

# Forta 316L/4404

EN 1.4404, ASTM TYPE 316L / UNS S31603

## General characteristics

A low-carbon, molybdenum-alloyed alternative to Supra 316/4401 that is widely used for various applications with higher than average corrosion resistance requirements. Forta 316L/4404 is strengthened with temper rolling for applications that require specific strength as well as improved weldability and intergranular corrosion resistance.

## Typical applications

- Chemical tanks and tubing
- Pulp and paper process equipment

## Products & dimensions

Cold rolled products, available dimensions (mm)

| Surface finish |               | Coil / Strip |        | Plate / Sheet |         |
|----------------|---------------|--------------|--------|---------------|---------|
|                |               | Thickness    | Width  | Thickness     | Width   |
| 2H             | Work hardened | 0.05-6.00    | 3-1530 | 0.25-6.00     | 18-1530 |

## Chemical composition

The typical chemical composition for this grade is given in the table below, together with composition limits given for the product according to different standards. The required standard will be fully met as specified on the order.

The chemical composition is given as % by mass.

|                    | C           | Mn    | Cr          | Ni          | Mo         | N     | Other |
|--------------------|-------------|-------|-------------|-------------|------------|-------|-------|
| <b>Typical</b>     | <b>0.02</b> |       | <b>17.2</b> | <b>10.1</b> | <b>2.1</b> |       |       |
| ASME II A SA-240   | ≤0.030      | ≤2.00 | 16.0-18.0   | 10.0-14.0   | 2.00-3.00  | ≤0.10 |       |
| ASME SA/EN 10028-7 | ≤0.030      | ≤2.00 | 16.5-18.5   | 10.0-13.0   | 2.00-2.50  | ≤0.10 |       |
| ASTM A240          | ≤0.030      | ≤2.00 | 16.0-18.0   | 10.0-14.0   | 2.00-3.00  | ≤0.10 |       |
| ASTM A666          | ≤0.030      | ≤2.00 | 16.0-18.0   | 10.0-14.0   | 2.00-3.00  | ≤0.10 |       |
| EN 10028-7         | ≤0.030      | ≤2.00 | 16.5-18.5   | 10.0-13.0   | 2.00-2.50  | ≤0.10 |       |

|                               |        |       |           |           |           |       |  |
|-------------------------------|--------|-------|-----------|-----------|-----------|-------|--|
| EN 10088-2                    | ≤0.030 | ≤2.0  | 16.5-18.5 | 10.0-13.0 | 2.0-2.5   | ≤0.10 |  |
| EN 10088-3                    | ≤0.030 | ≤2.00 | 16.5-18.5 | 10.0-13.0 | 2.0-2.5   | ≤0.10 |  |
| EN 10088-4                    | ≤0.030 | ≤2.0  | 16.5-18.5 | 10.0-13.0 | 2.0-2.5   | ≤0.10 |  |
| IS 6911                       | ≤0.030 | ≤2.00 | 16.0-18.0 | 10.0-14.0 | 2.00-3.00 | ≤0.10 |  |
| Linde Doc. 10214076           | ≤0.030 | ≤2.00 | 16.5-18.5 | 10.0-13.0 | 2.00-2.50 | ≤0.10 |  |
| TECHNETICS M118 Rev A (Z2 CND | ≤0.030 | ≤2.0  | 16-19     | 10.0-14.0 | 2.0-2.5   | ≤0.11 |  |

## Corrosion resistance

| Pitting corrosion resistance |      | Crevice corrosion resistance |
|------------------------------|------|------------------------------|
| PRE                          | CPT  | CCT                          |
| 24                           | 20±2 | <0                           |

PRE Pitting Resistant Equivalent calculated using the formula:  $PRE = \%Cr + 3.3 \times \%Mo + 16 \times \%N$

CPT Corrosion Pitting Temperature as measured in the Avesta Cell (ASTM G 150), in a 1M NaCl solution (35,000 ppm or mg/l chloride ions).

