UR™ 254: A 6Mo cost savings super austenitic stainless steel with PREN ≥ 42

UR™ 254 is a 18% Ni, 20% Cr, 6% Mo super austenitic stainless steel grade with 0.2% nitrogen additions, particularly designed to be cost effective. The 18% nickel and 0.7% copper additions combined with the chromium and molybdenum additions enhance the performance of the steel in many corrosive solutions encountered for example in chemical and petrochemical processes or chloride containing solutions. The alloy is also seawater resistant and has extensively been used in offshore applications (It is not recommended for use in stagnant seawater applications with temperatures higher than 30°C (86°F). Thanks to the 18% Nickel and the 0.2 Nitrogen additions, the microstructure is austenitic.

STANDARDS

- EURONORM: EN 1.4547 X1 Cr Ni Mo Cu 20-18-7
- ASTM: UNS S31254

CHEMICAL ANALYSIS - WEIGHT %

Typical values

<table>
<thead>
<tr>
<th>C</th>
<th>Cr</th>
<th>Ni</th>
<th>Mo</th>
<th>N</th>
<th>S</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.01</td>
<td>20</td>
<td>18</td>
<td>6.1</td>
<td>0.2</td>
<td>0.001</td>
<td>Cu = 0.7</td>
</tr>
</tbody>
</table>

PREN = [Cr%] + 3.3 [Mo%] + 16 [N%] ≥ 42

PHYSICAL PROPERTIES

Typical values

Density: 8.0 kg/dm³ – 0.28 lb/in³

<table>
<thead>
<tr>
<th>Temperature interval °C (°F)</th>
<th>Thermal expansion (αx10⁻⁶ K⁻¹)</th>
<th>T °C (°F)</th>
<th>Resistivity (µΩ.cm)</th>
<th>Thermal conductivity (W.m⁻¹.K⁻¹)</th>
<th>Specific heat (J.kg⁻¹.K⁻¹)</th>
<th>Young modulus E (GPa)</th>
<th>Shear modulus G (GPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 - 100 (68 - 212)</td>
<td>16.5</td>
<td>20 (68)</td>
<td>90</td>
<td>13</td>
<td>480</td>
<td>195</td>
<td>75</td>
</tr>
<tr>
<td>20 - 300 (68 - 572)</td>
<td>17</td>
<td>200 (392)</td>
<td>105</td>
<td>14.5</td>
<td>550</td>
<td>182</td>
<td>70</td>
</tr>
<tr>
<td>20 - 500 (68 - 932)</td>
<td>17.3</td>
<td>400 (752)</td>
<td>110</td>
<td>16</td>
<td>620</td>
<td>166</td>
<td>66</td>
</tr>
</tbody>
</table>
MECHANICAL PROPERTIES
Tensile properties - minimum values for plates th = 10 mm

<table>
<thead>
<tr>
<th>°C</th>
<th>R_p0.2</th>
<th>R_p1.0</th>
<th>R_m</th>
<th>°F</th>
<th>YS 0.2%</th>
<th>YS 1.0%</th>
<th>UTS</th>
<th>A/Elongation</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>300</td>
<td>330</td>
<td>650</td>
<td>68</td>
<td>43</td>
<td>48</td>
<td>94</td>
<td>35</td>
</tr>
<tr>
<td>100</td>
<td>235</td>
<td>270</td>
<td>610</td>
<td>212</td>
<td>35</td>
<td>39</td>
<td>88</td>
<td>35</td>
</tr>
<tr>
<td>200</td>
<td>195</td>
<td>225</td>
<td>560</td>
<td>392</td>
<td>28</td>
<td>33</td>
<td>81</td>
<td>35</td>
</tr>
<tr>
<td>300</td>
<td>175</td>
<td>205</td>
<td>525</td>
<td>572</td>
<td>25</td>
<td>30</td>
<td>76</td>
<td>35</td>
</tr>
<tr>
<td>400</td>
<td>160</td>
<td>190</td>
<td>510</td>
<td>752</td>
<td>23</td>
<td>28</td>
<td>74</td>
<td>35</td>
</tr>
</tbody>
</table>

