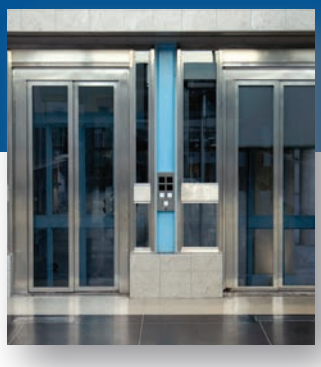
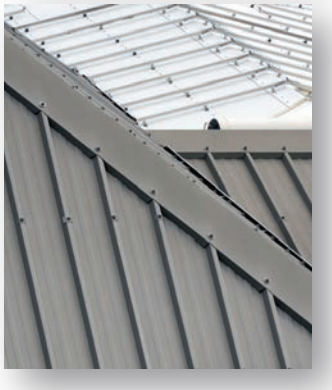
CLIFFS

# TYPE 430
# 430 ULTRA FORM®
## STAINLESS STEEL





**Appliances**

**Food Equipment**

**General Construction**

**Interior Architectural Trim**

**Restaurant Equipment**

**TYPE 430** is one of the most widely used of the non-hardenable ferritic stainless steels. With nominal 16% chromium (Cr), it combines good corrosion resistance and heat and oxidation resistance up to 1500 °F (816 °C) with good mechanical properties. Type 430 is a non-stabilized stainless steel and as such is not suitable for all welded applications.

**CLEVELAND-CLIFFS 430 ULTRA FORM® STAINLESS STEEL** was developed as a more formable version of Type 430. It is particularly suited for parts requiring more complex shapes. Cleveland-Cliffs 430 ULTRA FORM Stainless Steel combines good corrosion resistance with heat and oxidation resistance up to 1500 °F (816 °C), while having improved mechanical properties over regular Type 430. Cleveland-Cliffs 430 ULTRA FORM stainless steel has a more equiaxed grain microstructure and contains a small addition of titanium (Ti). The alloy can be supplied with a matte-pickled, temper passed finish or a directional-polished finish.

# Product Description

## AVAILABLE FORMS

Cleveland-Cliffs produces Type 430 in coils and cut-to-length sheet in thicknesses of 0.010 – 0.145 in. (0.25 – 3.68 mm) and widths up to and including 48 in. (1219 mm). Cleveland-Cliffs 430 ULTRA FORM Stainless Steel is produced in coils in thicknesses from 0.015 – 0.12 in. (0.38 – 3.05 mm) and widths up to and including 48 in. (1219 mm). Cleveland-Cliffs offers a lower interstitial version of Type 430 stainless steel called 430LI. For additional capabilities, contact your Cleveland-Cliffs representative.

| Composition | | TYPE 430 (wt %) | 430 ULTRA FORM (wt %) |
|---|---|---|---|
| Carbon | (C) | 0.12 max. | 0.12 max. |
| Manganese | (Mn) | 1.00 max. | 1.00 max. |
| Phosphorus | (P) | 0.040 max. | 0.040 max. |
| Sulfur | (S) | 0.030 max. | 0.030 max. |
| Silicon | (Si) | 1.00 max. | 1.00 max. |
| Chromium | (Cr) | 16.0 – 18.0 | 16. 0 – 18.0 |
| Titanium | (Ti) | — | 0.5 max. |
| Nickel | (Ni) | 0.75 max. | 0.5 max. |
| Iron | (Fe) | Balance | Balance |

## SPECIFICATIONS

Type 430 sheet and strip is covered by the following specifications:

- AMS 5503
- ASTM A240

### TABLE 1 – ROOM TEMPERATURE MECHANICAL PROPERTIES

| Alloy | 0.2% YS, ksi. (MPa) | UTS, ksi. (MPa) | Elongation % in 2 in. (50.8 mm) | Rockwell Hardness, B |
|---|---|---|---|---|
| Type 430 | 48 (343) | 73 (503) | 28 | 78 |
| Cleveland-Cliffs 430 ULTRA FORM SS | 45 (310) | 70 (483) | 30 | 78 |