CCT Critical Crevice Corrosion Temperature is the critical crevice corrosion temperature which is obtained by laboratory tests according to ASTM G 48 Method F

## Mechanical properties

The mechanical properties of the available products are given in the table below.

| Cold rolled coil and sheet      | R <sub>p0.2</sub><br>MPa | R <sub>p1.0</sub><br>MPa | R <sub>m</sub><br>MPa | Impact<br>strength J | Rockwell | HB    | HV |
|---------------------------------|--------------------------|--------------------------|-----------------------|----------------------|----------|-------|----|
| <b>Typical (thickness 1 mm)</b> | <b>300</b>               | <b>325</b>               | <b>625</b>            |                      |          |       |    |
| ASME II A SA-240                | ≥ 170                    |                          | ≥ 485                 |                      |          | ≤ 217 |    |
| ASME SA/EN 10028-7              | ≥ 240                    | ≥ 270                    | 530 - 680             |                      |          |       |    |
| ASTM A240                       | ≥ 170                    |                          | ≥ 485                 |                      | ≤ 95HRB  | ≤ 217 |    |
| EN 10028-7                      | ≥ 240                    | ≥ 270                    | 530 - 680             |                      |          |       |    |
| EN 10088-2                      | ≥ 240                    | ≥ 270                    | 530 - 680             |                      |          |       |    |
| EN 10088-4                      | ≥ 240                    | ≥ 270                    | 530 - 680             |                      |          |       |    |
| IS 6911                         | ≥ 170                    |                          | ≥ 485                 |                      | ≤ 95HRB  | ≤ 217 |    |
| Linde Doc. 10214076             | ≥ 240                    | ≥ 270                    | 530 - 680             |                      |          |       |    |
| TECHNETICS M118 Rev A (Z2 CND   | ≥ 240                    | ≥ 270                    | 530 - 680             |                      |          |       |    |

| Hot rolled coil and sheet       | R <sub>p0.2</sub><br>MPa | R <sub>p1.0</sub><br>MPa | R <sub>m</sub><br>MPa | Impact<br>strength J | Rockwell | HB         | HV |
|---------------------------------|--------------------------|--------------------------|-----------------------|----------------------|----------|------------|----|
| <b>Typical (thickness 4 mm)</b> | <b>300</b>               | <b>350</b>               | <b>600</b>            |                      |          | <b>170</b> |    |
| ASME II A SA-240                | ≥ 170                    |                          | ≥ 485                 |                      |          | ≤ 217      |    |
| ASME SA/EN 10028-7              | ≥ 240                    | ≥ 270                    | 530 - 680             |                      |          |            |    |
| ASTM A240                       | ≥ 170                    |                          | ≥ 485                 |                      |          | ≤ 217      |    |
| EN 10028-7                      | ≥ 240                    | ≥ 270                    | 530 - 680             |                      |          |            |    |
| EN 10088-2                      | ≥ 240                    | ≥ 270                    | 530 - 680             |                      |          |            |    |
| EN 10088-4                      | ≥ 240                    | ≥ 270                    | 530 - 680             |                      |          |            |    |
| IS 6911                         | ≥ 170                    |                          | ≥ 485                 |                      | ≤ 95HRB  | ≤ 217      |    |
| Linde Doc. 10214076             | ≥ 240                    | ≥ 270                    | 530 - 680             |                      |          |            |    |

