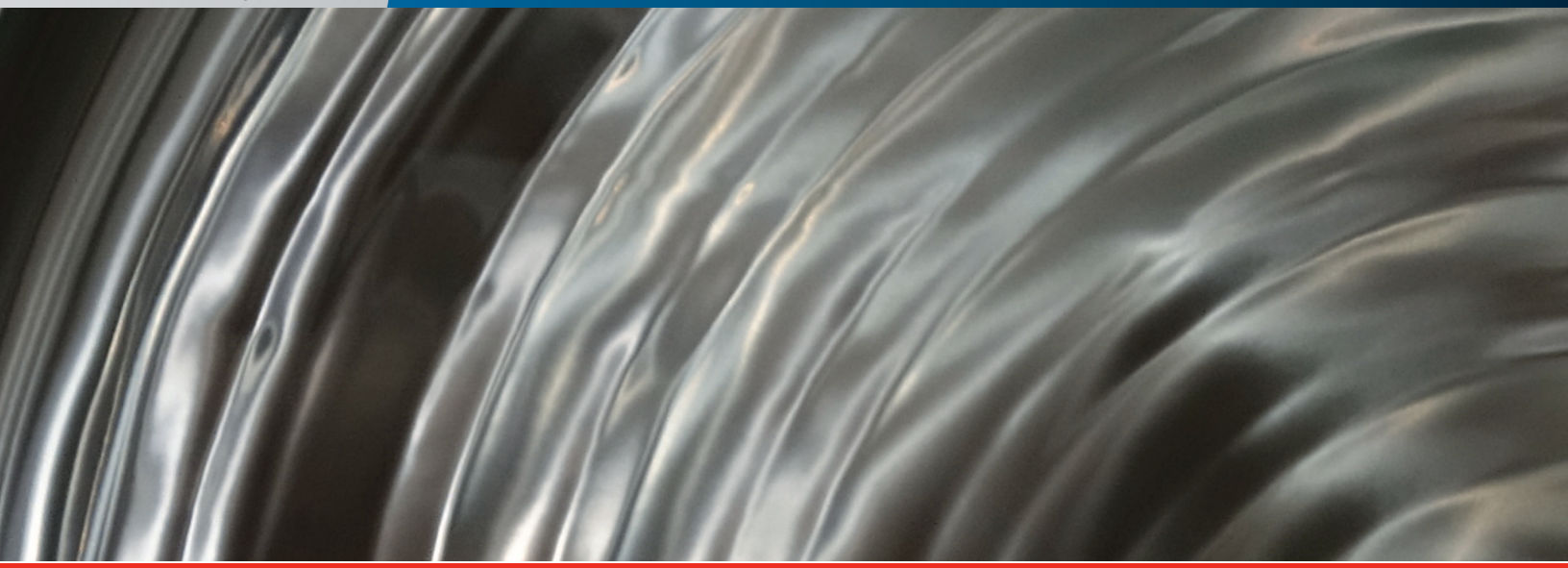
APACHE
STAINLESS EQUIPMENT

LEVERAGING STAINLESS STEEL FINISHES ON SANITARY EQUIPMENT



Discover the cleaning efficiencies and sanitation benefits on a spectrum of stainless steel finishes.

Leveraging Stainless Steel Finishes on Sanitary Equipment

For many food and chemical producers, the level of finishing on processing equipment may be prescribed by federal, state and local regulatory agencies. In sanitary applications, however, the finish as well as the material must also be designed for easy and reliable cleaning and sanitation. Agencies require sanitary finishes to have a minimum RA (roughness average,) but processors are seeing the advantages of exceeding regulatory compliance due to the decreased sanitation time and decreased bacteria risk proven with higher-end finishes.

This white paper serves as an educational and informational reference to include:

- Definitions of stainless finishes and measurement designations
- An overview of surface textures of stainless steels
- A guide to stainless steel finishes
- RA comparison data by finish type

For original equipment manufacturers, the level of complexity for stainless steel fabrication of sanitary equipment is significant. Each industry requires experience and controlled processes for quality fabrication. Tooling, process and technique are very important.

