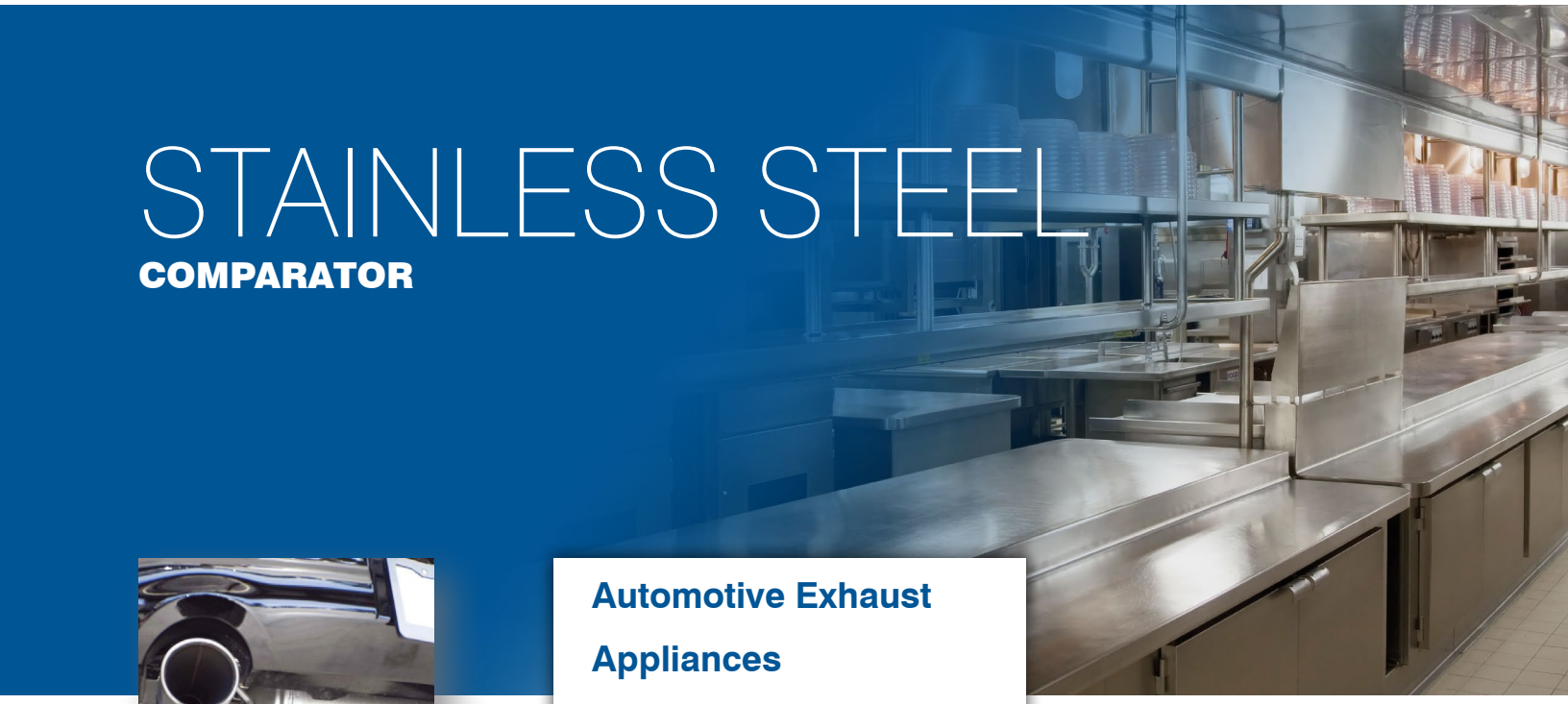
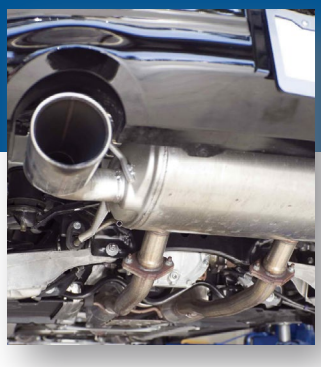
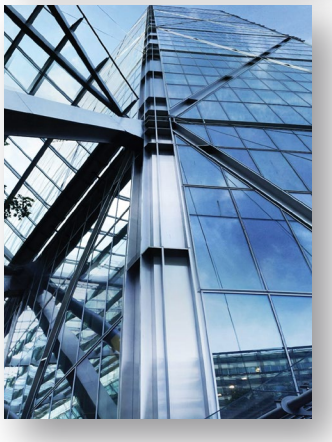
CLIFFS

STAINLESS STEEL
COMPARATOR







Automotive Exhaust

Appliances

Architectural

Cutlery / Cookware

Heating, Ventilation – and Air Conditioning

This product comparator reviews the fundamentals of stainless steels. It compares the types, grades, chemistries, finishes and applications of stainless steels produced by Cleveland-Cliffs. The basic product information contained in the following pages will help you match your application needs with a specific grade of stainless steel.

