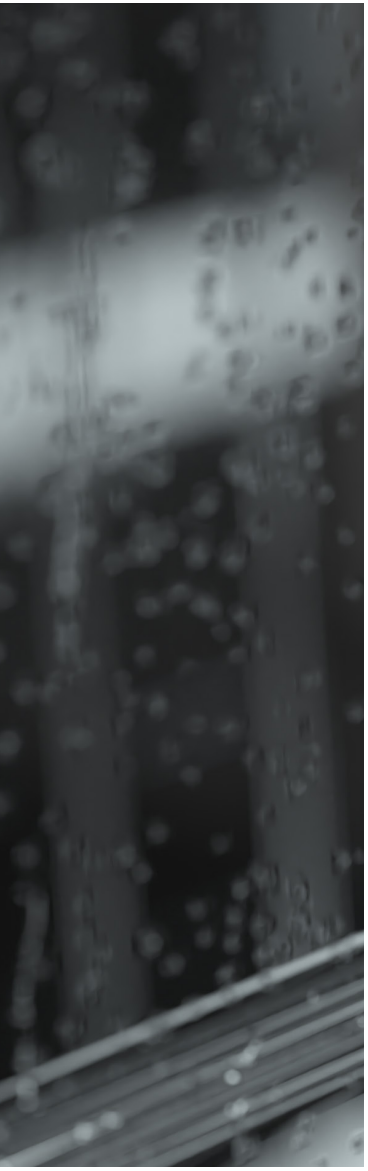
outokumpu

Catering for extremes in commercial kitchens

Stainless steel must cater for extremes in commercial kitchens. When used for appliances like dishwashers, ovens and hobs as well as food preparation surfaces it has to handle everything from wet conditions to flames and freezing temperatures, as well as meeting strict hygiene standards and expectations for durability and long life.

But not all stainless steels grades are the same beneath their shiny surface. Extreme expertise in metallurgy is required to produce the perfect recipe for every application. In this article Outokumpu outlines the main types of stainless steel found in kitchens – austenitic and ferritic - and explains the key factors that influence their selection.



Why choose stainless steel for catering equipment?

For end-users, stainless steel not only provides aesthetic appeal in the kitchen environment, its exceptional corrosion resistance, strength and durability means that it will outlast most competing materials. Furthermore, it is easy to keep clean and hygienic thanks to its hard, metallic surface that makes it difficult for bacteria to adhere and survive. It is also non-toxic and perfectly neutral in contact with foodstuffs – even with aggressive acids from fruit and vegetables - ensuring that their taste and appearance remain unchanged.

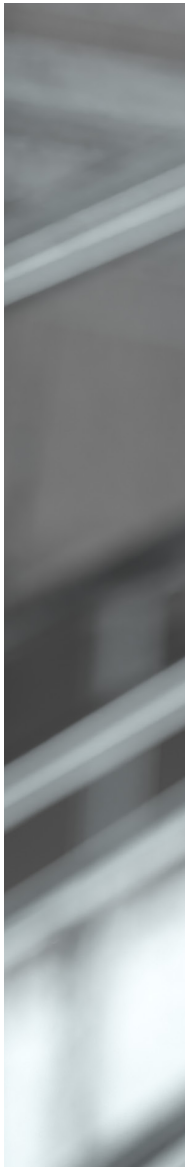
For manufacturers of catering equipment, stainless steel is good for forming into complex shapes, although it should be noted that the level of formability depends on the grade selected. It is also sustainable as it is produced using around 85 percent recycled steel content and is 100 percent recyclable at the end of its long working life.

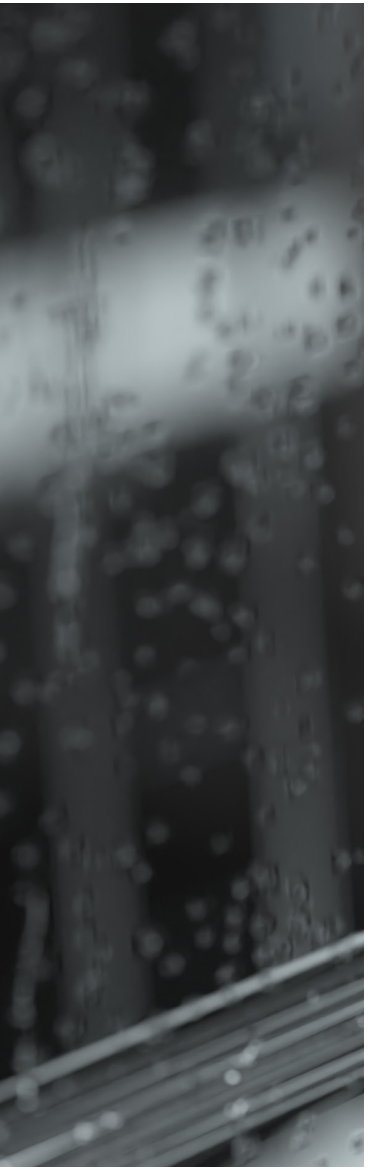
What gives stainless steel its corrosion resistance?

Stainless steels are not fundamentally noble materials in the same way as gold or platinum. Instead they derive their corrosion resistance from a thin, invisible and insoluble oxide layer, commonly called the passive film, or passive layer.

Even though this passive layer is only a few nanometers thick, it effectively isolates the metal beneath from its surroundings so that electrochemical reactions causing corrosion are inhibited. The passive layer reduces the corrosion rate to only a fraction of what it would be otherwise.