### TABLE 2 – PHYSICAL PROPERTIES

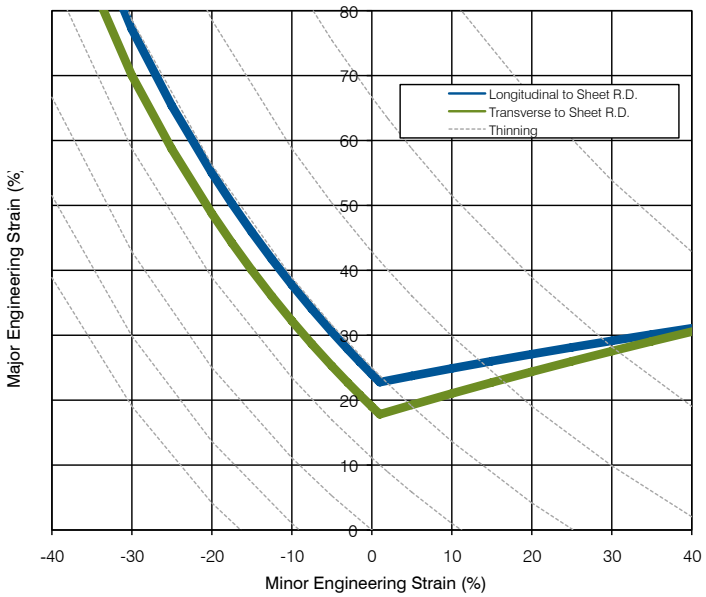
| | |
|---|---|
| Density, lbs/in.$^3$ (g/cm$^2$) | 0.28 (7.74) |
| Electrical Resistivity, $\mu\Omega$•in. ($\mu\Omega$•cm)<br>70° C (21° C) | <br>23.68 (60) |
| Specific Heat, BTU/lb./°F (kJ/kg•K)<br>32 – 212° F (0 – 100° C) | <br>0.11 (0.46) |
| Thermal Conductivity, BTU/hr./ft./°F (W/m•K)<br>at 212° F (100° C)<br>at 932° F (500° C) | <br>15.1 (26.1)<br>15.2 (26.3) |
| Coefficient of Thermal Expansion, in./in./°F ($\mu$m/m•K)<br>32 – 212° F (0 – 100° C)<br>32 – 1000° F (0 – 538° C) | <br>5.8 x $10^{-6}$ (10.4)<br>6.3 x $10^{-6}$ (11.4) |
| Modulus of Elasticity, ksi. (MPa) | 29 x $10^3$ (200 x $10^3$) |

# Formability

Cleveland-Cliffs 430 ULTRA FORM Stainless Steel is readily drawn and formed. The ULTRA FORM Stainless Steel condition improves the consistency from one coil to another. Figure 1 shows the Forming Limit Curve for Cleveland-Cliffs 430 ULTRA FORM Stainless Steel 0.024 in. (0.6 mm) thick with a mill supplied 2B finish. Cleveland-Cliffs 430 ULTRA FORM Stainless Steel coils have a higher plastic strain ratio ($r_m$ value) and lower delta r-value than standard Type 430 sheet material.

Type 430 is readily drawn and formed. Its drawing characteristics are similar to those of low-carbon steel, although it is stronger in the annealed condition and will require stronger tooling and increased power. It is also adaptable to most hot-forming operations.

### FIGURE 1 –FORMING LIMIT CURVE




**Cleveland-Cliffs 430 ULTRA FORM Stainless Steel Coil, #2B Finish, 0.024 in. thick**

Determined using CamSys Localized Nodal Strain Measurement Method 0.1 in. Square Grid Pattern.

## HEAT TREATMENTS

Anneal: Heat to 1400 – 1525° F (760 – 829° C), air cool or water quench.