The process for sanitary stainless steel fabrication starts with the selection of the metal and handling of the material. The fundamental process of working with stainless steel with sanitary requirements includes careful handling to prevent contamination from the manufacturing environment and the use of protective surfaces throughout all processes.

In sanitary applications, stainless steel equipment requires a sanitary finish. The term “sanitary finish” in general refers to a smooth, scratch-free, non-corrosive finish. There are several mechanical and chemical finishes that can fulfill agency requirements for sanitary specifications. In choosing the type of finish, it is important to understand the definitions and criteria for how finishes are designated.

Surface Texture The surface of the material including irregularities and deviations, including roughness and grain.

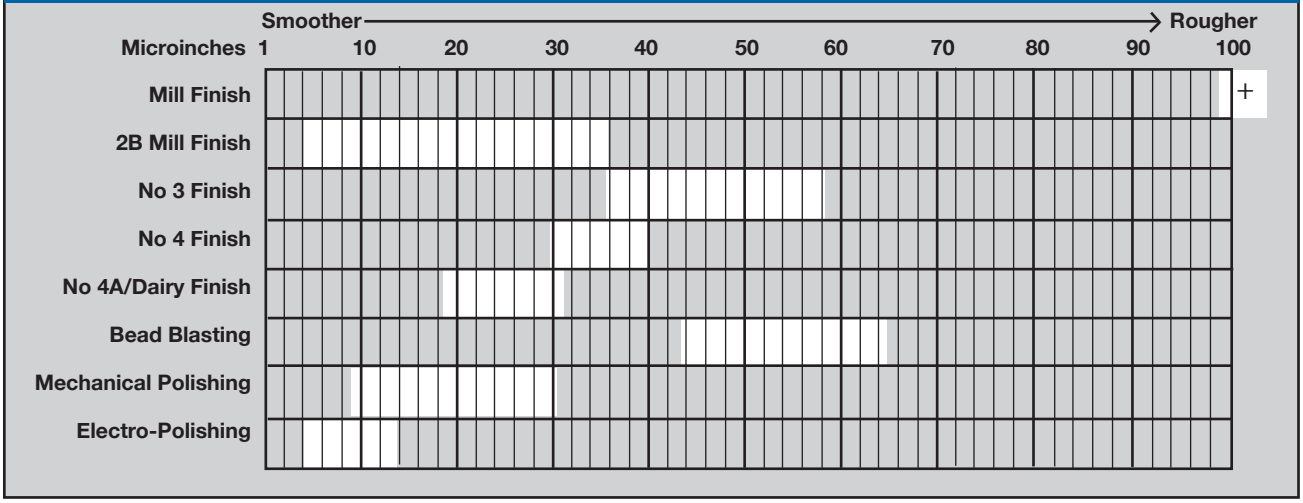
Grit is defined as the size of the abrasive used in the polishing process. Typically coarse, lower grit numbers are associated with grinding and higher grit numbers are associated with polishing. Grit size however does not fully define the surface.

RA (Roughness Average) A standard for an average of the peaks and valleys of the metal’s surface, measured in microinches or micrometers.

RMS (Root Mean Square) is a machining standard used to diagnose machine operations and surface finish.

The fineness of the finish and ultimate success of the sanitation effectiveness is measured in RA, the roughness average measured by height in millionths of an inch or microinches. A profilometer determines RA values of small surface variations and calculates their average to determine roughness.

RA Surface Textures of Stainless Steel Finishes*



**This chart compares RA surface designations in a range of finishes. More precise RA values are dependent on the gauge of material. Refer to page seven (7) for more specific finish designations by gauge.*

There are two different methods for achieving a polished finish. The first is mechanical. Mechanical polishing involves the removal of material using an abrasive, mechanical process. Typically, grit sizes of 120 and finer are used for mechanical polishing.

The other method for polishing is to use a chemical surface treatment. Chemical treatments remove the outer layer of corrosion in the material to preserve the integrity of the metal.

Below is a description of textures and finishes featuring both mechanical and chemical methods, commonly used to produce Apache's tank and vessel processing equipment as well as the Mepaco food processing equipment line.