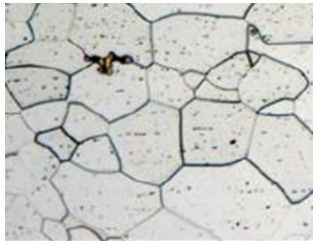
The passive layer forms spontaneously in environments containing enough oxidants. Moreover, if the metal beneath the passive layer is exposed by mechanical damage, such as scratches, it self-heals spontaneously. The oxygen content of air, and most aqueous solutions, is enough for both the creation and maintenance of the passive layer. In the right conditions stainless steel could last forever.



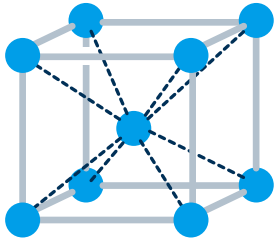


Two types of stainless steel for commercial catering equipment

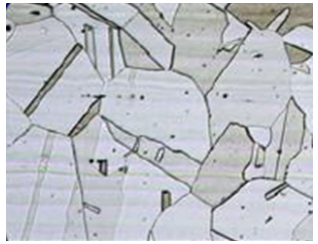
Iron is the main constituent of all steels. Pure iron normally exists in one of two kinds of crystal structure. One is alpha-iron with a body-centered-cubic (bcc) lattice – forming a material known as ferrite, which is magnetic. The other is a gamma-iron face-centered-cubic (fcc) lattice – forming austenite, which is non-magnetic - see Figure 1.



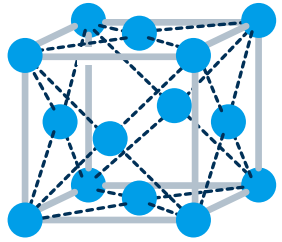
Ferritic steels



bcc-lattice

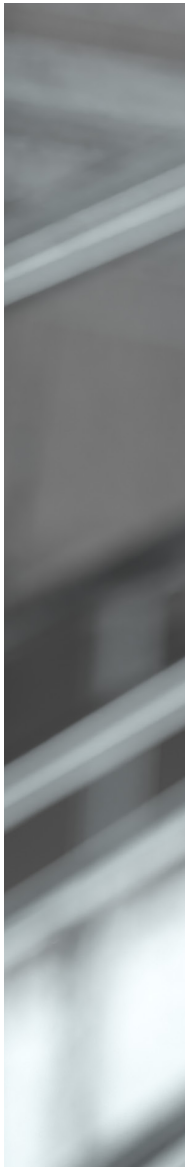


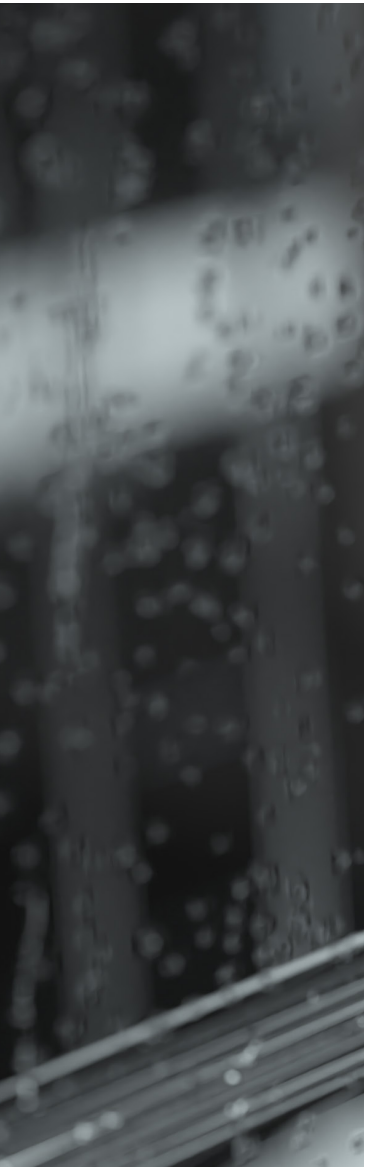
Austenitic steels



fcc-lattice

Fig. 1. Pure iron can take on two crystal structures.



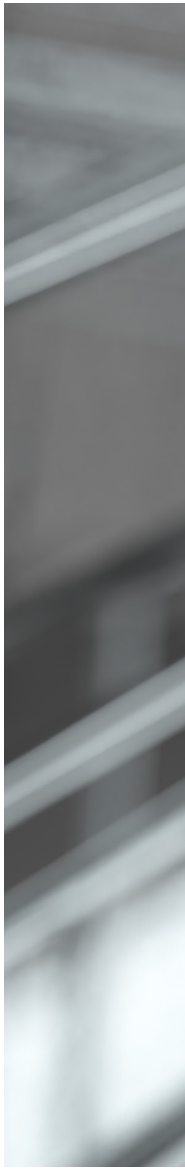


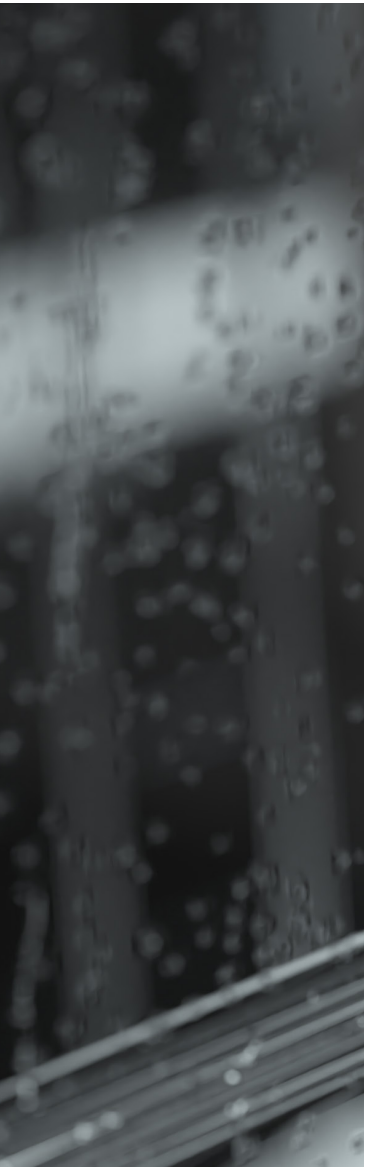
At room temperature, pure iron exists as ferrite. It transforms into austenite at temperatures above 911°C. However, special alloying elements called austenite formers - like nickel, manganese, cobalt or nitrogen – enable austenite to exist at room temperature. Iron alloyed with more than 12 percent chromium (Cr) results in a ferritic steel that creates the protective oxide layer on its surface. Because of their characteristic microstructure, austenitic steels show different properties to ferritic steels.