What is Stainless Steel?

In the early 1900s, metallurgists noticed that chromium (Cr) had a greater attraction to oxygen (O_2) than iron (Fe) did, so they added chromium to steel. Studies proved that, when at least 10% chromium was added, the chrome bonded with oxygen to form a very tight, transparent layer over the steel surface that prevented rusting by precluding further oxidation. This transparent layer is self-healing when damaged by scratches, wear or denting.

Stainless steels are materials of enduring beauty. These steels also withstand the corrosive attack of many acids. They possess strength and toughness at both extremes of the temperature scale, yet can be fabricated into intricate shapes for many uses. Because of this outstanding versatility, stainless steel deserves careful consideration for any product where one or more of the following requirements are involved:

- Abrasion Resistance
- Appearance
- Corrosion Resistance
- Oxidation Resistance at High Temperatures
- Strength and Ductility at Cryogenic Temperatures
- Strength at Elevated Temperatures

There are more than 250 different types of stainless steels. These various grades of stainless are divided into five major classes. These classes have been developed to consolidate the chemistries and mechanical properties required to meet specific customer application needs.

AUSTENITIC STAINLESS STEELS

Austenitic stainless steels are the most specified grades produced because of their excellent formability and corrosion resistance. All 200 and 300 series steels are austenitic, and contain 15% to 30% chromium and 2% to 20% nickel (Ni) for enhanced surface quality, formability, and increased corrosion and wear resistance. They are non-magnetic in the annealed condition. However, depending on the composition, primarily the nickel content, they become slightly magnetic when cold worked. These steels are used for appliances, kitchen equipment, automotive trim, cookware, processing equipment and a variety of industrial and decorative applications.

FERRITIC STAINLESS STEELS

This group of ferritic stainless steels (400 series) contain 10.5% to > 30% chromium for corrosion scaling at elevated temperatures and resistance. They are non-hardenable by heat treating, and always magnetic. Ferritic stainless steel is used in applications where resistance to corrosion and oxidation is important. The lower chromium (11%) ferritics are primarily used in automotive exhaust.

Ferritics with intermediate chromium contents (15 – 17%) are used for automotive trim, hot-end automotive exhaust, appliances, and cooking utensils. The high-chromium ferritics (18 – 30%) are used in automotive exhaust, trim, and appliance applications requiring high oxidation and corrosion resistance.

MARTENSITIC STAINLESS STEELS

These 400-series steels usually contain a minimum of 11.5 – 18% chromium and have higher levels of carbon than ferritics. They are capable of being heat treated to a wide range of useful hardness and strength levels, and are used extensively in cutlery, sports knives, multipurpose tools and structural parts.

PRECIPITATION-HARDENING (PH) STAINLESS STEELS

There are two general groups of PH grade stainless steels: martensitic and semi-austenitic. The martensitic group includes Cleveland-Cliffs 17-4 PH® Stainless Steel and Cleveland-Cliffs 15-5 PH® Stainless Steel chromium nickel (CrNi), with niobium (Nb) and copper additions. They develop their high strength and hardness through heat treatment, which precipitates the copper. The martensitic PH steels are used in aerospace, chemical, petrochemical and food processing applications.

The semi-austenitic grades are Cleveland-Cliffs 17-7 PH® Stainless Steel and Cleveland-Cliffs PH 15-7 Mo® Stainless Steel. They are austenitic in the annealed state, but martensitic in the hardened condition. Cleveland-Cliffs 17-7 PH Stainless Steel has excellent high strength and fatigue properties, and is used in aerospace components. Cleveland-Cliffs PH 15-7 Mo Stainless Steel is used in applications requiring high strength and hardness, such as retaining rings, springs and aircraft bulkheads.

