Heat-Resistant Austenitic Stainless Steel
(ASTM : UNS 31060)
(NSSMC-NAR-AH-4)
1 Alloy Design • Features

1. Alloy design of NSSMC-NAR-AH-4

- Oxidation Resistance
- Erosion Resistance
- Creep Rupture Strength
- Microstructural Stability
- Cost Saving
- Weldability

- High Cr≥22.5%
- Addition of rare earth metals
- Solid solution strengthening: Addition of N
- Grain boundary strengthening: Addition of B
- Optimization of CrN / NiN
- Decrease of Si
- Grain size control

0.3%Si-0.07%C-23%Cr-11%Ni-0.2%N-La+Ce+B

2. Superior High Temperature Properties

- Higher tensile strength and creep strength at high temperature than SUS310S (JIS G4303).
- Excellent oxidation resistance at 900—1000°C superior to SUS310S.
- Superior structure stability after long-term exposure to high temperature (700—900°C), without a drastic drop in toughness like SUS310S.

3. Superior Weldability

- Lower sensitivity of weld hot cracking than SUS310S, especially favorable for thick plates welding.

4. Cost Saving

- Reasonably designed chemical composition as compared with SUS310S.

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2 Main Use Applications

2. Fuel cell reforming Tube.
3. Auto parts (Exhaust Manifold etc.)
4. Substitute for SUS310S. Especially suited for material requiring high-temperature mechanical strength.

3 Specification and Physical Properties

1. Specification

<table>
<thead>
<tr>
<th>Designation</th>
<th>C</th>
<th>Si</th>
<th>Mn</th>
<th>P</th>
<th>S</th>
<th>Cr</th>
<th>Ni</th>
<th>N</th>
<th>other elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSSMC-NAR-AH-4</td>
<td>≤0.05</td>
<td>≤0.10</td>
<td>≤1.50</td>
<td>≤0.040</td>
<td>≥0.030</td>
<td>22.00</td>
<td>10.00</td>
<td>0.18</td>
<td>0.25</td>
</tr>
<tr>
<td>UNS S31060</td>
<td>≤0.05</td>
<td>≤0.10</td>
<td>≤0.50</td>
<td>≤1.00</td>
<td>≤0.040</td>
<td>22.50</td>
<td>10.00</td>
<td>0.18</td>
<td>0.25</td>
</tr>
<tr>
<td>(for reference)</td>
<td>SUS 310S</td>
<td>≤0.08</td>
<td>≤1.50</td>
<td>≤2.00</td>
<td>≤0.045</td>
<td>22.00</td>
<td>19.00</td>
<td>0.00</td>
<td></td>
</tr>
</tbody>
</table>

2. Physical Properties

Table 1: Chemical Composition (wt%)
### Mechanical Properties

#### Table 5: Mechanical Properties

<table>
<thead>
<tr>
<th>Designation</th>
<th>0.2% Yield Strength (N/mm²)</th>
<th>Tensile Strength (N/mm²)</th>
<th>Elongation (%)</th>
<th>Hardness (HRB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSSMC-NAR-AH-4</td>
<td>≧280</td>
<td>≧600</td>
<td>≧40</td>
<td>≦95</td>
</tr>
<tr>
<td>UNS S31060</td>
<td>(for reference) SUS 310S</td>
<td>≧205</td>
<td>≧520</td>
<td>≧40</td>
</tr>
</tbody>
</table>

### Properties of NSSMC-NAR-AH-4

#### Chemical Composition

#### Table 6: Typical Chemical Composition (wt%)

<table>
<thead>
<tr>
<th>Designation</th>
<th>C</th>
<th>Si</th>
<th>Mn</th>
<th>P</th>
<th>S</th>
<th>Cr</th>
<th>Ni</th>
<th>N</th>
<th>La+Ce</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSSMC-NAR-AH-4</td>
<td>0.07</td>
<td>0.31</td>
<td>0.48</td>
<td>0.021</td>
<td>0.001</td>
<td>23.11</td>
<td>10.95</td>
<td>0.197</td>
<td>0.03</td>
<td>0.003</td>
</tr>
<tr>
<td>(for reference) SUS 310S</td>
<td>0.05</td>
<td>0.58</td>
<td>1.21</td>
<td>0.023</td>
<td>0.001</td>
<td>24.63</td>
<td>20.25</td>
<td>0.024</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

#### Microstructure

- Austenitic structure
- Grain size: Average grain size of ASTM No.7 or coarser, as measured by Test Methods E112 (Thickness ≧ 6mm)

Photo 1. Typical microstructure after solution heat treated

2.0 μm

### High-temperature Properties

#### Fig.1 Tensile properties at high temperature

#### Fig.2 Tensile properties at room temperature

#### Fig.3 Creep rupture properties

#### Fig.4 Charpy impact properties after aged at 700~900℃

#### Fig.5 Cyclic oxidation test result in the air

#### Fig.6 Continuous oxidation test result (200h)
5 Resistance to high-temperature erosion

Fig. 7 Erosion test result (900°C)

<table>
<thead>
<tr>
<th>Alloy</th>
<th>Designation</th>
<th>Erosion Rate @ 900°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1H4</td>
<td></td>
<td>0.5</td>
</tr>
<tr>
<td>SUS 310S</td>
<td></td>
<td>1.0</td>
</tr>
</tbody>
</table>

Maximum depth of eroded area 500µm

6 Weldability

Fig. 8 Hot cracking test result (Longi Varestraint test)

Welding Consumables

For TIG welding

- WEL TIG AH-4
  - 1.2, 1.6, 2.0, 2.4, 3.2mmφ

For SMA welding

- WEL AH-4
  - 2.6, 3.2, 4.0, 5.0mmφ

Available Sizes

- Available maximum length: 6,000mm
- Consult us for custom-made dimensions.