Both ferritic and austenitic grades have catering applications. Figure 2 shows the chemical compositions of some typical grades. The most commonly used grades are ferritic 430 and austenitic 304.

Grade	AISI	C	Cr	Mo	Ni	Others
Ferritic Steels						
1.4016 X 6 Cr 17	430	0.040	16.0			
1.4509 X 2 CrTiNb 18	441	0.020	17.5			Ti 0.15, Nb 0.40
1.4510 X 3 CrTi 17	439	0.020	17.0			Ti
Austenitic Steels						
1.4301 X 5 CrNi 18-10	304	0.040	18.1		8.2	
1.4401 X 5 CrNiMo 17-12-2	316	0.040	17.2	2.1	10.1	
1.4404 X 2 CrNiMo 17-12-2	316L	0.020	17.2	2.1	10.1	

Fig. 2. The chemical composition of some typical ferritic and austenitic stainless steels.





Austenitic stainless steel offers significant advantages in severe forming operations, such as deep drawing of sinks, as shown in Figure 3 and 4. In particular, its capability for work hardening offers more design options, making austenitic steel a good choice for high level, prime products.

Stress-strain diagrams

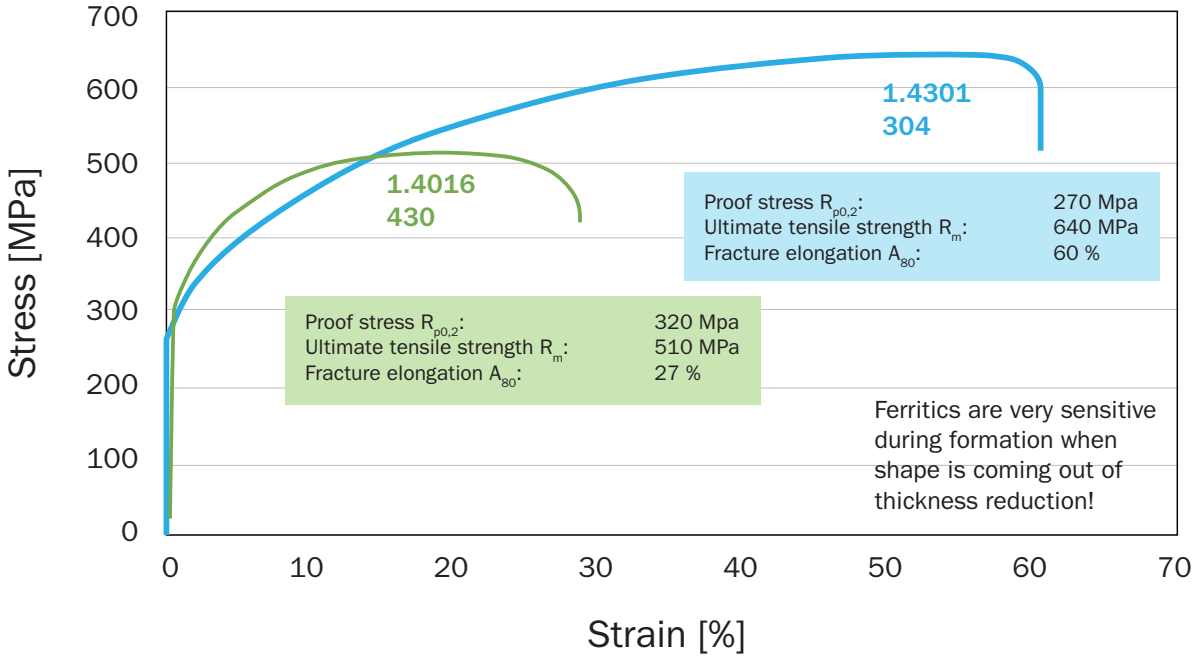
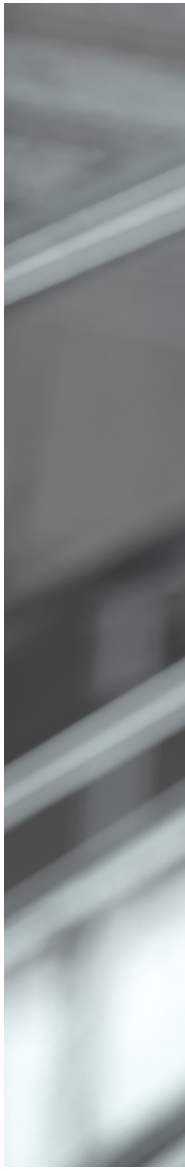
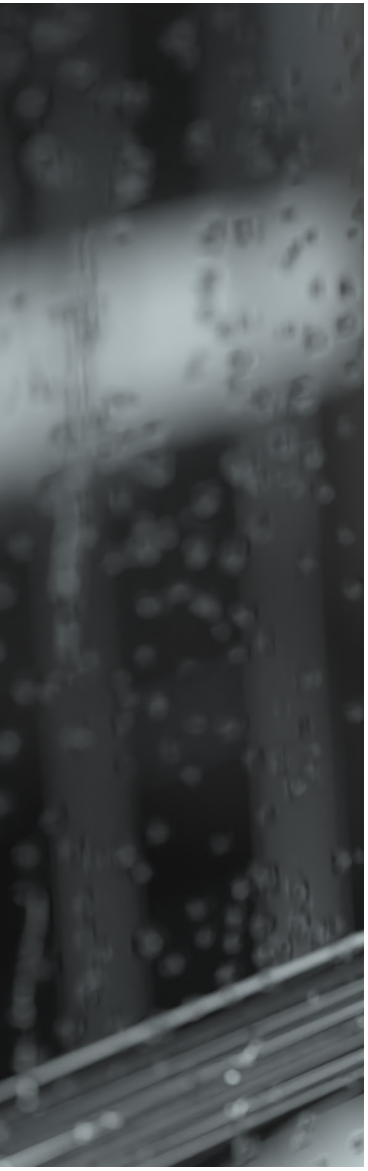
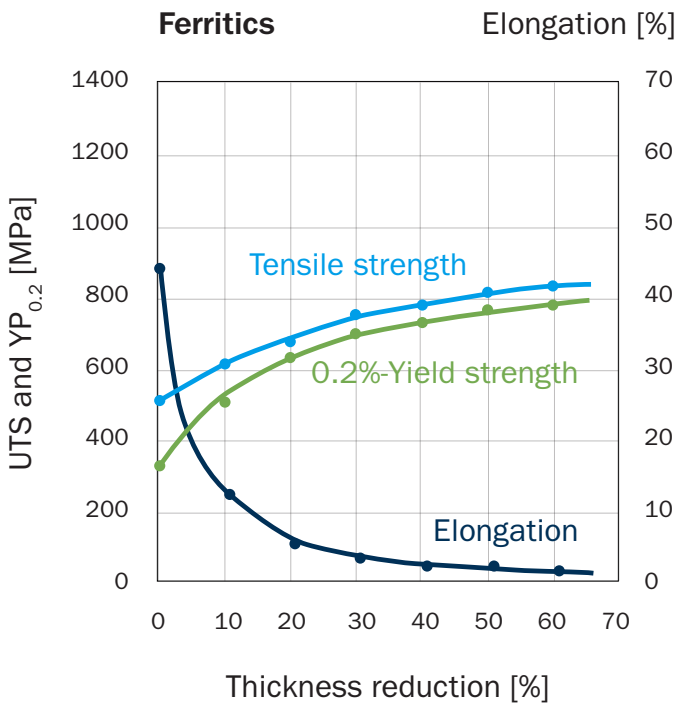


