Introduction

We have been manufacturing boiler steel tubes and pipes used in all fields, mainly power generation boilers, up to the present day, ever since we first started manufacturing seamless steel tubes for boilers for the first time in Japan in 1912. During this time, higher temperatures and pressures and larger-capacity boilers have been developed and have undergone rapid technological innovations, together with changes in fuel conditions. Recently in particular, high-efficiency generation has been demanded in order to control total carbon dioxide emissions, from the viewpoint of the worldwide conservation of the global environment, and ultra-supercritical pressure boilers, pressurized fluidized bed boilers, gas turbine-combined power generation boilers, and high-efficiency industrial waste incineration boilers have been constructed one after another, as new thermal power generation boilers. Steel tubes and pipes, to be used to respond to these situations, have been demanded to maintain both high quality and high performance. There has also emerged a need for various steel tubes and pipes such as economic steel tubes and specially-shaped steel tubes.

In rapid response to these requests, as an advanced manufacturer of boiler steel tubes and pipes, we have aggressively proceeded with the development of new materials, improvement of production technology, installation of new facilities, and improvement of inspection and quality control technologies.

We are confident that our boiler steel tubes and pipes will fulfill your expectations in every aspect, such as quality, performance, and access to service networks across various countries.

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Every type of steel tube and pipe can be manufactured.

A power generation boiler consists of an economizer, a furnace (evaporator), a superheater tube, a reheater tube, a main steam pipe, a reheat pipe, a water feed pipe, and a feed water heater tube. We manufacture various carbon steel, alloy steel, and stainless steel tubes and pipes to suit the usage conditions of these pieces of equipment. In addition to JIS standard products, we also manufacture foreign standard products such as ASME (ASTM), EN, and DIN, along with our own proprietary special products.

Power plant system diagram

<table>
<thead>
<tr>
<th>Steel grade</th>
<th>Compositions</th>
<th>Our own developed steel</th>
<th>Applicable Standards (abbreviation)</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulfuric acid corrosion-resistant steel</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.15-0.25C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbon steel</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.25-0.40C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.35-0.5Mo</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.50-0.6Mo</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.00-1.15Mo</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low-alloy steel</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.25-1.50Mo</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.50-1.75Mo</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.00-2.25Mo</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High chrome ferritic steel</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.25Cr-1Mo</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.00Cr-1Mo</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.50Cr-1.5Mo</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Austenitic stainless steel</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.00Cr-1Mo</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>11.00Cr-1Mo</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>12.00Cr-1Mo</td>
<td></td>
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</tr>
</tbody>
</table>

HCM2S™ and MN25R were developed jointly with Mitsubishi Heavy Industries, Ltd.

* HCM2S and MN25R were developed jointly with Mitsubishi Heavy Industries, Ltd.
NIPPON STEEL Boiler Steel Tubes and pipes Activity
Three Mainstays of Reliability

Boiler tubes and pipes require extremely superior quality and a variety of steel grades and dimensions suited to usage situations.

To fully meet these requirements, our boiler tubes and pipes have emerged from a secure system through years of experience and foremost engineering prowess, as a backdrop. They are manufactured based on an integrated production system and on strict quality design and quality control, ranging from raw materials to final products.

In line with diversifying needs, we are developing new materials and products, and are conducting a wide variety of research and development, including manufacturing process research. Thus, our boiler tubes and pipes that have a superior track record and receive a high level of trust, all based on three mainstays: integrated production, quality assurance, and research and development.

Our boiler tubes and pipes are consistently controlled, from steel-making to tube and pipe-making, in order to ensure the manufacturing of all steel grades, as well as to assure uniform and stable quality, through strict quality control during each process. Particularly, steel-making processes, from component mixture to final heat treatment, undergo optimum quality design regarding boiler steel tubes and pipes, by putting years of experience and high engineering prowess to full use so that products can endure long usage periods of one or two decades. In order to bring the quality design into shape, a new refining method in steel-making is introduced and various manufacturing processes are selected according to dimensions, material properties, and internal and external surface accuracy.

Seamless steel tubes and pipes are hot manufactured using mandrel mill-rolling process, extrusion process, and push bench process.

The mandrel mill-rolling process is used to manufacture small-diameter carbon steel tubes and low-alloy steel tubes. The extrusion process is used to manufacture high-alloy steel tubes, such as stainless steel, and special tubes, such as finned tubes. The push bench process is suited for manufacturing large-diameter, thick-wall tubes, and enables the manufacturing of carbon steel, alloy steel, and stainless steel tubes and pipes.

These hot manufactured tubes are cold finished using cold-drawing and cold-rolling processes that fit the applications and thermal treatments.
## Manufacturing process of seamless steel tubes and pipes

(Some steel grades are not applicable in the following flow.)