DUPLEX STAINLESS STEELS

These alloys have a mixture of austenite and ferrite in their structure. They exhibit characteristics of both phases with higher strength and ductility. Nitrogen is added to second generation duplex alloys, providing strength and increased weldability. NITRONIC® 19D Stainless Steel has good cyclic oxidation, high strength and excellent stress corrosion resistance. Type 2205 provides very good pitting and uniform corrosion resistance, high strength and high resistance to stress corrosion cracking

STAINLESS STEEL COMPARATOR

TABLE 1 – RELATIVE CHARACTERISTICS OF STAINLESS CLASSIFICATIONS*

	Low C Steel	Austenitic	Ferritic	Martensitic	Duplex	Precipitation Hardening
Room Temp. Strength	L	M/H	M	VH	H	VH
Formability	H	M/H	L/M	L	L/M	L/M
Toughness	M/H	H	L/M	M	M	M
Corrosion Resistance	L	H	M/H	M	H	M/H
Strength at Temperature	L	H	L/M	—	M	H
Oxide Resistance	L	M	H	—	M/H	M
Weldability	H	M/H	M/H	L	L/M	M
Cost	L	H	M	M	H	H

**Low (L), Medium (M), High (H), and Very High (VH)*
This table is intended to give general guidance. Individual alloys in each family may be optimized for performance in a given area

Alloys Make the Grade

From heat to heat, the manufacture of quality stainless steels demands precise control of raw material ingredients and melting practices. Exact quantities of presorted scrap and alloying elements are delivered to the melting furnaces so that the heats will be within specified composition ranges. Those composition ranges typically include a group of chemical elements for each grade of stainless steel.

ALLOYING ELEMENTS

Following is a list of alloying elements found in stainless steels and their functions.

Cr CHROMIUM forms a surface film of chromium oxide to make the stainless steel corrosion resistant. It also increases the scaling resistance at elevated temperatures.

Ni NICKEL stabilizes the austenitic structure and increases ductility, making stainless steel easier to form. It increases high temperature strength and corrosion resistance, particularly in industrial and marine atmospheres, chemical, food and textile processing industries.

Si SILICON increases scaling resistance by forming a tight initial scale that will withstand cyclic temperature changes. It resists carburizing at high temperatures and slightly increases tensile strength and hardness. Small amounts of silicon are added to all grades of stainless for deoxidizing.

Mn MANGANESE promotes the stability of austenite at or near room temperature, and improves hot working properties. An addition of up to 2% manganese has no effect on strength, ductility and toughness. Manganese is important as a partial replacement of nickel in 200 series stainless grades.

Mo MOLYBDENUM increases corrosion resistance, strength at elevated temperatures and creep resistance. It expands the range of passivity and counteracts tendency to pit, especially in chloride environments.

Al ALUMINUM is a very strong ferrite former and lowers the hardenability of stainless steel. It improves scaling resistance.

C CARBON strengthens stainless steel, but promotes the formation of precipitates harmful to corrosion resistance.

Nb NIOBIUM combines with carbon to reduce susceptibility to intergranular corrosion. It acts as a grain refiner and promotes the formation of ferrite.

Cu COPPER is added to stainless steels to increase their resistance to certain corrosive environments. It also decreases susceptibility to stress corrosion cracking and provides age-hardening effects. Can be used to control work hardening.

Ti TITANIUM combines with carbon to reduce susceptibility to intergranular corrosion. It acts as a grain refiner and promotes the formation of ferrite.