Fig. 3. Comparison of the stress-strain properties of ferritic (430) and austenitic (304) stainless steels.





Work hardening effect



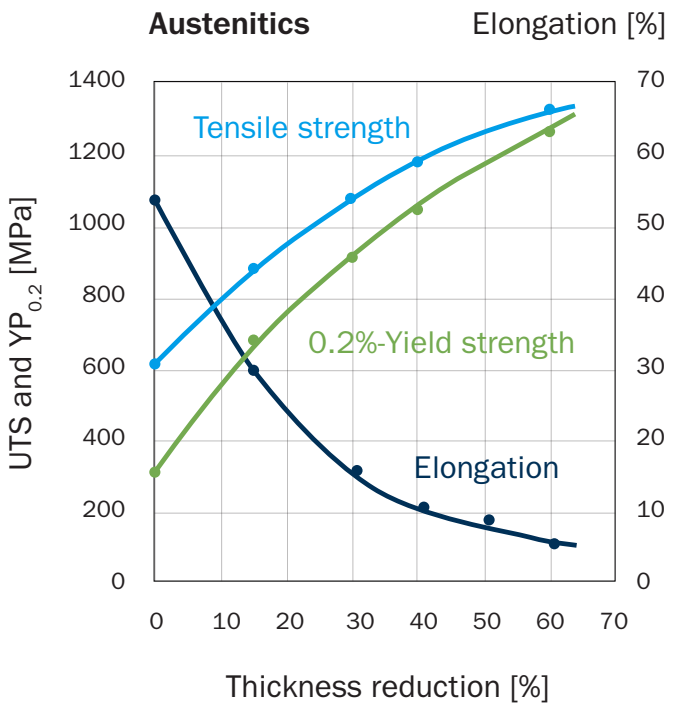
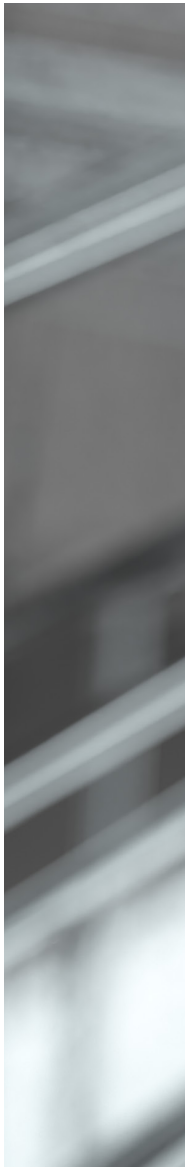
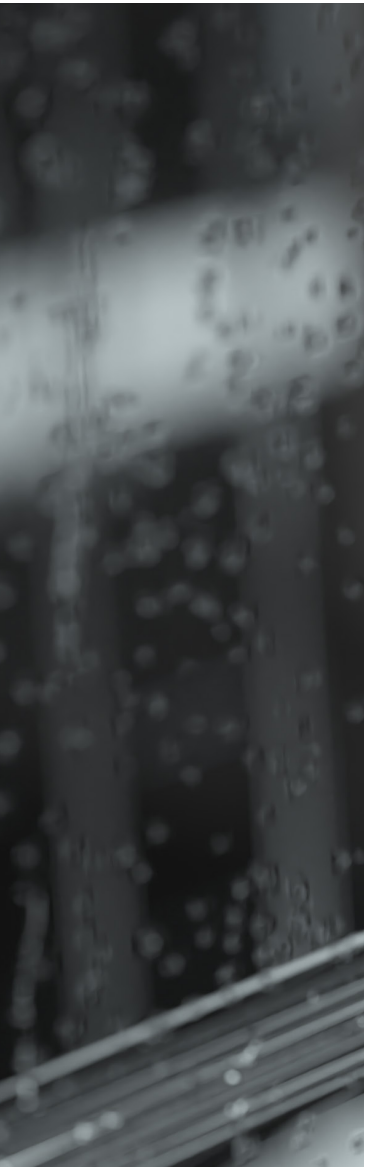