### TABLE 3 – FORMING LIMIT CURVE MATERIAL TEST DATA

| Property | Orientation to Sheet R.D. | | |
|---|---|---|---|
| | L | D | T |
| *Tensile/Hardness Test (ASTM E8, E694, E18, A370)* | | | |
| 0.2% YS (ksi.) | 42.4 | 45.2 | 44.6 |
| UTS (ksi.) | 71.6 | 73.4 | 71.6 |
| % El. in 2" (man'l) | 29.7 | 27.2 | 29.2 |
| n-value (10%-Ult.) | 0.200 | 0.194 | 0.192 |
| Strength Coeff. (ksi.) | 121.0 | 123.3 | 119.6 |
| HRB | 61 (57 HR30-TW) | | |
| *Stretch r (plastic strain ratio) at 18% (ASTM E517)* | | | |
| r-value | 1.31 | 1.24 | 2.14 |
| $r_m$ | 1.48 | | |
| delta r | 0.48 | | |
| delta r (Max – Min) | 0.90 | | |
| Ridging No. | 2.0 | | |
| Olsen Cup Height (in.) | 0.319 | | |

# Corrosion Resistance

Type 430 has excellent corrosion resistance, including high resistance to nitric acid as well as to sulfur gases and many organic and food acids. This alloy does not provide the resistance to pitting by dilute reducing acids that is provided by the chromium-nickel stainless steels.

The corrosion resistance of Cleveland-Cliffs 430 ULTRA FORM Stainless Steel is superior to 11% chromium Type 409 but not equivalent to the level of austenitic stainless Type 304. Cleveland-Cliffs 430 ULTRA FORM Stainless Steel is comparable to standard Type 430 in most environments as is shown in the following immersion, electrochemical, pitting and intergranular corrosion tests.

Because of its relatively high chromium content, the material provides good resistance to oxidation. Its maximum scaling temperature is 1500 °F (816 °C) for continuous service.

## IMMERSION TESTS

Immersion tests were performed on duplicate machined specimens. Testing was performed under static conditions for 24 hours. Corrosion rates were calculated from mass measurements. All test solutions were prepared to w/w% as described in ASTM G31.

### TABLE 4 – CHEMICAL IMMERSION TESTING AT 50° C

| Chemical | Type 430 | Cleveland-Cliffs 430 ULTRA FORM SS |
|---|---|---|
| 1% Hydrochloric Acid | 19 | 13 |
| 5% Sulfuric Acid | 50 | 38 |
| Household Bleach | 17 | 2 |
| 20% Sodium Hydroxide | <2 | <2 |
| 60% Acetic Acid | <2 | <2 |
| 10% Citric Acid | <2 | <2 |

## INTERGRANULAR CORROSION RESISTANCE

Samples of Cleveland-Cliffs 430 ULTRA FORM Stainless Steel and standard Type 430 were tested for intergranular corrosion resistance as-annealed and after 1250 °F (675 °C) 2 hour exposures. Testing was carried out using ASTM Standard A763 Practice W (Oxalic acid etch) and the more stringent Practice Z accelerated (Strauss Test), boiling $CuSO_4$-Cu solution results shown below revealed both alloys passed the two practices.

### TABLE 5 – ACCELERATED STRAUSS TEST – ASTM A763 PRACTICE Z

| Sample Material | Top Side | Bottom Side |
|---|---|---|
| Cleveland-Cliffs 430 ULTRA FORM SS | Pass | Pass |
| Type 430 | Pass | Pass |
| Cleveland-Cliffs 430 ULTRA FORM SS with HT | Pass | Pass |
| Type 430 with HT | Pass | Pass |

## BREAKDOWN POTENTIAL

Electrochemical Breakdown Potential is measured using multiple potentiodynamic scans in deaerated 3.5% NaCl solution at a fixed scan rate of 1.667mV/s. The breakdown potential ($E_{pit}$) is the potential where the anodic current increases rapidly the higher the $E_{pit}$, the more resistant the alloy is to localized corrosion. All test specimens were prepared to a diamond-polished finish.

