

CARE AND CLEANING OF STAINLESS STEEL

Introduction

Cleanliness and stainless steel are closely related and, in many applications, each is dependent upon the other. In the handling of food, chemicals, pharmaceuticals and in the use of stainless steel as a construction material (roofs, wall panels, entry ways, signs, etc.), stainless steel provides the degree of corrosion resistance that is necessary to prevent product contamination or surface rusting. However, stainless steel performs best when clean - cleanliness is essential for maximum resistance to corrosion.

This handbook describes various practices for cleaning stainless steel during manufacture and in use. This includes methods for removing free-iron contamination on stainless steel surfaces that may have been picked up from metalworking tools; and for removing general accumulation of dirt, grime and surface stains that occur during normal handling and exposure to the elements.

The reader should keep in mind that there are few specific rules for a cleaning procedure. Accordingly, the methods discussed in this handbook are suggestions. Each manufacturer or user, after obtaining competent advice with respect to their individual requirements, should select methods appropriate to those requirements.

What is Stainless Steel?

Stainless steel is not a single alloy, but rather the name applies to a group of iron-based alloys containing a minimum 10.5% chromium. Other elements are added and the chromium content increased to improve the corrosion resistance and heat resisting properties, enhance mechanical properties, and/or improve fabricating characteristics. There are over 50 stainless steel grades that were originally recognized by the American Iron and Steel Institute (AISI). Three general classifications are used to identify stainless steel. They are:

1. Metallurgical structure.
2. The AISI numbering system (200, 300 and 400 series numbers).
3. The Unified Numbering System, which was developed by the American Society for Testing Materials (ASTM) and the Society of Automotive Engineers (SAE) to apply to all commercial metals and alloys.

The various types of stainless steel are detailed in a designer handbook, "Design Guidelines for the Selection and Use of Stainless Steel," available from the Specialty Steel Industry of North America (SSINA). Several other publications are also available, including: "Stainless Steel Fabrication", "Stainless Steel Fasteners", "Stainless Steel Finishes", "Stainless Steel Specifications", and "Stainless Steel Architectural Facts", to mention a few.

Alloy Types

304 is the basic chromium-nickel austenitic stainless steel and has been found suitable for a wide range of applications. It is the most readily available in a variety of product forms. This grade is easy to form and fabricate with excellent resistance to corrosion.

304L is the low carbon version of 304. It is sometimes specified where extensive welding will be done.

316 offers more corrosion-resistance through the addition of molybdenum. This grade is desirable where the possibility of severe corrosion exists, such as heavy industrial atmospheres and marine environments.

316L is the low carbon version of 316.

430 is a straight chromium ferritic stainless steel with lower corrosion resistance than the 300 series, It is principally employed for interior use.

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Forms and Finishes

Sheet, strip, plate and bar forms are shown in Table 1. Sheet finishes are shown in Table 2. Bar product conditions and finishes are shown in Table 3. Plate is shown in Table 4. In addition to the common mill and polished finishes, there are numerous special finishes used for architectural applications. Some of the more delicate finishes require special precautions when cleaning and the advice of the supplier should be obtained. The most common special finishes are shown in Table 5.

Cleaning of Stainless Steel

Stainless steels need to be cleaned for aesthetic considerations and to preserve corrosion resistance. Stainless steel is protected from corrosion by a thin layer of chromium oxide. Oxygen from the atmosphere combines with the chromium in the stainless steel to form this passive chromium oxide film that protects from further corrosion. Any contamination of the surface by dirt, or other material, hinders this passivation process and traps corrosive agents, reducing corrosion protection. Thus, some form of routine cleaning is necessary to preserve the appearance and integrity of the surface. Stainless steels are easily cleaned by many different methods. They actually thrive with frequent cleanings, and, unlike some other materials, it is impossible to "wear out" stainless steel by excessive cleaning. The effect of surface/pattern roughness, grain/pattern orientation, and designs that allow for maximum rain cleaning (exterior applications) should be considered.