Stainless Steel Textures & Finishes

Mill Finish A Mill Finish has an unpolished, dull-gray, matte appearance. This finish forms the basis for supply condition for all stainless steel flat products, and also forms the basis for additional finishing operations. It is hot or cold rolled with a RA of more than 100 microinches, depending on the gauge of the material. (Gauge refers to cold rolled; plate is hot rolled material.)

2B Mill Finish This is a widely used stainless steel finish, common in industrial, chemical and food applications. It is corrosion resistant and has a typcial RA range of 40 (7 gauge) to 15 (16 gauge) microinches.

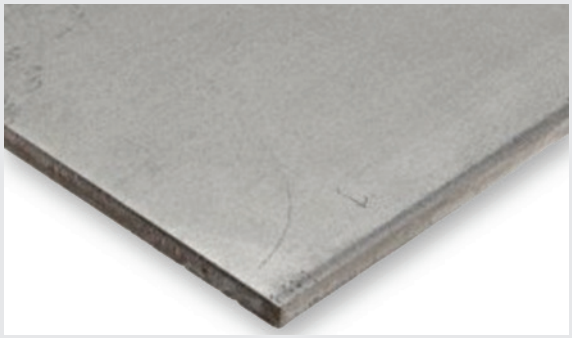
No. 3 Finish The No. 3 Finish uses a 120 grit abrasive. It has a *semi-polished finish* with an RA range of 36 - 58 microinches.

No. 4 Finish This finish uses a 150 grit abrasive, and shows a *polished, brushed surface*. The RA range is 29 - 40 microinches.

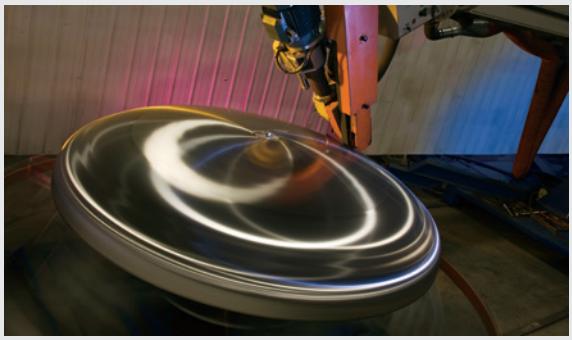
No. 4 Dairy / 4A Finish For processing industries, the number 4 Dairy is required to meet the basic 3-A standards. It uses a 180 grit and has a RA range of 18 - 31 microinches.

Bead Blasted The process of bead blasting utilizes bead material such as glass, ceramic beads or dry ice to produce a non-directional, textured surface with a soft satin appearance and low-reflectivity. The finer the blasting media, the more corrosion resistant the surface performance. The RA values are typically greater than 45, but are dependent on the blasting process and the stainless material.

A profilometer (RA meter) is used to measure the roughness average of peaks and valleys in stainless material.



Stainless material with a mill finish has a rough, dull and non-uniform appearance.



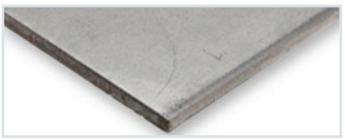
Mechanical polishers use an abrasive material (measured by grit coarseness) to create the finish.

Providing a matte appearance, Apache has experienced results in improved RA smoothness after the pickle passivation, descaling process.

Comparison Chart
...next

MECHANICAL FINISHES

Mill Finish



Description

(Mill finish - Plate)
The baseline for comparison, this is unfinished steel in basic supply condition.

Applications

Structural

Sanitation Environment

None - not used in food contact areas

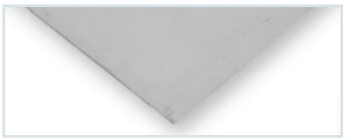
RA

>100 microinches
Depending on material

Caution

Does not meet sanitary, food contact or processing finishing requirements

2B Finish



Description

(2B Finish -Gauge)
Common corrosion resistant, heat resistant, smooth, (not brushed) steel

Applications

Material handling, processing, direct food contact

Sanitation Environment

Suitable for caustic sanitary wash down procedures

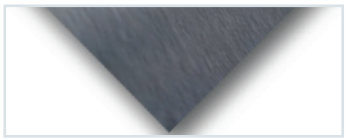
RA

36 (7 gauge) to 15 (16 gauge) in microinches

Caution

Note that 2B finishes can have the same RA as higher end finishes depending on gauge, compare economies when making material decisions unless otherwise required by compliance factions.