Fig. 4. **Austenitic steel becomes stronger due to work hardening.**





Austenitic steel also offers better corrosion resistance. This is illustrated in Figure 5 that compares the pitting resistance of different steel grades. This does not mean that 430 will not perform adequately in catering applications. But 304 is significantly better.

Corrosion resistance – pitting resistance

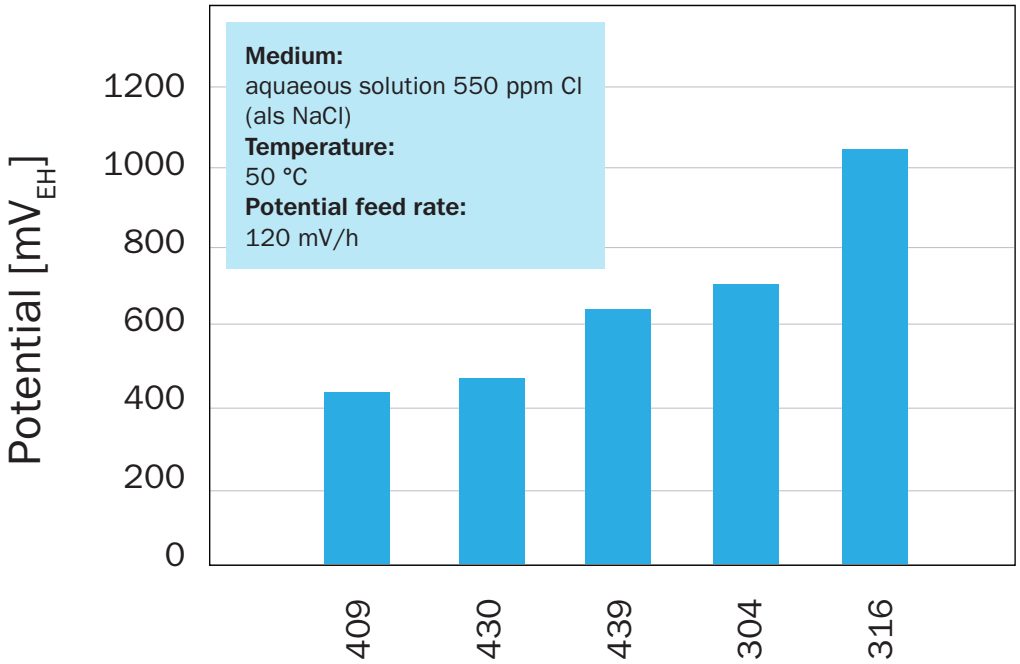
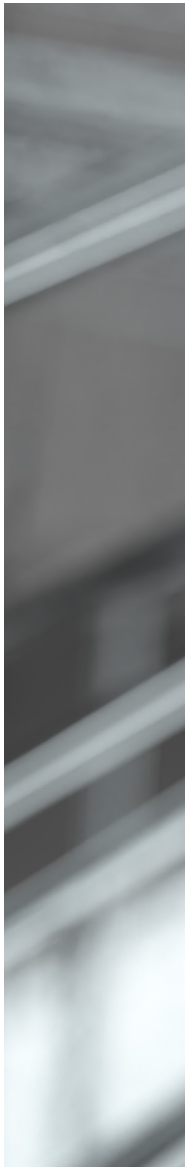
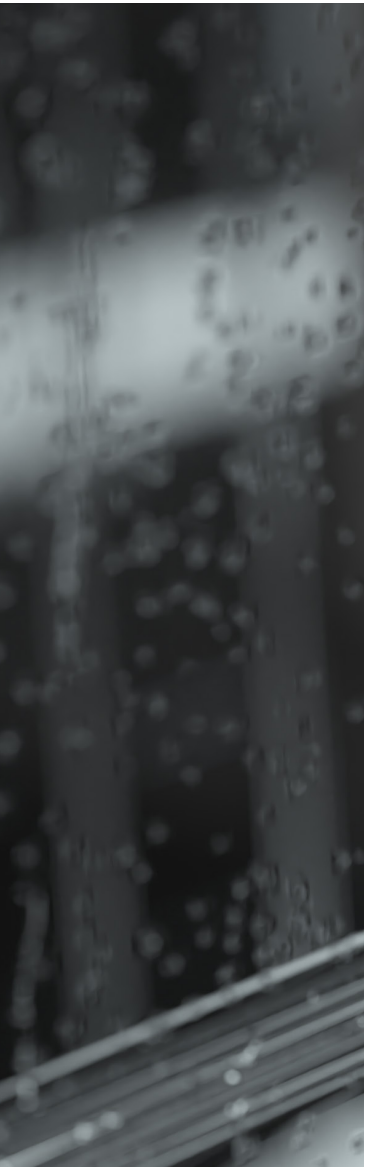