Impact toughness: KCV > 60J/cm² (70 ft lbs) at -196 °C (-320 °F)

Hardness values: HV₁₀: [190 - 230]

STRUCTURE
The UR™ 254 chemical analysis (18 Ni, 0.2 N) gives an austenitic microstructure. Ferrite islands may be observed at mid-thickness of the plates. The alloy remains ductile down to -196 °C (320 °F). Due to the high chromium and molybdenum contents, the UR™ 254 alloy must be water-quenched to obtain the optimum microstructure, and avoid phase precipitation during cooling. Phase precipitations may occur in the 700-1100 °C (1292-2012 °F) temperature range. The solution annealing heat treatment is typically performed in the 1120-1170 °C (2048-2138 °F) temperature range and followed by water quenching.

CORROSION RESISTANCE
Pitting and crevice corrosion resistance
The high chromium, molybdenum and nitrogen contents of alloy UR™ 254 (PREN ≥ 42) explain why the grade is resistant to localized corrosion even in acidified oxidizing environments. The alloy has been successfully used for seawater applications.

General corrosion resistance
Thanks to its well balanced composition with 18% nickel and high chromium molybdenum and nitrogen additions, UR™ 254 alloy is a typical multipurpose super austenitic grade for severe service conditions. It outperforms alloy UR™ 904L (UNS N08904) in most applications. Alloy UR™ 254 is not designed for concentrated sulfuric acid solutions. It contains 6% Mo but less nickel than the other grades of the 6 Mo family.
### Delivery Conditions

#### Size Range

<table>
<thead>
<tr>
<th></th>
<th>Hot rolled plates</th>
<th>Clad plates</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Thickness</strong></td>
<td>5 to 120 mm</td>
<td>6 to 150 mm</td>
</tr>
<tr>
<td></td>
<td>3/16” to 5&quot;</td>
<td>1/4” to 6”</td>
</tr>
<tr>
<td><strong>Width</strong></td>
<td>Up to 3300 mm</td>
<td>Up to 3300 mm</td>
</tr>
<tr>
<td></td>
<td>Up to 130”</td>
<td>Up to 130”</td>
</tr>
<tr>
<td><strong>Length</strong></td>
<td>Up to 12000 mm</td>
<td>Up to 14000 mm</td>
</tr>
<tr>
<td></td>
<td>Up to 472”</td>
<td>Up to 551”</td>
</tr>
</tbody>
</table>

*Other sizes are available on request.*
PLATE PROCESSING

HOT FORMING
Furnace atmosphere must be slightly oxidizing and free of sulphur compounds. Put the plate in the furnace at specified temperature. Temperature range for hot forming: 1200°C to 900°C (2190°F to 1650°F). Reheat as often as necessary to reduce hardening and effects on structure. Solution annealing is necessary after hot working:

- Temperature: 1120°C – 1170°C (2050°F – 2138°F)
- Soaking time: 1 to 2 min per mm of thickness at annealing temperature
- Cooling: water quench

COLD FORMING
The cold formability of UR™ 254 is excellent, but due to its high Mo content, the work hardening is higher than for 316L. Intermediate annealing may be necessary. To remove forming stress, or when there is risk for SCC in highly caustic media, an annealing may be necessary (see heat treatment).

PICKLING
The cleanliness of the surface is very important to maintain the high corrosion resistance of this alloy. Nitric, fluoric or sulfuric-fluoric baths can be used for pickling. The best results are obtained with a heated bath (40-60°C, 104-140°F).