Types of Surface Contaminants

DIRT: Like any surface that is exposed to the environment, stainless steel can get dirty. Dirt and soil can consist of accumulated dust and a variety of contaminants that come from many sources, ranging from the wind to everyday use. These contaminants will vary greatly in their effect on appearance and corrosivity and ease of removal. While some may be easily removed, others may require specific cleaners for effective removal. It may be necessary to identify the contaminate or experiment with various cleaners. Frequently, warm water with or without a gentle detergent is sufficient. Next in order are mild non-scratching abrasive powders such as typical household cleaners. These can be

Table 1 Classification of Stainless Steel Product Forms

| Item | Description | Dimensions Thickness | Width | Diameter or Size |
|--------------------------|---|--------------------------------------|---------------------------------------|----------------------|
| Sheet | Coil and cut lengths: Mill finishes Nos. 1, 2D, & 2B Pol. finishes Nos. 3, 4, 6, 7 & 8 | under 3/16" (4.76mm) | 24" (609.6mm) & over all widths | _____ |
| | | under 3/16" (4.76mm) | | |
| Strip | Cold finished, coils or cut lengths Pol. finishes Nos. 3, 4, 6, 7 & 8 | under 3/16" (4.76mm) | under 24" (609.6mm) all widths | _____ |
| | | under 3/16" (4.76mm) | | |
| Plate | Flat rolled or forged | 3/16" (4.76mm) & over | over 10" (254mm) | _____ |
| Bar | Hot finished rounds, squares, octagons and hexagons | _____ | _____ | 1/4" (6.35mm) & over |
| | Hot finished flats | 1/8" (3.18mm) to 8" (203mm) incl. | 1/4" (6.35mm) to 10" (254mm) incl. | _____ |
| | Cold finished rounds, squares, octagons and hexagons | _____ | _____ | over 1/8" (3.18mm) |
| | Cold finished flats | 1/8" (3.18mm) to 4 1/2" (114mm) | 3/8" (9.53mm) to 4 1/2" (114mm) | _____ |
| Wire | Cold finishes only: (in coil) Round, square, octagon, hexagon, and flat wire | under 3/16" (4.76mm) | under 3/8" (9.53mm) | _____ |
| | | | | |
| Pipe & Tubing | Several different classifications, with differing specifications, are available. For information on standard sizes, consult your local Steel Service Center or the SSINA. | | | |
| Extrusions | Not considered "standard" shapes, but of potentially wide interest. Currently limited in size to approximately 6 1/2" (135.1mm) diameter, or structurals. | | | |

Table 2 Standard Mechanical Sheet Finishes

| Unpolished or Rolled Finishes: | |
|--------------------------------|---|
| No. 1 | A rough, dull surface which results from hot rolling to the specified thickness followed by annealing and descaling. |
| No. 2D | A dull finish which results from cold rolling followed by annealing and descaling, and may perhaps get a light roll pass through unpolished rolls. A 2D finish is used where appearance is not of primary concern. |
| No. 2B | A bright, cold-rolled finish resulting in the same manner as No. 2D finish, except that the annealed and descaled sheet receives a final light roll pass through polished rolls. This is the general-purpose cold-rolled finish that can be used as is or as a preliminary step to polishing. |
| Polished Finishes: | |
| No. 3 | An intermediate polish surface obtained by finishing with a 100-grit abrasive. Generally used where a semifinished polished surface is required. A No. 3 usually receives additional polishing during fabrication. |
| No. 4 | A polished surface obtained by finishing with a 120-150 mesh abrasive, following initial grinding with coarser abrasives. This is a general-purpose bright finish with a visible "grain" which prevents mirror reflection. |
| No. 6 | A dull satin finish having lower reflectivity than No. 4 finish in a medium of abrasive and oil. It is used for architectural applications and ornamentation where a higher luster is undesirable, and to contrast with brighter finishes. |
| No. 7 | A highly reflective finish that is obtained by buffing finely ground surfaces but not to the extent of completely removing the "grit" lines. It is chiefly for architectural and ornamental purposes. |
| No. 8 | The most reflective surface obtained by polishing with successively finer abrasives and buffing extensively until all grit lines from preliminary grinding operations are removed. It is used for applications such as mirrors and reflectors. |

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used with warm water, bristle brushes, sponges or clean cloths. Ordinary carbon steel brushes or steel wool should be avoided as they may leave particles embedded on the surface which can lead to RUSTING. For more aggressive cleaning, a small amount of vinegar can be added to the scouring powder. Cleaning should always be followed by rinsing in hot water. When water contains mineral solids, which leave water spots, it is advisable to wipe the surface completely with dry towels.

FINGERPRINTS AND STAINS: Fingerprints and mild stains resulting from normal use in consumer and architectural applications are the most common surface contaminants. Fortunately, these usually affect only appearance and seldom have an effect on corrosion resistance. They are easy to remove by a variety of simple cleaning methods. Fingerprints are probably the most troublesome marks to remove from the surface of smooth polished or bright finished stainless steel. Fortunately, they can be removed with glass cleaner or by gentle rubbing with a paste of soda ash (sodium carbonate) and water applied with a soft rag. Once again, this should be followed by a thorough warm water rinse. There are several special surface finishes where fingerprints present special problems: polished No. 6, etched, some abrasive blasted finishes, and light electrochemical colors applied over satin or brushed finishes. (NOTE: there are several finishes designed to withstand fingerprints: embossed, swirl patterns, lined patterns, etc.).