<table>
<thead>
<tr>
<th>Product</th>
<th>Works</th>
<th>Manufacturable range (outside diameter)</th>
<th>Feature</th>
</tr>
</thead>
</table>
| Kansai Works | Wakayama area | 31.8 ~ 426.0mm | 1. The tube manufacturing efficiency is high.  
|          |                  |                                        | 2. The surface is smooth, and thickness deviation is small. |
| Special steel shapes tubes and pipes | Kansai Works | 33.4 ~ 275.0mm | 1. High alloy, stainless steel, and special metal tubes and pipes can be manufactured.  
|          | Amagasaki area (Hikari Pipe & Tube Div.) | 34.4 ~ 175.0mm | 2. Various special steel shapes tubes and pipes can be manufactured by changing die and mandrel shapes.  
|          |                  | Outside diameter 275 mm or less  
|          |                  | Minimum cross-section area 100 mm | 3. An order for small-lot and multiple-product types can be filled. |
| Hot-finished seamless steel pipes | BENKAN KIKOH Corporation | 165.2 ~ 1270.0mm | 1. This product is suited for manufacturing large-diameter, thick-wall steel pipes.  
|          |                  | 21.7 ~ 914.4mm | 2. The external and internal surfaces can be machined. |
| Hot-finished seamless steel tubes and pipes | Kansai Works | 6.0 ~ 908.0mm | 1. The dimensions are accurate, and their dispersion is small.  
|          | Amagasaki area(Kainan) | 15.9 ~ 157.0mm | 2. The external and internal surfaces are finely finished. |
|          | Osaka area | 6.0 ~ 168.3mm |         |

### Integrated production system

1. Blast furnace
2. Converter
3. Steel ingot
4. Electric arc furnace
5. Continuous casting
6. Bloom and Billet
7. Bar steel mill
8. Blank furnace
9. Steel mill
10. Piercer
11. Mandrel mill
12. 3-roll stretch reducer
13. 3-roll extracting sizer
14. Hot-finished seamless steel tubes and pipes
15. Kansai Works
16. Wakayama area
17. Kansai Works
18. Amagasaki area
19. Kyushu Works
20. Oita area (Hikari Pipe & Tube Div.)
21. Special steel shapes tubes and pipes
22. Outside diameter 275 mm or less
23. Minimum cross-section area 100 mm
24. Cold finished seamless steel tubes and pipes
25. Chain-type cold-drawing bench
26. Cold pilger mill
27. Vertical expanding press
28. Piercer
29. Mandrel mill
30. Horizontal extrusion press
31. Vertical piercing press
32. Cold rolling and drawing
33. Chain-type cold-drawing bench
34. Hydraulic cold-drawing bench
Boiler tubes and pipes are strongly demanded in order to satisfy especially strict usage conditions, along with operational reliability. We conduct strict quality control in all processes, from steel-making to tube and pipe-making, and we have established the following quality assurance system.

1. Independence of the quality assurance department
   The quality assurance department is independent from the manufacturing department and has primary authority and responsibility concerning quality in order to take charge of ensuring such quality.

2. Standardization of tasks
   Various tasks related to manufacturing and quality are standardized and documented for unification.

3. Adoption of an inspector qualification system
   All inspections engaged in work affecting quality have received strict training and have passed a qualification test.

4. Full adoption of nondestructive tests
   Various required tests and inspections are conducted according to applications, and nondestructive tests are applied to all products in the final inspection.

5. Establishment of periodic gauges and tester calibration systems
   Various gauges and testers are periodically calibrated to ensure quality inspection.
Our boiler tubes and pipes have been used the world over, embodying various characteristic products through distinguished engineering prowess and abundant experience, and they have earned high reputation and trust not only in Japan but also overseas. It is no exaggeration to say that this is also a good result of systematic research and development systems, ranging from raw materials to products. At present, with the aim of a further leap forward, we are proceeding with research from the following broad angles.

- Research on high-temperature creep strength properties
- Research on high-temperature corrosion protection materials
- Research on coal-fired steel tube materials
- Research on weldability and workability
- Research on manufacturing processes for quality stability
- Research on nondestructive inspection and measurement technologies

We will also further improve the research department and enhance its functions, and will strive to help promote global iron-making in future.
Developed Seamless Tubes and Pipes Products for Boilers

<table>
<thead>
<tr>
<th>Main proprietary steel grades</th>
<th>Classification</th>
<th>Brand name</th>
<th>Compositions</th>
<th>Applicable standard (abbreviation)</th>
<th>Characteristics</th>
<th>Example of application</th>
<th>Composition (mass%)</th>
<th>Normal temperature limits (property)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>C</td>
<td>Si</td>
</tr>
<tr>
<td><strong>Ferritic steel tubes and pipes</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbon steel tubes and pipes</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low-alloy steel tubes and pipes</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>High chromium steel tubes and pipes</td>
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<td></td>
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<tr>
<td>Ni-based alloy tubes and pipes</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>** Austenitic stainless steel tubes and pipes **</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>SUH20</td>
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</tr>
</tbody>
</table>

*CC : Code Case () is the UNS number code.
*MTI means Ministry of Economy, Trade and Industry.
**S-TEN™1 Sulfuric and hydrochloric acid dew-point corrosion-resistant steel tubes**

There are cases where the exhaust gas treatment equipment of waste combustion facilities or boiler air preheaters using fuel containing sulfur and chlorine is subjected to sulfuric and hydrochloric acid dew-point corrosion. In such an acid dew-point corrosion environment, not only common steel but also stainless steel cannot be used.