### TABLE 6 – ELECTROCHEMICAL BREAKDOWN POTENTIAL

| Material | Average $E_{pit}$ vs. Ag/AgCl, (mV) |
|---|---|
| Cleveland-Cliffs 430 ULTRA FORM SS | 300 MV |
| Type 430 | 290 MV |

# Corrosion Resistance

## FERRIC CHLORIDE PITTING AND CREVICE CORROSION RESISTANCE

ASTM G48 Practice A was performed on machined 1 x 2 in. coupons with a mill supplied 2B finish and a #4 polish. Coupons were exposed to 6% ferric chloride at 50 °C (122 °F) for times of 4, 8, and 24 hours after which coupons were removed, cleaned and mass loss measured.

### TABLE 7

| ASTM G48 – Pitting Test at 50° C, (g/cm²) | | | |
|---|---|---|---|
| | Hours in Test | | |
| | 4 | 8 | 24 |
| Type 430 2B | 0.005 | 0.013 | 0.026 |
| Cleveland-Cliffs 430 ULTRA FORM SS 2B | 0.013 | 0.018 | 0.030 |

### TABLE 8

| ASTM G48 – Pitting Test at 50° C, (g/cm²) | | | |
|---|---|---|---|
| | Hours in Test | | |
| | 4 | 8 | 24 |
| Type 430 #4 Polished | 0.011 | 0.015 | 0.024 |
| Cleveland-Cliffs 430 ULTRA FORM SS #4 Polished | 0.012 | 0.015 | 0.024 |

ASTM G48 Practice A was performed on machined 1 x 2 in. coupons with a mill supplied 2B finish and a #4 polish. Coupons were exposed to 6% ferric chloride at 50 °C (122 °F) for times of 4, 8, and 24 hours after which coupons were removed, cleaned and mass loss measured.

### TABLE 9

| ASTM G48 – Crevice Test at 50° C, (g/cm²) | | | |
|---|---|---|---|
| | Hours in Test | | |
| | 4 | 8 | 24 |
| Type 430 2B | 0.007 | 0.010 | 0.023 |
| Cleveland-Cliffs 430 ULTRA FORM SS 2B | 0.013 | 0.014 | 0.024 |