SHOP OIL AND GREASE: Shop oils, which may carry grease, grit and metal chips, commonly produce surface soiling after many shop operations. Greases and other contaminants may also soil surfaces in food preparation and many other household and commercial situations. These soils may be corrosive in themselves or may not allow the surface to maintain passivity, and so periodic removal is a necessity. Initially, soap or detergent and water may be tried or a combination of detergent and water plus a solvent. The removal of oil and grease from stainless steel parts by immersion in chemical solvents is frequently used with cold-formed or machined

Table 3 Conditions and Finishes for Bar

| Conditions | Surface Finishes* |
|---|---|
| Hot worked only | (a) Scale not removed (excluding spot conditioning) (b) Rough turned** (c) Pickled or blast cleaned and pickled |
| Annealed or otherwise heat treated | (a) Scale not removed (excluding spot conditioning) (b) Rough turned (c) Pickled or blast cleaned and pickled (d) Cold drawn or cold rolled (e) Centerless ground (f) polished |
| Annealed or cold worked to high tensile strength*** | (d) Cold drawn or cold rolled (e) Centerless ground (f) polished |

* Surface finishes (b), (e), and (f) are applicable to round bars only.
 ** Bars of the 4xx series stainless steels which are highly hardenable, such as Types 414, 420, 420F, 431, 440A, 440B and 440C, are annealed before rough turning. Other hardenable grades such as Types 403, 410, 416 and 416Se, may also require annealing depending on their composition and size.
 *** Produced in Types 302, 303Se, 304 and 316.

Table 5 Special Stainless Steel Finishes

| Finish | Description |
|---------------------|--|
| Selective Polishing | Selective polishing of unprotected areas to produce patterns |
| Swirl | Swirl patterns obtained with grinding wheels or stainless steel wire brushes |
| Engine Turn | Rings, circles or overlapping circles created with a CNC-operated machine |
| Distressed | Random scratch pattern covering entire surface |
| Angel Hair | Finer random scratch pattern |
| Abrasive Blast | Matte, uniform, blast media choice determines appearance |
| Selective Etching | Etching of selective surface areas to obtain pattern |
| Embossing | Raised patterns pressed into the the stainless by rolling |
| Electrochemical | Applied to cut sheets, numerous colors (also called INCO or light interference coloring) |
| Epoxy Paint | Applied to coils, full range of colors |
| Sputtering | Thin layer of colored material applied to surface |
| Plating | Electroplating with colored and/or precious metals |
| Perforated Designs | Simple or elaborate patterns |

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parts that are laden with lubricants. This process, in its simplest form, consists of bringing liquid solvent into contact with the surface to be cleaned and allowing dissolution to take place; for example, trichloroethylene or similar liquid or stirring a batch of small parts in a container of solvent. Non-halogenated solvents, such as acetone, methyl alcohol, ethyl alcohol, methyl ethyl ketone, benzene, isopropyl alcohol, toluene, mineral spirits, and turpentine work well. Many of these solvents are widely used as individual cleaners, but there are thousands of blended or compound cleaners on the market. Users are advised to contact suppliers of solvents for information on their applications on stainless steel.

Types of Cleaners and Methods: General Precautions

In selecting cleaning practices, consider the possibility of scratching and the potential for post-cleaning corrosion caused by incompletely removed cleaners. Scratching can occur on a bright mirror finish by cleaners that contain hard abrasives, or even by "grit" in wash water. This is usually not a problem on dull finishes, or those surfaces with a coarse polishing grit. The best preventative measure is to avoid using abrasive cleaners unless absolutely necessary. When abrasives are needed, first experiment on a inconspicuous area. A "soft abrasive," such as pumice, should be used. Abrasives can permanently damage some colored and highly polished finishes. Advice should be obtained from the finish supplier when cleaning special finishes. Many cleaners contain corrosive ingredients which require thorough post-clean rinsing with clean water; however, thorough rinsing is recommended for all cleaning procedures.

CLEAN WATER AND WIPE: The simplest, safest, and least costly method that will adequately do the job is always the best method. Stainless surfaces thrive with frequent cleaning because there is no surface coating to wear off stainless steels. A soft cloth and clean warm water should always be the first choice for mild stains and loose dirt and soils. A final rinse with clean water and a dry wipe will complete the process and eliminate the possibility of water stains.