No. 4 Finish



Description

Characterized by short, polished brushed lines

Applications

Used in clean rooms and in food processing equipment

Sanitation Environment

Suitable for caustic sanitary wash down procedures

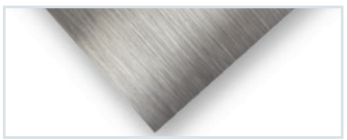
RA

29 to 40 microinches

Caution

Note that a No. 4 finish is not compliant for 3A standards; a 4A finish will satisfy RA requirements for the Dairy/ Cheese manufacturing industy.

No. 4A Finish



Description

Also characterized by short, polished brushed lines, the 4A finish uses a finer grit polish

Applications

Used in clean rooms, processing equipment, used in Pharmaceutical industries and complies to 3A Dairy standards

Sanitation Environment

Suitable for caustic sanitary wash down procedures

RA

18 - 31 microinches
(3A standards require 32 or less)

Caution

Welds are also required to be ground to a No. 4A finish to meet 3A Dairy standards

Mepaco®

CHEMICAL FINISHES

Bead Blast

Description

A uniform, non-directional, low-reflective surface; bead blasting can be mechanical or chemical (dry ice)

Applications

Used when a uniform finish is desired in structural, material handling or food handling applications

Sanitation Environment

Bead blasting on common 304 and 316 stainless material is suitable for caustic wash down procedures

RA

>45
depending on
blasting process

Caution

Bead blasting is not necessarily a smooth finish, the RA and smoothness depends on the stainless material used, the fineness of the blasting media and the blasting process.

Passivation

Description

A chemical (typically nitric or citrus acid) treatment that produces a formation of a protective passive film on stainless steel

Applications

Most stainless steel material is passivated, polished or treated in some way to prevent corrosion; passivation may also be a federal specification

Sanitation Environment

Passivated stainless material can withstand caustic wash down procedures

RA

RA values have
no significant improvement
after passivation*

Caution

Chemical passivation is a protective treatment, not a descaling process.

Federal Specification No.

A-967

Pickle Passivation

Description

Also referred to as descaling, pickle passivation removes the scale and leaves a clean matte finish free from contamination

Applications

Used in pharmaceutical industries as a federal specification and in food processing industries to reduce food safety risk

Sanitation Environment

Suitable for caustic, aggressive sanitary wash down environments

RA

Depending on material, pickle passivation can result in up to 25% increased smoothness measured in RA*

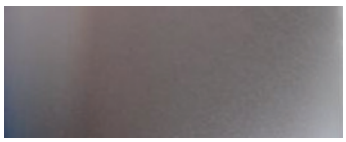
Caution

Partner with expert finishing specialists who perform the recommended procedures for best results.

Federal Specification No.

A-380

Electro-Polishing



Description

Surface metal is dissolved, removing all embedded contaminants, creating a smooth, mirror finish

Applications

Used in pharmaceutical industries as a federal specification and in food processing industries to prevent bacterial attachment and reduce food safety risk

Sanitation Environment

Highest grade of passive surface available, can be subjected to long term caustic wash down

RA

Depending on material, electropolishing can result in up to 50% increased smoothness measured in RA*

Caution

Partner with expert finishing specialists who perform the recommended procedures for best results.

Federal Specification No.

B-912

*Apache In-house finishing before/after tests; results vary depending on stainless material.

Passivation Passivation is the removal of excess iron or iron compounds from the surface of stainless steel by means of a chemical, typically an acid based solution. Unlike pickle passivation, no metal is removed from the surface during the process. The process has little affect on the RA values of the stainless material being passivated.