FIGURE 2 – ASTM G48 PRACTICE A PITTING CORROSION – MILL SUPPLIED 2B FINISH

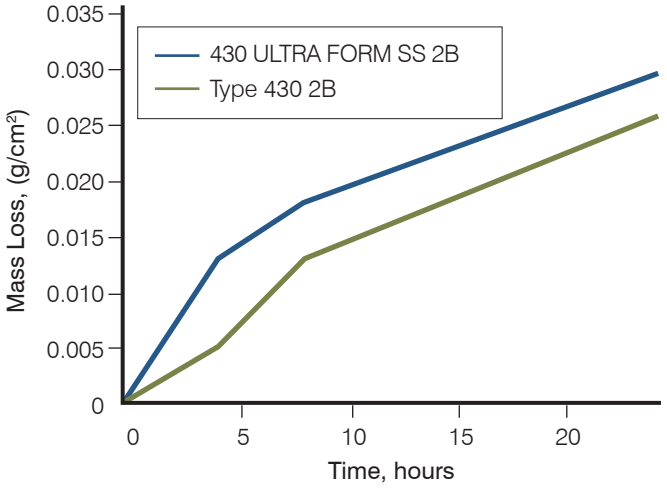



FIGURE 3 – ASTM G48 PRACTICE A PITTING CORROSION – #4 POLISH FINISH

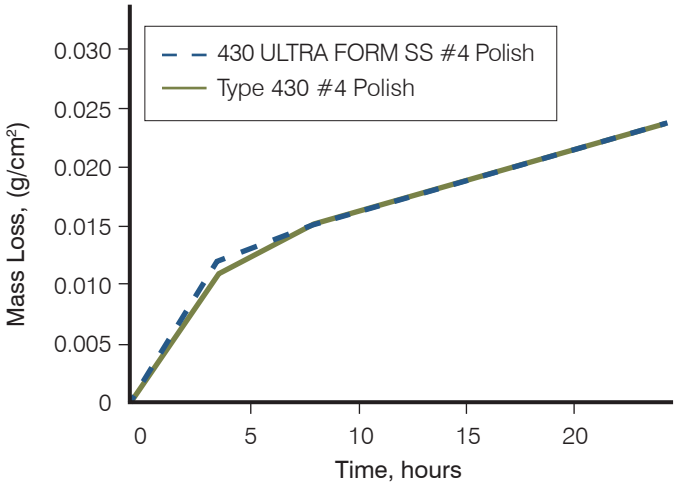
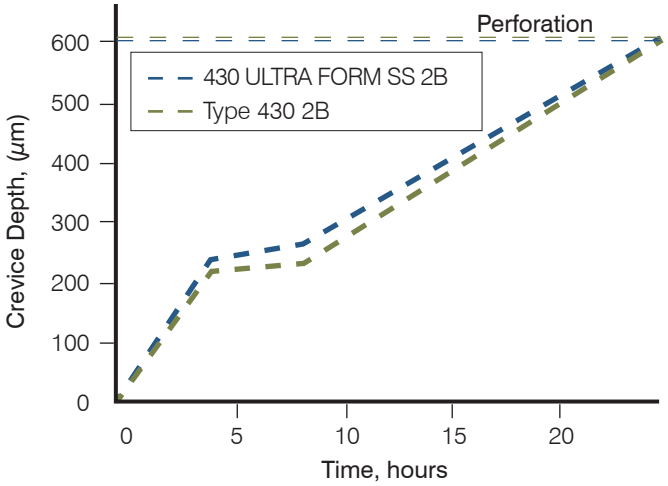



FIGURE 4 – ASTM G48 PRACTICE B, CREVICE CORROSION TEST



# TYPE 430 | 430 ULTRA FORM® STAINLESS STEEL

## WELDABILITY

Cleveland-Cliffs 430 ULTRA FORM Stainless Steel is considered to be more weldable than Type 430. The small addition of titanium will partially help in preventing the formation of harmful chromium carbides which can lead to intergranular corrosion in welds, however, it is not sufficient to fully stabilize the grade. Cleveland-Cliffs 430 ULTRA FORM Stainless Steel may not be suitable for all welded applications and consideration should be given to the degree of corrosion resistance that is required. The heat of welding can cause grain growth and reduce weld zone toughness in the ferritic stainless steels. Maximum toughness can be achieved by minimizing weld discontinuities, maintaining low weld heat input, and occasionally warming parts prior to forming.

When a weld filler is needed, AWS E/ER 439 or 430Ti is often specified. W18Cb is suggested for elevated temperature service and E/ER308L for better ductility in ambient service conditions.

The ferritic class of stainless steels is generally considered to be weldable by the common fusion and resistance techniques. Special consideration is required to avoid brittle weld fractures during fabrication by minimizing discontinuities, maintaining low weld heat input, and occasionally warming the part somewhat before forming. This particular alloy is generally considered to have poorer weldability than the most common alloy of the stainless class, Type 409. Major differences are the higher carbon content and the lack of stabilizing elements for this alloy which require post weld annealing to restore optimum corrosion and forming characteristics. When a weld filler is needed, AWS E/ER 308L and Type 430 are most often specified. Type 430 is well known in reference literature and more information can be obtained in this way.

## 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.

**CLEVELAND-CLIFFS INC.**
200 Public Square
Suite 3300
Cleveland, OH 44114-2315
844.STEEL99 | 844.783.3599
clevelandcliffs.com



March 2022