

ENAMELING

STEELS



Appliances
Barbecue Grills
Plumbingware
Architectural



Cleveland-Cliffs manufactures four enameled products to meet a variety of porcelain enameling and formability requirements: UNIVIT®, VIT-PLUS®, I-F Enameling Steel, and UNIVIT® APX Type IV. These products are manufactured specifically for use in appliances, plumbing ware, barbecue grills, architectural panels, and applications in various other industries. UNIVIT APX Type IV is a new product and is consistent with ASTM A424 Type IV enameling steel. UNIVIT APX Type IV is a superior replacement for UNIVIT (comparable to Type I in ASTM A424).

Porcelain enameling characteristics, formability, and mechanical properties of Cleveland-Cliffs Enameling Steels are precisely controlled during production to achieve both surface properties suitable for enameling, and to meet your application's forming requirements. Please note that Cliffs intends to collaborate with customers currently utilizing UNIVIT to transition to UNIVIT APX Type IV.

ENAMELING STEELS

PRODUCT FEATURES

ENAMELABILITY

Enameling Steels can be readily coated with porcelain enameling systems.

EXCELLENT SURFACE APPEARANCE

Enameling Steels have manufacturing controls in place to allow consistent surface quality, before and after porcelain enameling.

DESCRIPTION

UNIVIT and UNIVIT APX TYPE IV are specialty enameling steels developed for applications where direct-on cover coat enameling is employed. They are equally well suited for those applications using ground coat, ground coat plus cover coat, and two coat-one fire porcelain enameling systems. These interchangeable products are free of porcelain enamel fish scale, regardless of the enameling system employed. UNIVIT is described in ASTM A424 Type I and UNIVIT APX Type IV is described by Type IV in ASTM A424.

VIT-PLUS is a controlled chemistry, nondecarburized steel. It has good strength-after-fire properties as shown in Figure 2. It is well suited for ground coat, ground coat + cover coat, and some two coat-one fire enameling systems. It is not recommended for direct-on cover coat porcelain enamel applications. Like the UNIVIT product, VIT-PLUS is free of porcelain enamel fishscale regardless of the enameling system employed. VIT-PLUS is described in ASTM A424 Type II.

I-F Enameling Steel is a vacuum degassed, titanium stabilized steel. I-F Enameling Steel can be used for ground coat, ground coat + cover coat, and two coat-one fire porcelain enameling systems. It is not recommended for use in direct-on, cover coat, enameling systems because the level of titanium in the base metal may interfere with the development of good porcelain-to-steel adherence. The porcelain enamel frit supplier should be made aware of the use of I-F Enameling Steel as minor formulation changes may be required depending on the particular enameling system.

Fishscale will not be a hazard providing adequate porcelain enamel adherence and bubble structure are attained during the firing operation. Because of its excellent formability, it is most often used in the production of very difficult to form parts. I-F Enameling Steel can also be used where base metal sag during firing might be a problem (see Figure 1). I-F Enameling Steel is described in ASTM A424 Type III.

FORMABILITY

Enameling Steels can be used to produce parts containing simple bends to parts with extreme deep drawing requirements.

WELDABILITY

Enameling Steels can be joined using accepted welding practices suitable for porcelain enameling operations.

FIGURE 1 – BASE METAL SAG

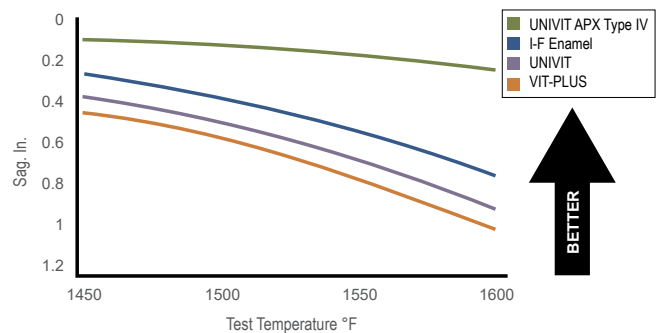
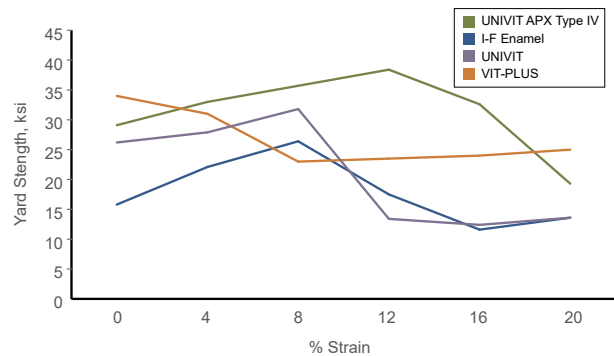


FIGURE 2 – STRENGTH AFTER STRAIN & FIRE



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SURFACE FINISH

Enameling Steels are manufactured with matte finishes obtained by rolling with specially roughened rolls on the cold mill and the temper mill. Different finishes can be provided to maintain effective lubrication during metal forming or to satisfy specific part/customer specifications.