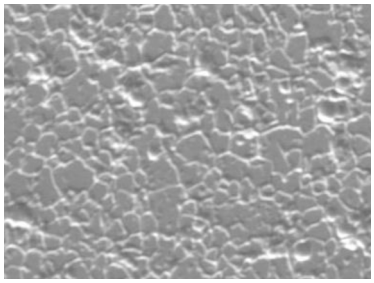
Pickle Passivation is the immersion of the metal in a pickling bath or coating the material with pickling solution, such as nitric-hydroflouric acid. The process removes both metallic contamination and heat-treating scales. Pickle passivated stainless steel has a matte appearance. Apache's tests have confirmed improvements up to 25% in RA readings on material that has been pickle passivated.

Electropolishing Electropolishing is an electrochemical process that removes surface material from stainless steel. The process includes an immersion of the stainless steel component into a temperature controlled bath of electrolyte that is charged with a DC power supply. Electrolytes used in electropolishing are concentrated sulfuric and phosphoric acid solutions. The finish has a mirror appearance. Apache's before/after tests have shown improvements in RA smoothness up to 50%; results vary depending on stainless material.

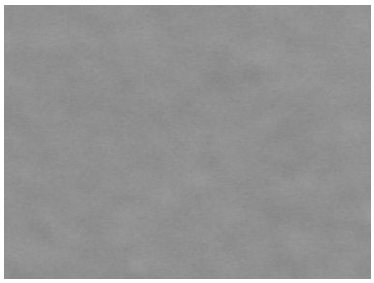
While surface standards such as 3-A, requires smooth, impervious material, free of cracks and crevices, often processors need to choose the finish that meets those requirements with the best decision that fits their cleaning processes, risk factors and overall business objectives.

Below is a study, conducted at Apache, that compares high-end finishes under 200X magnification. It shows the RA smoothness in four finish examples of 304 Stainless Steel. In the study, the Electropolished finish is more than six times smoother in RA readings than the Bead Blasted finish. These findings are only significant to the processor if smoother finishes provide the benefit to cleaning and sanitation in their manufacturing processes.

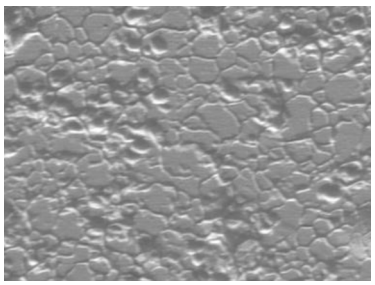
SURFACE SMOOTHNESS TEST UNDER 200X MAGNIFICATION



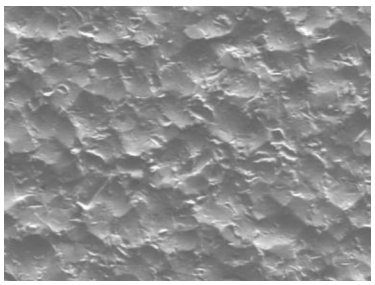
304 Stainless Steel 2B Finish
15 - 17 RA (12 gauge)



304 Stainless Steel
Electropolished Finish
5 - 6 RA



304 Stainless Steel 2B Finish
20 - 30 RA (10 gauge)



304 Stainless Steel Bead Blast
Finish 35 - 45 RA

Steel & Finish Info Sheet

FINISH DESIGNATION	
1-9 RA (1-10 RMS)	#8
4-13 RA (5-15 RMS)	2B (16 Ga. Sheet)
9-18 RA (10 - 20 RMS)	2B (14 Ga. Sheet)
13 -22 RA (15-25 RMS)	2B (12 Ga. Sheet)
18-27 RA (20-30 RMS)	2B (11 Ga. Sheet)
18-31 RA (25-35 RMS)	2B (10 Ga. Sheet)
22-36 RA (25-40 RMS)	2B (7 Ga. Sheet)
10-16 RA (11-18 RMS)	#7 (320 Grit)
13-27 RA (15-30 RMS)	#6 (240 Grit)
18-31 RA (20-35 RMS)	#4 Dairy (180 Grit)
29-40 RA (32-45 RMS)	#4 (150 Grit)
36-58 RA (40-65 RMS)	#3 (120 Grit)
49-76 RA (55-85 RMS)	2D (80 Grit)