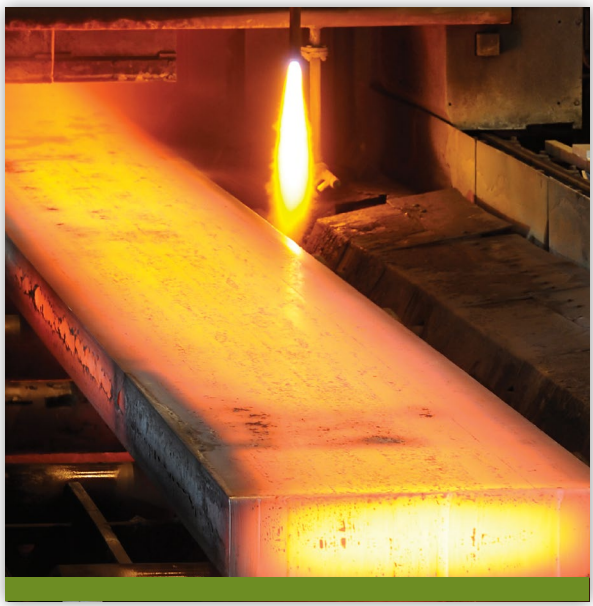


TABLE 2 – AUSTENITIC STAINLESS STEELS

Product	UNS EN JIS	Typical Chemical Composition %			Other Significant Elements	Characteristics	Typical Applications
		Cr	Ni	C			
Type 201	S20100 1.4371 SUS 201	16	3.5-5.0	0.06	Mn – 7	Low Ni, high work hardening	Hose clamps, cookware
Cleveland-Cliffs 201LN	–	16	4	0.025	Mn – 6.75 N – 1.5	Low Ni, high work hardening, improved weldability	Cryogenic applications, springs, food processing
NITRONIC® 30 SS	S20200 1.4373 SUS 202	16	2.5	0.02	Mn – 8.5 N – 0.17	High strength, abrasion resistance, good formability	Hose clamps, truck and bus frames, bulk solids handling equipment, coal buckets and hopper cars
Type 301	S30100 1.4310 SUS 301	17	6.0-8.0	0.1	–	High strength, high work hardening	Wheel covers, springs, hose clamps, food processing equipment
Type 304	S30400 1.4301 SUS 304	18	8.0-12.0	0.06	–	Multipurpose	Food equipment, tubing, architectural trim
Type 304L	S30403 1.4306 SUS 304L	18	8.0-12.0	0.02	–	Low carbon minimizes carbide precipitation during welding	Welded parts and other 304 applications
Type 305	S30500 1.4303 SUS 305	18	10.0-13.0	0.06	–	Excellent drawability, low work hardening	Deep drawn parts, fuel filter tubes
Type 309S	S30908 1.4833 SUS 309S	22	12.5	0.05	N – 0.10	Oxidation resistant	Heating elements, furnace parts, auto exhaust systems
Type 316	S31600 1.4401 SUS 316	16.5	10.5	0.05	Mo – 2	Pitting corrosion resistance	Heat exchangers, chemical equipment, marine applications
Type 316L	S31603 1.4404 SUS 316L	16.5	10.8	0.02	Mo – 2	Low carbon minimizes carbide precipitation during welding	Welded Type 316 applications
Type 321	S32100 1.4541 SUS 321	17	9.5	0.02	Ti – 5x(C+N) min.	Titanium stabilized	Heat exchangers to intermediate temperatures, aircraft

STAINLESS STEEL COMPARATOR

TABLE 3 – FERRITIC STAINLESS STEELS

Product	UNS EN JIS	Typical Chemical Composition %			Other Significant Elements	Characteristics	Typical Applications
		Cr	Ni	C			
Type 409	S40920 1.4512 SUS 409	11	—	0.01	Ti – 0.20	Economical corrosion and oxidation resistance	Automotive exhaust systems, heat exchangers, furnace liners
Aluminized Type 409	—	11	—	0.01	Ti – 0.20 Aluminum Coating	Economical corrosion, oxidation, salt and cosmetic corrosion resistance	Automotive exhaust systems, heat exchangers, furnace liners
Cleveland-Cliffs 409 Ni	S40975 1.4516 —	11	0.85	0.02	Ti – 0.20 Mn – 0.75	Corrosion resistance superior to mild and low-carbon steels	Exhaust flanges, coal handling equipment, transportation equipment
Cleveland-Cliffs 11 Cr-Cb™ ULTRA FORM® SS	—	11	—	0.01	Si –1.30 Nb – 0.35	More oxidation and creep resistant than Types 409 and 439	Auto exhaust components, high-temperature use, furnaces
Cleveland-Cliffs 41003	S41003 — —	11	0.40	0.02	Si –0.40 Mn –0.80	Excellent weldability, toughness and fabricating characteristics	Tubing for bus and truck frames, hopper cars, chutes, storage tanks and shipping containers
Cleveland-Cliffs 400 Cb	—	11.5	—	0.01	Nb – 0.15 Al –0.15	Corrosion resistance comparable to Type 409, better surface finish	Electrical Cabinetry
Cleveland-Cliffs 400	—	12	—	0.015	Al – 0.15	Corrosion resistance comparable to Type 409, better surface finish	Applications requiring improved finish over Type 409, caskets
Type 410S	S41008 1.4000 SUS 410S	12	—	0.015	—	Low-cost, general purpose	Mild corrosive service fractionation towers
Cleveland-Cliffs 13-4 SR® SS	—	13	0.25	0.025	Al – 3.75 Ti – 0.30	High electrical resistivity, good oxidation resistance	Locomotive braking resistors, resistance heating elements, automotive exhaust
Cleveland-Cliffs 15 Cr-Cb® ULTRA FORM® SS	— — SUS 425	14.5	—	0.01	Ti – 0.25 Cb –0.35 Mn – 1.0 Si – 1.3	Oxidation resistant	Exhaust flanges, exhaust manifolds, catalytic converters
Type 430	S43000 1.4016 SUS 430	16.5	—	0.05	—	General-purpose corrosion resistance	Appliance, food equipment, misc. automotive, flue liners, roofing
Cleveland-Cliffs 430 ULTRA FORM® SS	—	17	—	0.035	T – 0.17	Improved formability and weldability	Restaurant equipment, appliances, interior architectural trim
Type 434	S43400 1.4113 SUS 434	16.5	—	0.065	Mo –1.0	Improved corrosion resistance over Type 430	Automotive trim
Type 436	S43600 — —	16.8	—	0.03	Mo – 1.0 Nb – 0.4	Controlled roping	Automotive trim
Cleveland-Cliffs 436L	— 1.4513 SUS 436L	17.5	—	0.01	Mo – 1.0 Ti – 0.30	Resistant to stress corrosion cracking, excellent formability	Automotive exhaust applications