|                                  |                                       |                                       |                                    |                                    |                 |           |           |
|----------------------------------|---------------------------------------|---------------------------------------|------------------------------------|------------------------------------|-----------------|-----------|-----------|
| TECHNETICS M118 Rev A (Z2 CND    | ≥ 240                                 | ≥ 270                                 | 530 - 680                          |                                    |                 |           |           |
| <b>Hot rolled quarto plate</b>   | <b>R<sub>p0.2</sub></b><br><b>MPa</b> | <b>R<sub>p1.0</sub></b><br><b>MPa</b> | <b>R<sub>m</sub></b><br><b>MPa</b> | <b>Impact</b><br><b>strength J</b> | <b>Rockwell</b> | <b>HB</b> | <b>HV</b> |
| <b>Typical (thickness 15 mm)</b> | <b>260</b>                            | <b>300</b>                            | <b>570</b>                         |                                    |                 |           |           |
| ASME II A SA-240                 | ≥ 170                                 |                                       | ≥ 485                              |                                    | ≤ 95HRB         | ≤ 217     |           |
| ASME SA/EN 10028-7               | ≥ 220                                 | ≥ 260                                 | 520 - 670                          |                                    |                 |           |           |
| ASTM A240                        | ≥ 170                                 |                                       | ≥ 485                              |                                    | ≤ 95HRB         | ≤ 217     |           |
| EN 10028-7                       | ≥ 220                                 | ≥ 260                                 | 520 - 670                          |                                    |                 |           |           |
| EN 10088-2                       | ≥ 220                                 | ≥ 260                                 | 520 - 670                          |                                    |                 |           |           |
| EN 10088-4                       | ≥ 220                                 | ≥ 260                                 | 520 - 670                          |                                    |                 |           |           |
| IS 6911                          | ≥ 170                                 |                                       | ≥ 485                              |                                    | ≤ 95HRB         | ≤ 217     |           |
| Linde Doc. 10214076              | ≥ 220                                 | ≥ 260                                 | 520 - 670                          |                                    |                 |           |           |
| TECHNETICS M118 Rev A (Z2 CND    | ≥ 220                                 | ≥ 260                                 | 520 - 670                          |                                    |                 |           |           |

|                 |                                       |                                       |                                    |                                    |                 |           |           |
|-----------------|---------------------------------------|---------------------------------------|------------------------------------|------------------------------------|-----------------|-----------|-----------|
| <b>Wire rod</b> | <b>R<sub>p0.2</sub></b><br><b>MPa</b> | <b>R<sub>p1.0</sub></b><br><b>MPa</b> | <b>R<sub>m</sub></b><br><b>MPa</b> | <b>Impact</b><br><b>strength J</b> | <b>Rockwell</b> | <b>HB</b> | <b>HV</b> |
| <b>Typical</b>  | <b>220</b>                            | <b>260</b>                            | <b>530</b>                         |                                    |                 |           |           |

<sup>1)</sup>Elongation according to EN standard:

A<sub>80</sub> for thickness below 3 mm.

A for thickness = 3 mm.

Elongation according to ASTM standard A<sub>2</sub>" or A<sub>50</sub>.

# Physical properties

Physical properties according to EN 10088 are shown below.

| Density<br>kg/dm <sup>3</sup> | Modulus of<br>elasticity<br>GPa | Thermal exp. at<br>100 °C<br>10 <sup>-6</sup> /°C | Thermal<br>conductivity<br>W/m°C | Thermal<br>capacity<br>J/kg°C | Electrical<br>resistance<br>μΩm | Magnetizable |
|-------------------------------|---------------------------------|---------------------------------------------------|----------------------------------|-------------------------------|---------------------------------|--------------|
| 8.0                           | 200                             | 16,0                                              | 15                               | 500                           | 0.75                            | No           |

## Fabrication

More detailed information concerning welding procedures can be obtained from the Outokumpu Welding Handbook, available from our sales offices.

## Standards & approvals

The most commonly used international product standards are given in the table below.

| Standard                                                         | Designation            |
|------------------------------------------------------------------|------------------------|
| ASME SA/EN 10028-7                                               | 1.4404                 |
| ASME SA-240M Code Sect. II. Part A                               | TYPE 316L / UNS S31603 |
| ASTM A240/A240M                                                  | TYPE 316L / UNS S31603 |
| ASTM A666                                                        | TYPE 316L / UNS S31603 |
| EN 10028-7, PED 2014/68/EU                                       | 1.4404                 |
| EN 10088-2                                                       | 1.4404                 |
| EN 10088-3                                                       | 1.4404                 |
| EN 10088-4                                                       | 1.4404                 |
| IS 6911, AMENDMENT NO. 2                                         | ISS 316 L              |
| Linde Doc 10214076 rev.02                                        | 1.4404                 |
| TECHNETICS M118 Rev A (Z2 CND 17-12 acc RCCM M3307) + JN 14-2016 | 1.4404                 |

## Contacts & Enquiries

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