SURFACE PROTECTION AND LUBRICATION

To prevent staining in transit, it is recommended that Enameling Steel be supplied with a rust preventative oil.

FORMABILITY AND MECHANICAL PROPERTIES

The formability of all steel products is a result of the interaction of many variables. These variables include: the mechanical properties of the steel, the forming system (tooling) used to manufacture parts, and the lubrication used during forming. Of these three, Cleveland-Cliffs can directly affect the mechanical properties of the steel.

UNIVIT, VIT-PLUS and UNIVIT APX Type IV are produced to provide maximum formability and can be supplied as Commercial Steel (CS) for moderate forming or bending applications. For more stringent forming applications, Drawing Steel (DS), should be ordered. I-F Enameling Steel should be ordered for the most difficult to form parts.

Typical mechanical properties are shown in Table 1.

Spin forming and related fabrication techniques may affect the void structure of the enameling steel product which could compromise the fishscale resistance. This should be considered when evaluating this fabrication technique.

JOINING SYSTEMS

Porcelain Enameling Steels can be readily joined using a variety of joining processes, such as resistance welding, low heat input arc welding, laser welding, and mechanical fastening. Resistance spot, seam, and projection welding are commonly used for joining Enameling Steels due to the high production rate and low per weld cost characteristics of this group of processes. The effects of each of these on subsequent porcelain enameling operations must be thoroughly evaluated by the end user for each specific application. A material's physical and electrical properties directly affect welding processes. Therefore, welding parameters may need adjustment when changing grade of Enameling Steel, surface finish, or lubricant/oil.

APPLICATIONS

Enameling Steels are used for various applications requiring cleanability, thermal shock capability, chemical resistance, corrosion protection, weather resistance, certain mechanical or electrical properties, and where color or appearance is important. Some common applications include ranges, washers and dryers, barbecue grills, water heater tanks, plumbingware, cookware, chemical processing tanks, agricultural storage tanks, architectural panels, signs, and tanning beds.

SPECIFICATIONS

Enameling Steels are produced in conformance to the following specifications:

ASTM A424	Steel sheet for porcelain enameling
ASTM A568	General requirements

For any specification not listed here, contact your Cleveland-Cliffs sales representative.

OUTSIDE PROCESSING

Tailored blanks, tension leveling, re-squaring, slitting, cut-to-length, and coil coating are just some of the services Cleveland-Cliffs can provide through arrangements with outside processors.

TECHNICAL ASSISTANCE

Cleveland-Cliffs' technical representatives can provide you with more detailed information concerning this product. They also are available to assist in reviewing any welding, forming, porcelain enameling, or other material selection issues.

MILL LIMITS

Enameling Steels are available in thicknesses from 0.019 – 0.085 in.

(0.48 – 2.16 mm), and widths up to 80 in. (2032 mm) depending on dimension and product quality. For sizes outside these limits, please contact your Cleveland-Cliffs sales representative.

The standard coil inner diameter is 24 in. (609 mm). Thickness, width, and flatness tolerances are covered in ASTM A568.

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TABLE 1 – TYPICAL MECHANICAL PROPERTIES –STANDARD GRADES

Grade	YS		UTS		Elong. %	n-Value	r _m
	ksi	MPa	ksi	MPa			
Type I – UNIVIT (DS)	25	170	43	295	44	0.22	<1.3
Type II – VIT-PLUS (DS)	26	180	44	300	42	0.22	<1.3
Type III – I-F Enamel	20	140	44	300	46	0.24	≥1.3
UNIVIT APX Type IV	23	160	42	290	43	0.22	1.7

Typical properties produced by Cleveland-Cliffs for these grades. Note that UNIVIT APX Type IV will replace UNIVIT.

TABLE 2 – TYPICAL CHEMISTRIES

Grade	C	Mn	P	S	Si	Cu	Al	Ti
UNIVIT*	0.003	0.21	0.01	0.01	0.01	0.02	0.05	-
VIT-PLUS	0.04	0.21	0.01	0.01	0.01	0.02	0.05	-
I-F Enamel	0.005	0.2	0.01	0.01	0.01	0.02	0.05	0.09
UNIVIT APX Type IV	0.003	0.27	0.01	0.01	0.01	0.02	0.05	-

**Chemistry listed is the typical product chemistry after mill processing. The carbon level is higher on heat analysis.*

About Cleveland-Cliffs Inc.

Cleveland-Cliffs is a leading North America-based steel producer with focus on value-added sheet products, particularly for the automotive industry. The Company is vertically integrated from the mining of iron ore, production of pellets and direct reduced iron, and processing of ferrous scrap through primary steelmaking and downstream finishing, stamping, tooling, and tubing. 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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