Fig. 5. **A comparison of the pitting resistance of steel grades.**





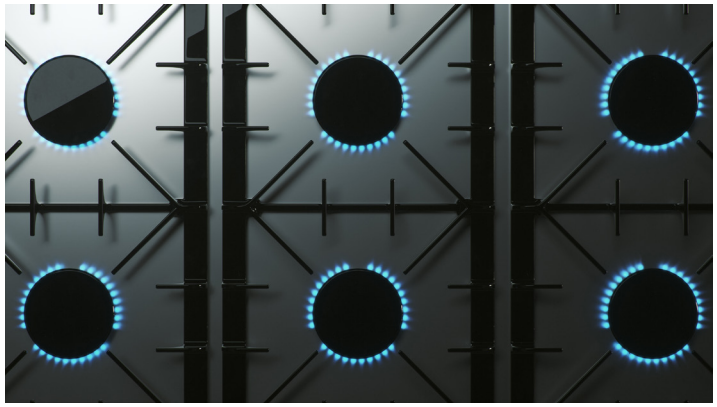
Bright or dull? Matching the surface finish to your application

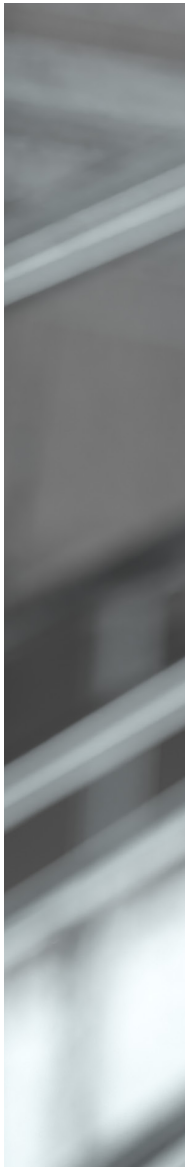
The most popular surface finish for the cold rolled strip used in catering equipment is the ‘bright’ annealed 2R or the ‘dull’ annealed and pickled 2B. A variety of special finishes are also available including polished, brushed and patterned.

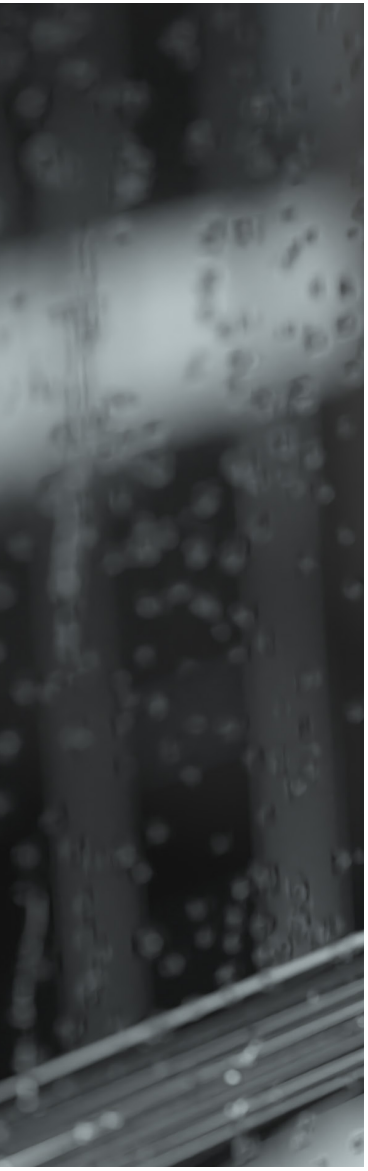
Because stainless steel is protected by its self-healing passive layer it lasts much longer than competing steel materials protected by coatings, as they wear off over time.

In some cases, stainless steel can be coated with plastic film protection either for surface protection during manufacturing or to facilitate forming. These films are removed at the end of the production process.

Outokumpu experts can support customers in the selection of the right surface finish to meet their aesthetic design and performance needs. They can tailor a stainless steel solution according to the specific requirements of each application.







Manufacturing processes are straightforward – but there are rules

Stainless steel is not a direct ‘drop-in’ substitute for ordinary carbon steel in manufacturing processes as ferritic and austenitic grades show different behaviors. There are therefore some specific rules that need to be followed. These are relatively straightforward and are fully documented in guidelines for forming, joining and welding while Outokumpu’s technical support team can provide expert advice.

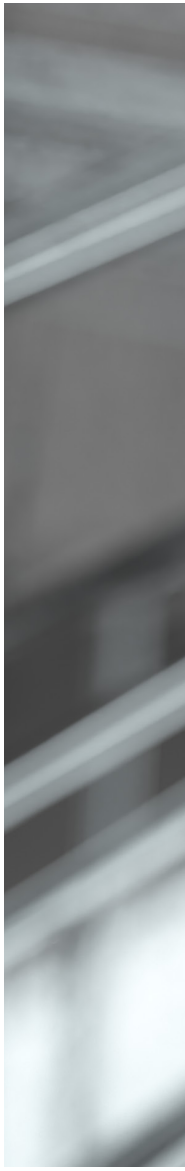
One example is when welding non-stabilized ferritic stainless steels, as 430 is prone to intergranular corrosion attack following welding. This is because chromium and carbon form chromium carbides on grain boundaries with the consequence that grain boundary zones are depleted in chromium, which lowers the local corrosion resistance. When welding is required stabilized ferritic grades such as 439 or 441 should be specified.

