless steels have a different structure that does allow these domains to align. As a result, these materials are magnetic and clearly respond to a magnet. They are frequently used in cutlery, household appliances, or components where magnetism may be useful or, at the very least, does not pose a problem.



Ferritic
MAGNETIC



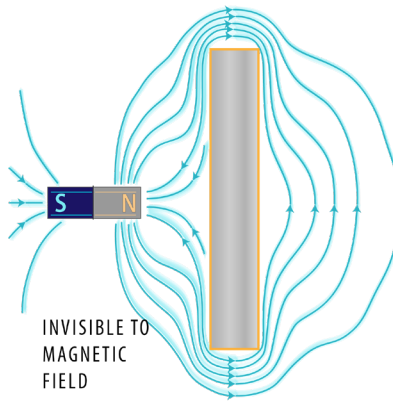
Austenitic
NON MAGNETIC

2 THE TECHNICAL KEY: MAGNETIC PERMEABILITY

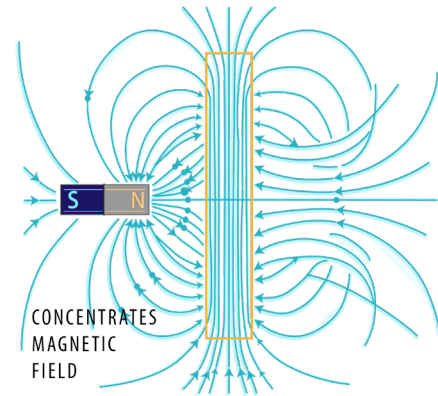
The behavior of stainless steels does not only depend on whether they “stick” to a magnet, but on how they interact with energy. To understand this, we use two indicators:

1. Magnetic permeability (μ):

in simple terms, this property indicates how “receptive” the material is to magnetism. It describes the ease with which magnetism passes through the metal. Ferritic and martensitic stainless steels have very high permeability (around 700, 1000, or even more), so they magnetize strongly. However, austenitic steels have values close to 1, behaving almost like air; they are practically indifferent to magnetic fields.



**A U S T E N I T I C
S T A I N L E S S S T E E L**
Permeability $\mu \approx 1$



**F E R R I T I C
S T A I N L E S S S T E E L**
Permeability $\mu > 700$

2. Electrical Resistivity (Response Speed): in precision engineering, it is not only important that the steel is magnetic, but that it “obeys” instantly. When attempting to magnetize a metal very quickly, small internal energy eddies (eddy currents) appear and act as an invisible brake. Stainless steel has high electrical resistivity, which hinders the formation of this “brake”. These stainless steel families offer a much faster response:

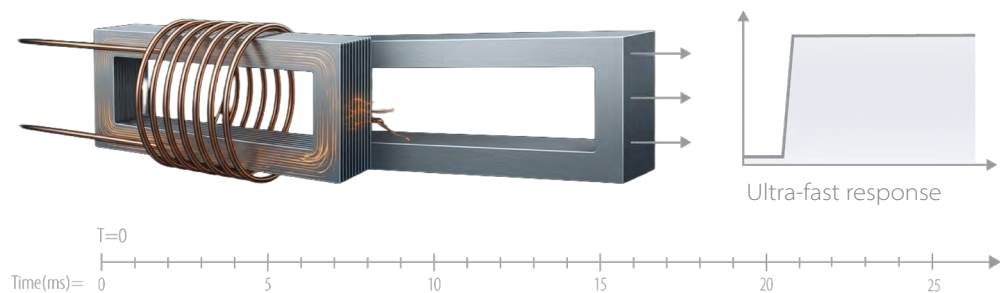
a Ferritics (400 Series): these are the speed specialists, with values between 60 and 78 $\mu\Omega$ cm, making them ideal for fuel injectors or solenoid valves that operate hundreds of times per second.

b Martensitics: these offer great mechanical strength and magnetism with a resistivity near 57 $\mu\Omega$ cm, excellent for components requiring physical robustness.

MATERIAL A: LOW RESISTIVITY (iron)



MATERIAL B: HIGH RESISTIVITY (ferritic stainless steel 400 series)



This high electrical resistance allows magnetism to enter and leave the material almost instantly, ensuring absolute accuracy in fast-response devices

3

WHEN DOES IT MATTER IN STAINLESS STEEL?

Magnetism in stainless steel is not a defect, but a characteristic utilized depending on the application.

For example, in induction cooktops, it is necessary for the stainless steel to be magnetic so that heat can be generated. Without this property, the plate simply would not work. Therefore, many utensils combine layers of austenitic stainless steel with magnetic bases

On the other hand, in environments such as MRI medical equipment, precision electronics, or watchmaking, completely non-magnetic stainless steels are preferred to avoid interference or risks associated with intense magnetic fields.



4

A CURIOUS PHENOMENON: INDUCED MAGNETISM

Even within stainless steel, magnetism can change. An austenitic steel, originally non-magnetic, can become slightly magnetic if it is cold-deformed, for example by bending, stamping, or machining it.

This occurs because mechanical stress partially alters its internal structure, transforming part of the austenite into martensite, a phase that is indeed magnetic.

To manage this transformation, materials engineering relies on several strategies:



BEFORE
304 Stainless -
Annealed, non
magnetic

PROCESS
Cold Work
Transformation

AFTER
Induced Magnetism
in Bend Zone

Chemical composition:

Austenite stability can be reinforced by adding more nickel, making it harder for the material to "become" magnetic after processing.

Predictive parameters:

The Md30 value (the temperature at which 30% deformation generates 50% martensite) is used to predict and control this sensitivity.

Heat treatments:

If manufacturing has already induced magnetism, an appropriate heat treatment can restore the original structure and its non-magnetic character.

Stainless steel is not simply magnetic or non-magnetic; it depends on its composition and structure. Magnetism, far from being a quality indicator, is a design tool that allows the material to be adapted to different needs.

The key lies in choosing the right grade for the application, ranging from completely non-magnetic materials to those designed to interact actively with magnetic fields.