TABLE 4 – FERRITIC STAINLESS STEELS (CONTINUED)

Product	UNS EN JIS	Typical Chemical Composition %			Other Significant Elements	Characteristics	Typical Applications
		Cr	Ni	C			
CHROMESHIELD® 29 Mo SS	S44735 — —	29	—	0.02	Mo – 4 Ti –0.15 Nb –0.35	Super ferritic, excellent resistance to chloride pitting and cervice corrosion	Secondary heat exchanger, tubing, furnace vents, chimney liners
Type 439*	S43035 1.4510 SUS 430LX	17	—	0.012	Ti –0.3	Wet corrosion and oxidation resistance	Auto exhaust components, heating units, welded tubing
Aluminized Type 439	—	17	—	0.012	Ti – 0.3 Aluminum Coating	Economical corrosion oxidation, salt and cosmetic corrosion resistance	Auto exhaust components, heating units, welded tubing
Cleveland-Cliffs 18 SR® SS	—	17	—	0.02	Al – 1.70 Ti – 0.2 Si 0. 60	More oxidation and creep resistant than Types 409 and 439	Auto exhaust components, high-temperature use, furnaces
THERMAK® 17 SS	—	17	—	0.01	Si – 1.3 Mn – 1.0 Nb – 0.3 Cu – 1.3	Improved oxidation resistance, high temperature strength and thermal fatigue resistance	Automotive manifolds, catalytic converter, exhaust resonator
Cleveland-Cliffs 18 Cr-Cb™ SS	— 1.4509 —	17.5	—	0.02	Ti – 0.25 Nb – 0.55	Oxidation resistant, creep resistant	Auto exhaust systems, heat exchangers, furnace components
Type 441	S44100 1.4509 —	18	—	0.01	Ti – 0.2 Nb – 0.45	Oxidation resistant, creep resistant	Heat exchangers, furnace components, auto exhaust systems
Type 444	S44400 1.4521 SUS 444	17.5	—	0.015	Ti – 0.25 Nb – 0.15 Mo – 2.0	Oxidation, corrosion and stress cracking resistance	Water heaters, solar panels, engine components
Type 435 Mod.	S44500 — SUS430J1L	19.5	—	0.02	Nb – 0.7 Cu –0.5	Improved formability and weldability	Automotive trim
CHROMESHIELD® 22 SS	—	21.7	—	0.2	Cu – 0.6 Mo – 0.4 Ti – 0.21 Nb – 0.25	Oxidation resistance, corrosion resistance	Food processing, cookware, architectural, auto exhaust systems