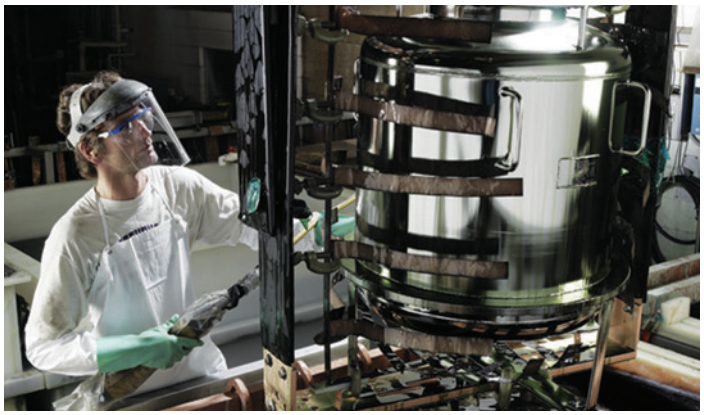
Note: The thinner the gauge material, the more rolling processes and cold reduction the material is subjected to, which creates a smoother surface.

STAINLESS STEEL GAUGE CHART	
Gauge	Decimal Size
28	.015
26	.018
24	.024
22	.030
20	.036
18	.048
16	.060
14	.075
13	.090
12	.105
11	.120
10	.135
8	.165
7	.1874

Since stainless steel resists corrosion, maintains its strength at high temperatures, and is easily maintained. It is widely used in items such as industrial and food processing products, as well as medical and health equipment. The most common US grades of stainless steel are:

TYPE 304 / 304L
The most commonly specified austenitic (chromium-nickel stainless class) stainless steel, accounting for more than half of the stainless steel produced in the world. This grade withstands ordinary corrosion in architecture, is durable in typical food processing environments, and resists most chemicals. Type 304 is available in virtually all product forms and finishes.

TYPE 316 / 316L
Austenitic (chromium-nickel stainless class) stainless steel containing 2%-3% molybdenum (whereas 304 has none). The inclusion of molybdenum gives 316 greater resistance to various forms of deterioration.



A portable vessel used in the pharmaceutical manufacturing industry emerges from the electropolishing tank at Apache Stainless Equipment Corporation.

Apache's food processing customers have more discretion in choosing equipment finishes even in food contact environments. The type of food product, bacterial count, manufacturing function and sanitation procedures all have an impact on the requirements as well as the selection of equipment finishes.

When weighing the advantages of food contact equipment finishes, the U.S. Dept. of Agriculture and Research Service offers a study conducted by the American Society of Mechanical Engineers on electropolishing and surface finishes. In the research, samples of stainless steel finishes were exposed to bacteria to allow growth. As microorganisms became attached to surfaces, they became more resistant to both physical and chemical sanitation practices. It was determined that out of eleven different finishes tested, the electropolished finish was the most resistant surface to bacterial attachment.

About Apache

The Apache Stainless Equipment Corporation employs experts and artisans in the fabrication of stainless equipment for a range of industries. Our expertise in high-end stainless finishes is shown on Apache's tanks and vessels, and Mepaco's food processing equipment used in the beverage, biotechnology, pharmaceutical and food processing industries.

Passivation, pickle passivation and electropolishing processes are offered in-house by experienced technicians; there is no dependency on outsourcing. Apache provides finishing services on tanks, vessels and food processing equipment as well as contract finishing requests.

Apache consists of five business groups: ASME tanks, portable vessels, carbon steel (Plover, WI,) contract manufacturing and Mepaco®. With modifiable options, Mepaco's product line includes: thermal processing equipment, mixers, blenders, augers, dumpers, sanitary conveyors and material handling systems.

As a 100% employee owned company, Apache's culture exemplifies continuous improvement, efficiency, innovation and commitment to our customer.

References:

The Fabricator, A publication of the Fabricators & Manufacturers Association, Intl.

ISSF, International Stainless Steel Forum

ASTM, International Standards Worldwide

USDA Agricultural Research Service

3-A, Basics of Sanitary Design

Apache and Mepaco industry experts and reference documents

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