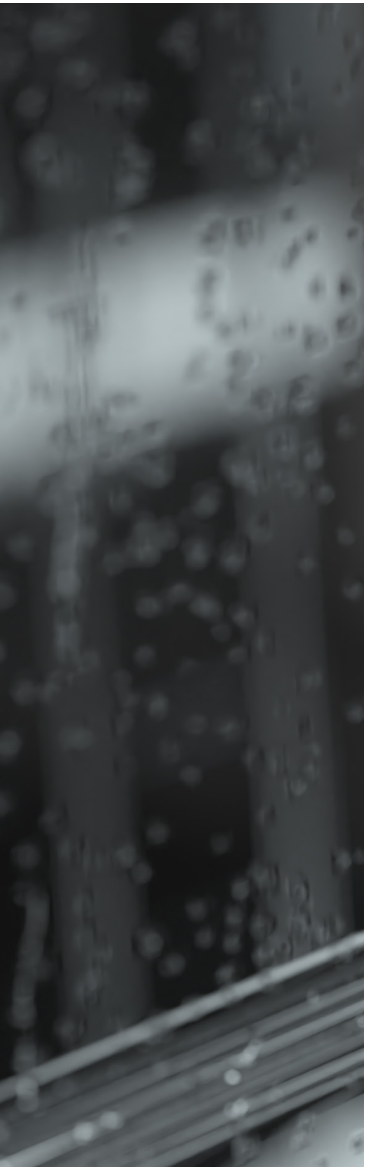
Keeping it clean

One of the key advantages of stainless steel is that it is easy to keep clean for maximum hygiene. This is due to its smooth non-porous surface that prevents aggressive liquids like tomato juice or acid juices permeating into the material. Furthermore, stainless steel does not require any further surface protection which might come away during use to create areas that could harbor dirt and germs.

To maintain the material in the best possible condition care should be taken to follow the instructions with regard to cleaning agents, disinfectants and cleaning processes. These include:

- Avoid using hard utensils
- Avoid over-heating
- Avoid leaving cleaner on the surface
- Rinse thoroughly, especially when using agents containing chlorine
- Always use the correct concentration of cleaner – never over-concentrate
- Dry thoroughly so that surfaces are never left wet





Three common misconceptions

There are three main things that designers considering stainless steel for catering equipment in commercial applications do not always fully appreciate:

Stainless steel can last a lifetime when treated with respect

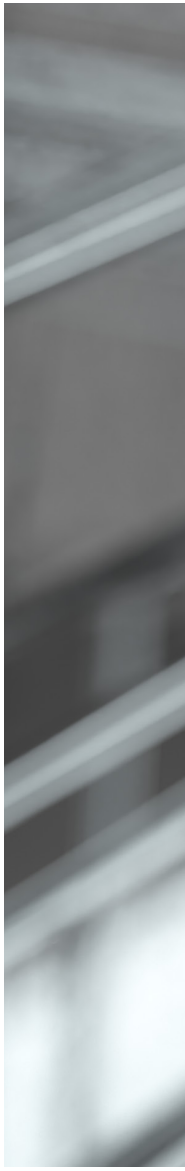
Stainless steel is robust and durable, but to ensure it will last a lifetime it should be treated with respect. That means following the guidelines with regard to design, especially with ferritic grades that can be subject to pitting and crevice corrosion.

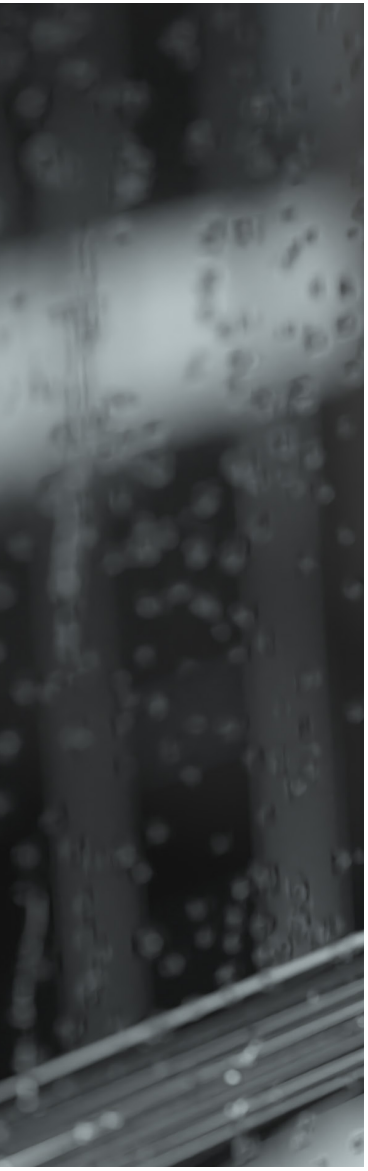
Scratches are not the end of the world

Surface scratches are detrimental to visual appeal, but they do not impact performance. Following a scratch, the stainless steel re-passivates very quickly so that the material maintains its corrosion resistance.

Stainless steel can be the most cost-effective choice of material

Stainless steel can appear expensive as the initial investment in the raw material is generally higher than for carbon steel. However, because of its strength, durability and corrosion resistance it has a long service life. Therefore, stainless steel always proves to be the most cost-effective material when its full life-cycle costs are compared against competing materials.





Making the choice between ferritic and austenitic grades

Figure 6 summarizes the relative merits of ferritic and austenitic grades in typical catering applications such as tables, sinks, gastro-norm containers, ovens, hobs and professional dishwashers. It is clear that austenitic stainless steel is excellent in all respects apart from price.