**Available as High Performance-10™ or ULTRA FORM®.*

TABLE 5 – MARTENSITIC STAINLESS STEELS

Product	UNS EN JIS	Typical Chemical Composition %			Other Significant Elements	Characteristics	Typical Applications
		Cr	Ni	C			
Type 410	S41000 1.4006 SUS 410	11.5	–	0.14	–	General purpose, hardenable	Cutlery, machine parts
Cleveland-Cliffs 410 Cb	–	11.5	–	0.12	Nb – 0.15	High strength and toughness, easier heat treating	Auto exhaust flanges
Cleveland-Cliffs 410 H	–	11.5	–	0.18	–	Increased hardenability	Cutlery, rulers
Type 420 LC	S42000 1.4021 SUS 420J1	–	–	–	–	–	–
Type 420	S42000 1.4034 SUS 420J2	12.5	–	0.38	–	Increased hardenability	Cutlery, multifunctional tools, weaving heddles
Type 420 HC	S42000 1.4034 SUS 420J2	12.5	–	0.42	–	Increased hardenability	Cutlery, scissors, surgical instruments
Cleveland-Cliffs 420 ULTRA HONE® SS	–	14.25	–	0.42	Mo – 0.85	Corrosion resistance	Cutlery, scissors
Type 440A	S44002 1.4109 SUS 440A	16.5	–	0.63	–	Increased hardenability, corrosion resistance	Cutlery, industrial knives

TABLE 6 – PRECIPITATION-HARDENING STAINLESS STEELS

Product	UNS EN JIS	Typical Chemical Composition %			Other Significant Elements	Characteristics	Typical Applications
		Cr	Ni	C			
Cleveland-Cliffs 15-5 PH® SS	S15500 1.4540 –	14.5	4.5	0.05	Cu – 3.0 Nb – 0.25	High strength and hardness, ferrite free	Aerospace, chemical and petrochemical, food processing
Cleveland-Cliffs PH 15-7 Mo® SS	S15700 1.4532 –	14.5	7.5	0.085	Mo – 2.0 Al – 1.0	High strength and hardness, formable	Retaining rings, springs, aircraft bulkheads
Cleveland-Cliffs 17-4 PH® SS	S17400 1.4542 SUS 630	15.5	4.5	0.05	Cu – 3.0 Nb – 0.25	High strength and hardness	Aerospace, chemical and petrochemical, food processing
Cleveland-Cliffs 17-7 PH® SS	S17700 1.4568 SUS 631	17	7	0.085	Al – 1.0	High strength, excellent fatigue properties, formable	Aerospace components, flat springs

TABLE 7 – DUPLEX STAINLESS STEELS

Product	UNS EN JIS	Typical Chemical Composition %			Other Significant Elements	Characteristics	Typical Applications
		Cr	Ni	C			
NITRONIC® 19D SS	–	21	1.25	0.02	Cu – 0.5 Mn – 5.0	Ferrite/austenite matrix, good cyclic oxidation, high strength and good stress corrosion resistance	Tubing, water heater tanks
Type 2205	S31803 S32205 1.4462 –	22	5.5	0.02	Mo – 3.0	Ferrite/austenite matrix, high strength, low thermal expansion, high resistance to stress corrosion cracking and corrosion fatigue	Heat exchangers, pipe, pressure vessels, tanks, fans, shafts and press rolls, roofing

Coated Stainless Steels

ALUMINIZED STEEL TYPE 1 STAINLESS STEELS

Aluminum coated Types 409 and 439 were developed to provide the automotive industry with longer-life exhaust system materials. Type 1 hot-dipped aluminum coating provides excellent resistance to muffler condensate corrosion and pitting from road salt, which allows the exhaust system to remain virtually rust free, thus retaining its good appearance.

DURANAR® is a registered trademark of PPG Industries

Reflections on Finish

Surface finish is an important element in any specification for stainless steel, regardless of the intended end use. For those applications in which appearance is important, finish is a design element and must be specified.

In architecture or other highly visible applications, the appearance of stainless steel is a critical design element, and specification of the wrong finish can alter the desired effect. In consumer products, the gleam of well-polished stainless steel has strong sales appeal. In institutional or commercial kitchen, restaurant and hospital applications, properly finished stainless helps to emphasize the feeling of cleanliness.

In addition to visual appeal of polished stainless, there are a number of functions served by properly prepared stainless surfaces. In sanitary applications, polished stainless steel not only looks clean, but also is easy to clean and keep clean.

There are also economic considerations in specifying finish. For example, a cold-rolled bright annealed finish might be specified instead of a more expensive No. 8 polished finish. Some proprietary rolled finishes might serve the same purpose as a No. 4 polished finish. A knowledge of finishes can sometimes result in significant savings.

