

# NAS 335X (UNS N08020)

## NAS High Corrosion Resistant Stainless Steel

NAS 335X is a stainless steel with extremely high corrosion resistance to sulfuric acid. It can be used in a wide range of sulfuric acid environments, including high concentration, high temperature environments. It possesses excellent intergranular corrosion resistance and stress corrosion cracking resistance.

### Steel Grade/Standard

| NAS      | JIS | ASTM A240/B463 | EN |
|----------|-----|----------------|----|
| NAS 335X | —   | UNS N08020     | —  |

### Chemical Composition

|                           | C     | Si    | Mn    | P      | S      | Ni          | Cr          | Mo        | Cu        | Nb       |
|---------------------------|-------|-------|-------|--------|--------|-------------|-------------|-----------|-----------|----------|
| Specification (ASTM A240) | ≤0.07 | ≤1.00 | ≤2.00 | ≤0.045 | ≤0.035 | 32.0~38.0   | 19.0~21.0   | 2.00~3.00 | 3.0~4.0   | 8xC~1.00 |
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[wt %]

### Physical Properties

|   |                      |                        |
|---|----------------------|------------------------|
| Density   | [g/cm <sup>3</sup> ] | 8.08                   |
| Specific heat   | [J/kg · K]           | 470                    |
| Electrical resistivity  | [μΩ · cm]            | 105                    |
| Thermal conductivity  | [W/m · K]            | 11.4                   |
| Average coefficient of thermal expansion [10 <sup>-6</sup> /°C] | 20~100°C             | 14.6                   |
|   | 20~200°C             | 15.9                   |
|   | 20~300°C             | 15.8                   |
|   | 20~400°C             | 16.0                   |
| Young's modulus   | [MPa]                | 18.9 × 10 <sup>4</sup> |
| Magnetism   |                      | None                   |
| Melting range   | [°C]                 | 1340~1389              |

Mechanical Properties

Mechanical Properties at Room Temperature

|                           |                                      | 0.2% proof stress [MPa] | Tensile strength [MPa] | Elongation [%] | Hardness [HB] |
|---------------------------|--------------------------------------|-------------------------|------------------------|----------------|---------------|
| Specification (ASTM B463) |                                      | ≥241                    | ≥551                   | ≥30.0          | ≤217          |
| Example                   | Cold-rolled sheet 2.0mm <sup>t</sup> | 431                     | 698                    | 38             | 176           |
|                           | Hot-rolled plate 6.5mm <sup>t</sup>  | 359                     | 666                    | 40             | 137           |
|                           | Hot-rolled plate 50mm <sup>t</sup>   | 315                     | 581                    | 42             | 156           |

Corrosion Resistance

NAS 335X is a high Ni, Mo and Cu added stainless steel which displays extremely high sulfuric acid resistance. As a low C, Nb added material, it also has excellent intergranular corrosion resistance.

Pitting Corrosion Resistance

| Alloy    | ASTM G48 Method A |      | ASTM G48 Method C                               |
|----------|-------------------|------|---|
|          | 22°C              | 50°C | Critical pitting corrosion temperature CPT (°C) |
| SUS 316L | x                 | x    | 15  |
| NAS 64   | ○                 | ○    | 55  |
| NAS 254N | ○                 | ○    | 80  |
| NAS 335X | ○                 | x    | 30  |

Test conditions ASTM G48 Method A (○: No pitting corrosion, x: Pitting corrosion)

- Test solution: 6%FeCl<sub>3</sub>
- Test temperature: 22°C, 50°C (Recommended temperature in this test)
- Test time: 72h

ASTM G48 Method C

- Test solution: 6%FeCl<sub>3</sub> + 1%HCl
- Test time: 72h

Crevice Corrosion Resistance

| Alloy    | ASTM G48 Method D                               |
|----------|---|
|          | Critical crevice corrosion temperature CCT (°C) |
| SUS 316L | < -10   |
| NAS 64   | 30  |
| NAS 254N | 45  |
| NAS 335X | < 0   |

Test conditions ASTM G48 Method D

- Test solution: 6%FeCl<sub>3</sub> + 1%HCl
- Test time: 72h

Acid Resistance

| Alloy    | Corrosion rate in sulfuric acid at 80°C (mm/y) |      |       |       |       |       |
|----------|--|------|-------|-------|-------|-------|
|          | 5%   | 10%  | 20%   | 40%   | 60%   | 80%   |
| SUS 316L | 1.67   | 4.69 | 71.91 | 764.9 | 704.5 | 33.74 |
| NAS 64   | <0.01  | 0.02 | 1.07  | 191.9 | 1054  | 60.72 |
| NAS 254N | 0.02   | 0.05 | 1.02  | 2.11  | 2.16  | 7.76  |
| NAS 335X | 0.01   | 0.02 | 0.31  | 0.12  | 0.09  | 2.15  |

Test time: 24h

| Alloy    | Corrosion rate in boiling sulfuric acid (mm/y) |       |       |       |
|----------|--|-------|-------|-------|
|          | 5%   | 10%   | 20%   | 40%   |
| SUS 316L | 8.19   | 24.61 | 178.9 | 3129  |
| NAS 64   | 0.35   | 1.65  | 17.68 | 2829  |
| NAS 254N | 1.17   | 3.30  | 7.90  | 24.65 |
| NAS 335X | 0.44   | 0.68  | 0.52  | 0.64  |

Test time: 24h

(Reference)

| Nippon Yakin | JIS        | UNS No. | Chemical composition      |
|--------------|------------|---------|---------------------------|
| SUS 316L     | SUS 316L   | S31603  | 17Cr-12Ni-2Mo             |
| NAS 64       | SUS 329J4L | S32506  | 25Cr-6.5Ni-3.3Mo-0.17N    |
| NAS 254N     | SUS 836L   | S32053  | 23Cr-25Ni-5.5Mo-0.2N      |
| NAS 335X     | —          | N08020  | 20Cr-33Ni-2.5Mo-3Cu-0.4Nb |

**Workability**

The hot workability and cold workability of NAS 335X are basically the same as those of standard austenitic stainless steels.

**Weldability**

TIG welding, MIG welding, and shielded metal arc welding are applicable in the same manner as with standard austenitic stainless steels. However, because NAS 335X is an Nb-added stainless steel, the welding heat input should be reduced as far as possible.

Use of ER320 or ER320LR welding electrodes is recommended.

**Machinability**

The machinability of NAS 335X is basically the same as that of standard austenitic stainless steels. In machining, a high speed steel tool or ultrahard tool should be used. It is also advisable to use a slower feed rate and deeper cutting depth.

**Heat Treatment**

Stabilizing heat treatment of NAS 335X should be performed at the temperature range from 925 to 1010°C followed by being quenched in water or rapidly cooled by other means. (Conditions provided in ASTM A480/A480M)

**Pickling**

Pickling is performed under the same conditions as with Type 304, using a mixture acid of nitric acid and hydrofluoric acid.

**Applications**

Sulfuric acid plants, various types of chemical and petrochemical plants

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