	Ferritics	Austenitics
Forming	○	●
Corrosion resistance	○	●
Welding	○ *	●
Aesthetics	○ **	●
Price	●	○

○ Good
● Excellent

*: unstabilized ferritics get intergranular corrosion
**: after forming ferritics may show ridging and roping

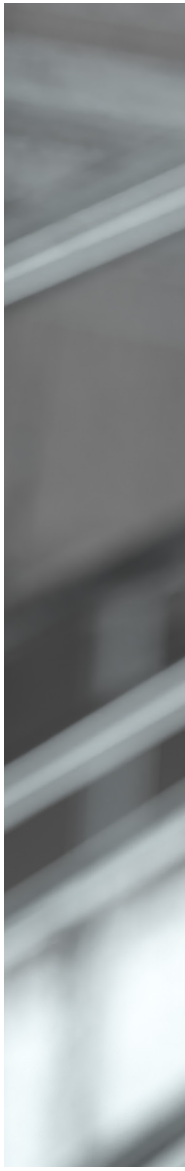
Fig. 6. Comparison between ferritic and austenitic stainless steel

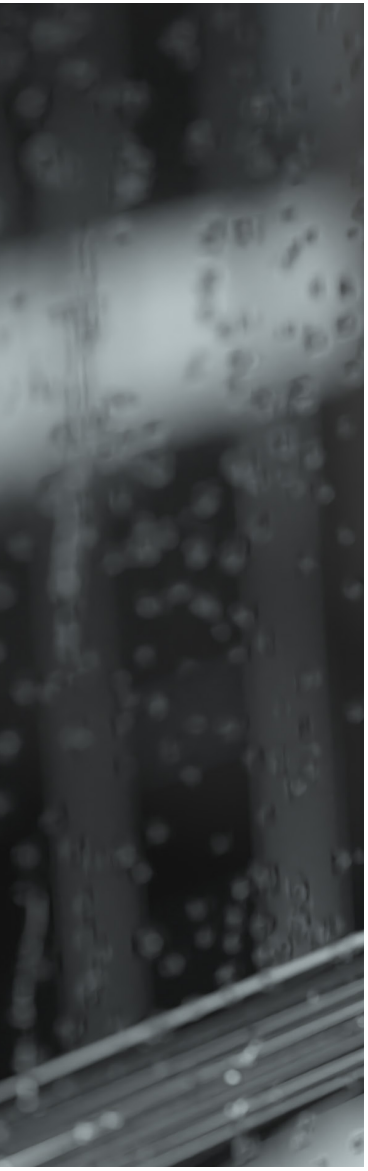
The advantages of using Outokumpu stainless steel

Outokumpu offers the complete range of ferritic and austenitic stainless steel grades in a large variety of surface finishes and product forms such as coils, sheets and blanks. The high quality of the mechanical properties and the uniform surface ensures high productivity in automated production lines.

Outokumpu also takes a flexible approach to supply. Its mills supply stainless steel directly to customers manufacturing high volumes of catering appliances when only a small number of different grades and dimensions are needed. A worldwide network of Service Centers supplies grades with multiple dimensions, smaller production quantities and requiring short delivery times.

The company has extensive experience in testing and recommending stainless steels in many major appliance and catering environments. Its team of highly skilled experts in forming, joining and corrosion provides solutions for demanding applications. Outokumpu also publishes a range of stainless steel handbooks covering machining, forming, welding and corrosion at outokumpu.com.





In specific cases, Outokumpu also offers testing of different stainless steel grades in a customer's own processes on their premises, supported by testing and evaluation by specialists in its own corrosion laboratory. These tests, together with long experience in the catering industry, ensure that the grade customers finally select is the best choice. This support goes beyond material selection to cover planning, logistics advice and adapted services for optimal products, cost-efficient operations, and well-planned deliveries.

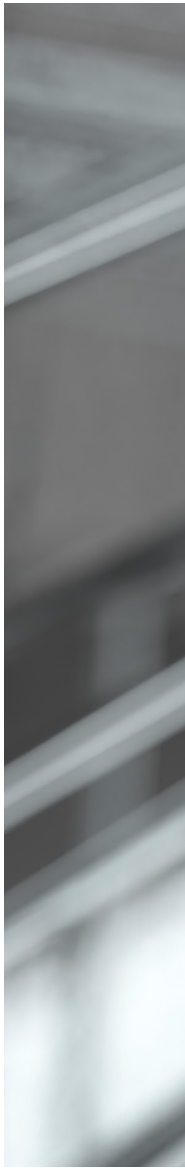
Sustainability is a further reason to work with Outokumpu. Stainless steel is a superb material for sustainable solutions as it is 100 percent recyclable, efficient and long-lasting. Outokumpu is industry leader in sustainability as according to internal estimates its stainless steel has the lowest carbon footprint of the industry when taking into account all indirect emissions, including raw materials. It is committed to reach carbon neutrality by 2050. It also leads the industry in terms of contribution to the circular economy. The recycled steel content of Outokumpu's stainless steel is over 85 percent and the company is continuously looking for ways to minimize its environmental impact.

Eight reasons to consider stainless steel for your extreme catering applications

Stainless steel is the ideal choice for extreme catering applications where it delivers:

- Corrosion resistance
- Aesthetic appeal
- Strength
- Durability
- Formability
- Hygiene
- Cost effectiveness over a long service life
- Sustainability

Working closely with customers, Outokumpu's expertise in material behavior and production techniques is complemented by a deep understanding of the appliance industry and its requirements. Interested? Let's tackle your catering extremes together.



Working towards a world that lasts forever

We work with our customers and partners to create long lasting solutions for the tools of modern life and the world's most critical problems: clean energy, clean water, and efficient infrastructure. Because we believe in a world that lasts forever.

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