NO. 1

A rough, matte surface that results from hot rolling to the specified thickness followed by annealing and descaling.

NO. 2D SHEET (STRIP NO. 1)

A matte finish produced by cold rolling to gauge, then annealing and pickling in acid to remove scale and oxide from an open air anneal.

NO. 2B SHEET (STRIP NO. 2)

A reflective cold-rolled finish produced in the same manner as a 2D sheet finish, except that a light temper pass on polished rolls is performed on the annealed and pickled product. This is the general-purpose cold-rolled finish that can be used as is, or as a preliminary step to polishing.

BRIGHT ANNEALED

A highly reflective cold-rolled finish produced by cold rolling to gauge, then bright annealing in a protective inert atmosphere. This process results in no scaling of the product, leaving a bright reflective finish. A light temper pass on polished rolls is performed on the bright annealed product. This finish is also available without the final temper pass, in which case the finish is not quite as bright.

NO. 3

A polished finish produced in the same manner as a 2B sheet finish, except that the product is belt polished using 120 grit emery cloth belts.

NO. 4

A polished finish similar to No. 3 Polish, except that the product is belt polished using 150 grit emery cloth belts, giving it a somewhat smoother appearance than No. 3.

UNIGRAIN® FINISH

A rolled-on grit finish produced in the same manner as a 2B sheet finish, except that grit rolls are substituted for polished rolls on the light temper pass. This product results in a uniform finish that can be substituted for polish finish in many applications.

TRICOT MATTE

A rolled-on matte finish produced in the same manner as a 2B sheet finish, except that shot-blasted rolls are substituted for polished rolls on the light temper pass. This product results in a dull, nondirectional finish that is suitable for many painting and coating applications.

Reflections on Finish

EMBOSSED

An imprinted overall design on the surface of cold-rolled stainless steel produced by passing the steel between rolls etched with the design pattern. Cleveland-Cliffs' embossed stainless steel is suitable for a wide variety of decorative applications.

LEINEN

A rolled-on, reflective, linen-like finish produced in the manner similar to a bright annealed and temper-rolled product. The non-directional glossy gray surface finish is an embossed pattern applied in the temper rolling operation, and either annealed or bright annealed. Leinen Finish is suitable for elevator doors, trim, ceiling panels and column covers

GREYSTONE® BRIGHT

A rolled-on, reflective, pebble-like finish produced in a manner similar to a bright annealed and temper-rolled product. With its random pattern, which allows for seamless connection of pieces, GREYSTONE Bright is ideal for moldings and trim, elevator door panels and exterior building panels.

GREYSTONE® MATTE

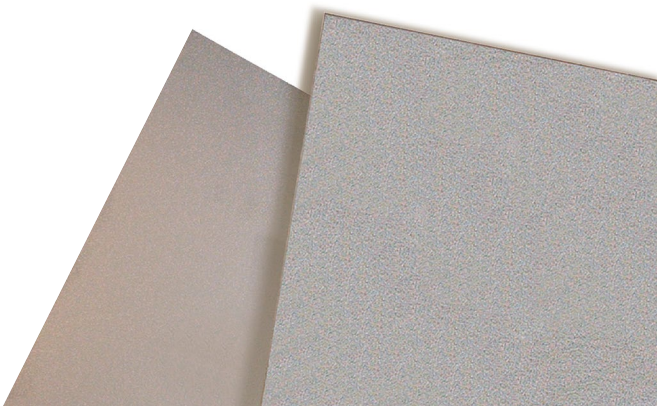
A rolled-on, dull, pebble-like finish produced on an annealed and pickled substrate in a manner similar to a 2B Sheet Finish. Initially designed for roofing applications to minimize the glare of sunlight, GREYSTONE Matte finish is ideal for a variety of architectural applications.

ILUMIBRITE® FINISH

A rolled-on, reflective, pebble-like finish produced in a manner similar to a bright annealed and temper-rolled product. With its random pattern, which allows for seamless connection of pieces, ILUMIBRITE finish is ideal for moldings and trim, elevator door panels and exterior building panels

STONE MATTE® FINISH

A rolled-on, matte, pebble-like finish produced on an annealed and pickled substrate in a manner similar to a 2B sheet finish. Initially designed for roofing applications to minimize the glare of sunlight, STONE MATTE finish is ideal for a variety of architectural applications.