SOLVENT CLEANING: Organic solvents can be used to remove fresh fingerprints and oils and greases that have not had time to oxidize or decompose. The preferred solvent is one that does not contain chlorine, such as acetone, methyl alcohol and mineral spirits. There are many compounded or blended organic cleaners that are commercially available and attempt to optimize both cleanability and safety attributes. Cleaning can be accomplished by immersing smaller articles directly into the solvent, wiping with solvent-impregnated cloths, or by sophisticated vapor or spray methods. The wiping technique sometimes leaves a streaked surface.

HOUSEHOLD CLEANERS: Household cleaners fall into two categories: detergent (non-abrasive) and abrasive cleaners. Both are effective for many mild dirt, stain and soil deposits, as well as light oils such as fingerprints. The abrasive cleaners are more effective but introduce the possibility of scratching the surface. However, the degree of abrasiveness will vary greatly with the particular product, and some brands will produce noticeable scratching on only the most highly polished and some colored surface. All these cleaners vary widely with respect to their acidity and the amount of chloride they contain. A neutral cleaner low in chloride is preferred unless the user is assured that the surface can be thoroughly rinsed after cleaning. The fact that the label states "for stainless steel" is no guarantee that the product is not abrasive, not acidic or low in chloride. The cleaning method generally employed with these cleaners is to apply them to the stainless surface and follow by cloth wiping, or to wipe directly with a cleaner-

Table 6 Effective Cleaning Methods

| Job | Cleaning Agents* | Comments |
|---|--|---|
| Routine Cleaning | Warm water, Soap, Ammonia, Detergent | Apply with sponge or soft cloth. Can be used on all finishes. |
| Fingerprints and Smears | 3M Stainless Steel Cleaner and Polish, Arcal 20, Lac-O-Nu, Lumin Wash, O'Cedar Cream Polish, Stainless Shine | Provides barrier film to minimize fingerprints. Can be used on all finishes. |
| Stubborn Stains and Discoloration | 3M Stainless Steel Cleaner and Polish, Allchem Concentrated Cleaner, Samae, Twinkle, Cameo Copper Cleaner, Grade FFF or Grade F Italian Pumice, Whiting or talc, Liquid Nu Steel, Copper's or Revere Stainless Steel Cleaner, Household Cleaners, Lumin Cleaner, Zud Restoro, Sta-Clean, Highlite, Allen Polish, Penny-Brite, Copper-Brite | Rub lightly, using dry damp cloth, in the direction of polish lines on the stainless steel. |
| Grease and Blood Burnt-on or Baked-on Foods | Scotch-Brite Power Pad 2001, Easy-Off De-Grease-It, 4% to 6% hot solution of such agents as tri-sodium polyphosphate, 5% to 15% caustic soda solution | Excellent removal on acids, all finishes. Particularly useful where rubbing is not practical. |
| Grease and Oil | Any good commercial detergent or caustic cleanser. | Apply with sponge or soft cloth in direction of polish lines. |

* NOTE: Use of proprietary names is intended only to indicate a type of cleaner and does not constitute an endorsement. Omission of any proprietary cleanser does not imply its inadequacy. All products should be used in strict accordance with instructions on package.

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impregnated soft cloth. In all cases, the cleaned surface should be thoroughly rinsed with clean water and wiped dry with a soft cloth if water streaking is a consideration.

COMMERCIAL CLEANERS: Many commercial cleaners compounded from phosphates, synthetic detergents, and alkalis are available for the cleaning of severely soiled or stained stainless surfaces. When used with a variety of cleaning methods, these cleaners can safely provide effective cleaning. Manufacturers should be consulted and their recommendations followed whenever using cleaners of this kind. The general precautions stated above also pertain to these cleaners.

Care of Stainless Steel

The cleaner stainless steel can be kept while in storage, being processed or during use, the greater the assurance of optimum corrosion resistance. Some tips on the care of stainless steel are listed below:

1. Use paper or other protective wrapping on the surface of the stainless steel until processing is complete.*
2. Handle stainless steel with clean gloves or cloths to guard against stains or finger marks.
3. Avoid the use of oily rags or greasy cloths when wiping the surface.
4. Do routine cleaning of exposed surfaces. Buildings with window washing systems can utilize this method to clean exterior panels.
5. Where possible, after cleaning, rinse thoroughly with water.
6. Cleaning with chloride-containing detergents must be avoided.
7. Even the finest cleaning powders can scratch or burnish a mill-rolled finish. On polished finishes, rubbing or wiping should be done in the direction of the polish lines, NOT across them.
8. DO NOT USE SOLVENTS in closed spaces or while smoking.

*** Many adhesive-backed papers and plastic sheets or tape applied to stainless steel for protection "age" in fairly short periods of time and become extremely difficult to remove. Manufacturers should be contacted regarding information as to how long protective films or paper can be left in place.**