WELDING
UR™ 254 can be welded by the following processes: TIG/GTAW, MIG/GMAW, SMAW with covered electrodes. This grade must be welded with filler metal: welds without filler have a low ductility and a low corrosion resistance. Keep the dilution of parent metal below 40% (more filler metal than parent metal). Due to the fully austenitic structure of UR™ 254, the following precautions must be taken:

- Minimise the heat input (string beads, no oscillation, diameter of covered electrodes limited to 3.2 mm). The heat input should preferably be limited to 1.2 kJ/mm
- Interpass temperature must be controlled to less than 120°C (248°F),
- No preheating for PWHT,
- Careful cleaning and degreasing of weld area and descaling and cleaning of finished weld are highly recommended.
- Carefully grind strike marks and other welding defects.
- Use run-on and run-off plates and anti-spatter protection where possible.
- Dry electrodes according to manufacturer's instructions.

UR™ 254 must be welded with niobium free Ni base filler materials like:
- PHYWELD NCW (Nb free 625 for PAW, GTAW, GMAW);
- ER Ni.Cr.Mo-10 (AWS A5.14) wires and E.Ni.Cr.Mo-10 (AWS A 5.11) electrodes (alloy C22 type);
- EL Ni.Cr.23.Mo-16 or SG - Ni.Cr.23 Mo-16 (DIN 1736) electrodes or filler metal (alloy 59 type) can be used.

Suitable electrodes and welding wire are available from various manufacturers. Technical support is available on request.
## MACHINING

<table>
<thead>
<tr>
<th>Operation</th>
<th>Tool</th>
<th>Lubrication</th>
<th>Depth of cut (mm)</th>
<th>Feed (mm)</th>
<th>Speed m/min (feet/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>18/12Mo</td>
<td>UR™ 254</td>
<td></td>
</tr>
<tr>
<td>Turning</td>
<td>High speed steel</td>
<td>Cutting oil</td>
<td>6 (0.23)</td>
<td>0.5 (0.019)</td>
<td>11 - 16 (36.1 - 52.5)</td>
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<tr>
<td></td>
<td>Carbide</td>
<td>Dry or cutting oil</td>
<td>6 (0.23)</td>
<td>0.5 (0.019)</td>
<td>70 - 80 (229.7 - 262.5)</td>
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<td></td>
</tr>
<tr>
<td>Milling profiling</td>
<td>High speed steel</td>
<td>Cutting oil</td>
<td>0.05 - 0.10 (0.002 - 0.0039)</td>
<td>10 - 20 (32.8 - 65.6)</td>
<td>10 - 20 (32.8 - 65.6)</td>
</tr>
</tbody>
</table>

**CONDITIONS**

- Depth of cut
- Feed
- Speed

### Depth of cut (mm) (inch)
- 6 (0.23)
- 3 (0.11)
- 1 (0.04)

### Feed (mm) (inch)
- 0.5 (0.019)
- 0.4 (0.016)
- 0.2 (0.008)

### Speed m/min (feet/min)
- 10 - 16 (32.8 - 52.5)
- 18 - 23 (59.1 - 75.5)
- 25 - 30 (82 - 98.4)

**Lubrication**

- Cutting oil
- Dry or cutting oil
- Cutting oil
- Cutting oil
- Cutting oil

**Condition No.**

- 18/12Mo
- UR™ 254
APPLICATIONS

> Natural and treated seawater systems, desalination plants
> Pollution control: smelters (ductings, chimneys linings...)
> Bleaching equipment for pulp and paper industries (washers)
> Chemical industries: chloride containing media; phosphoric acid, sulphuric acid – Fine chemical production

Technical data and information are to the best of our knowledge at the time of printing. However, they may be subject to some slight variations due to our ongoing research programme on steels. Therefore, we suggest that information be verified at time of enquiry or order. Furthermore, in service, real conditions are specific for each application. The data presented here are only for the purpose of description, and considered as guarantees when written formal approval has been delivered by our company. Further information may be obtained from the address opposite.

YOUR CONTACTS

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