Glossary of Stainless Sheet and Strip Terms

ABRASION RESISTANT STEELS
A family of steel products developed for those applications involved in sliding and impact abrasion.

AIR HARDENING STEEL
Steels, such as low chromium and martensitic stainless steels, that do not require quenching to produce hardening by the martensitic reaction.

ALLOYING
Alloying, in the common metallurgical sense, refers to the dissolving of one or more elements in a metal to produce a metallic mix or alloy.

BALANCED ANALYSIS
A term used to indicate the relative quantities of alloying elements necessary to produce the specified properties or metallurgical structures in a specific type of steel.

BRIGHT ANNEALED
Bright annealing prevents the formation of undesirable scale that occurs on the surface of steel during the annealing process. During typical annealing, the heated steel combines with oxygen in the air to form a layer of oxide on the steel's surface. In bright annealing, the steel is heated in a furnace filled with hydrogen or nitrogen gases, which prevents oxide scale formation.

BUFFING
A polishing operation utilizing a very fine abrasive compound on a prepared rotating wheel, which contacts the work surface.

DUPLEX
Steel exhibiting both austenitic and ferritic structures.

INTERGRANULAR CORROSION
Corrosion that occurs at the grain boundaries in austenitic stainless steels that have been heat treated between 850 –1450 °F. It is usually caused by precipitation of the chrome carbides.

ORANGE PEEL
Roughening of the surface sometimes encountered in forming or drawing stainless steels that have coarse grain structure.

OXIDE FILM THEORY
An expiration of passivity based upon the supposition that a relatively impermeable layer of oxide forms on the surface of stainless steel that retards attack by corrosives.

PASSIVITY
The ability of certain metals and alloys, especially the stainless steels, to resist normal corrosion to the point where the metal remains unattacked.

PRECIPITATION HARDENING
Hardening that is caused by the precipitation of a metallic compound from a supersaturated solid solution.

RETAINED AUSTENITE
A tendency in martensitic alloys to retain at room temperature at a fraction of the austenite phase that is stable at the high temperature and which fails to transform to martensite on cooling. This tendency increases with alloy, carbon content and rate of cooling.

ROPING
A fibrous surface pattern that can occur in 400-series sheet and strip when stretched or drawn. This pattern is always in the rolling direction and may require metal removal by polishing if a smooth surface is desired.

SEMI-HARDENING
A hardening treatment for martenstic steels in which the metal is quenched from such a low austenitizing temperature that only a portion of the metal transforms, yielding a semimartensitic alloy particularly adaptable to machining operations.

SENSITIZATION
A term used to describe the condition of the austenitic stainless steels resulting from heating them in the temperature range of approximately 800 – 1500 °F and cooling to room temperature. When the metal is held in the sensitization range, the carbon in the steel combines with some of the chromium and precipitates as chromium carbide at the grain boundaries. This depletes chromium in the area of the grain boundaries and makes the metal susceptible in those areas to attack in some corrosive media.

SIGMA PHASE
A brittle and hard intermetallic compound of the general formula iron chromium (FeCr), but having a composition range of broad extension, tending to form particularly in the ferrite of high chromium stainless steels when heated for a period of time in the general range of 925 – 1750 °F.

SUBZERO TREATMENT
Part of a hardening treatment in which the martensitic steel is quenched from the austenizing temperature and brought immediately to a very low temperature to promote the development of martensite – particularly useful for steels tending to have "retained austenite."

TEMPER
Part of a hardening treatment in which the martenistic steel is quenched from the austenizing temperature and brought immediately to a very low temperature to promote the development of martensite – particularly useful for steels tending to have "retained austenite."

CLIFFS

STAINLESS STEEL COMPARATOR

About Cleveland-Cliffs Inc.

Cleveland-Cliffs is the largest flat-rolled steel producer in North America. Founded in 1847 as a mine operator, Cliffs also is the largest manufacturer of iron ore pellets in North America. The Company is vertically integrated from mined raw materials, direct reduced iron, and ferrous scrap to primary steelmaking and downstream finishing, stamping, tooling, and tubing. The Company serves a diverse range of markets due to its comprehensive offering of flat-rolled steel products and is the largest supplier of steel to the automotive industry in North America. The Company is headquartered in Cleveland, Ohio with mining, steel and downstream manufacturing operations located across the United States and in Canada. For more information, visit www.clevelandcliffs.com.

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