We have thus developed S-TEN™ as a material that can be used in such an environment, and we manufacture and sell S-TEN™1 steel tubes.

S-TEN™1 steel tubes can be used as METI KA-STBA10, KA-STB380J2, ASME Code Case 2494, and "ASTM A423 Gr.3." They are also certified by classification societies such as NK(Japan), LR(United Kingdom), and TÜV(Germany).

**Chemical composition (mass%)**

<table>
<thead>
<tr>
<th></th>
<th>C</th>
<th>Si</th>
<th>Mn</th>
<th>P</th>
<th>S</th>
<th>Cu</th>
<th>Sb</th>
<th>Ni</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-TEN1</td>
<td>≤0.14</td>
<td>≤0.55</td>
<td>≤1.60</td>
<td>≤0.025</td>
<td>≤0.025</td>
<td>0.25~0.50</td>
<td>≤0.15</td>
<td>≤0.50</td>
</tr>
</tbody>
</table>

**Quality property**

- **Corrosion resistance**
  - Sulfuric acid resistance (50%, 70°C H₂SO₄)
  - Hydrochloric acid resistance (10.5%, 80°C HCl)

**Mechanical property**

- Tensile strength: 410min. 25min. (MPa)
- Yield strength: 255min. 25min. (MPa)
- Elongation: 473 322 38 (%)

In such environment, this steel has a corrosion resistance that is superior to stainless steel.

**Corrosion resistance after service exposure**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Dimensions (mm)</th>
<th>Material used</th>
<th>Quantity of corrosion</th>
<th>Depth of corrosion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Code</td>
<td></td>
<td></td>
<td>Average(%)</td>
<td>Ratio</td>
</tr>
<tr>
<td>Boiler air preheater</td>
<td>φ48.6×43.6</td>
<td>CR1A</td>
<td>1.85</td>
<td>1.00</td>
</tr>
<tr>
<td>Fuel: C heavy oil</td>
<td></td>
<td>Carbon steel</td>
<td>9.32</td>
<td>5.04</td>
</tr>
<tr>
<td>Usage condition</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2,627 hrs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>External surface</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air inside tube</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combustion gas</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For more detailed properties, refer to our catalogue "Sulfuric and Hydrochloric Acid Dew-point Corrosion-resistant Steel S-TEN™ Technical Information."
**Gr92 (NF616)**

Superior high-temperature strength 9Cr ferritic steel tubes, from tubes to large-diameter thick wall pipes

KA-STB(P)A29, ASTM A213 T92/A335 P92, ASME SA213 T92/SA335 P92 Code Case 2179

**Features**

- High-strength 9Cr ferritic steel pipes and tubes (All sizes are available, from thin-wall heating tubes to large-diameter thick-wall pipes.)
- The strength is about 1.3 times higher than that of the conventional Gr91 (ASME T91/P91).
- NF616 steel, with the world’s highest strength, as a high-temperature ferrite steel tube, was self-developed.
- A product family that satisfies all needs for thermal power generation boilers, the chemical industry, and nuclear power.
- Matching welding consumable are available.

**Application**

High-temperature 9Cr ferrite steel pipes and tubes (casting), main steam pipes, reheat pipes, and heat exchanger tubes

---

**Introduction to high-function steel grades**

**HCM2STM** Superior weldability and high-temperature strength 2.25Cr ferritic steel tubes

Developed jointly with Mitsubishi Heavy Industries, Ltd.

**KA-STB(P)A24J1, ASTM A213 T23/A335 P23, ASME SA213 T23/SA335 P23 Code Case 2199**

**Features**

- High-strength 2.25Cr ferritic steel tubes (tubes and large-diameter thick-wall pipes)
- The strength is about 1.8 times higher than that of conventional STB(P)A24
- Weldability is improved as compared with conventional steels. The thin wall tubes suppresses welding cracks even if post weld heat treatment.
- Matching welding consumable are available.

**Application**

Large-diameter thick wall pipes, superheater tubes, and reheater tubes (steam at relatively low temperatures to 575°C) for thermal power generation, and heat recovery boilers

**Chemical composition (mass%)**

<table>
<thead>
<tr>
<th>Standard</th>
<th>C</th>
<th>Si</th>
<th>Mn</th>
<th>P</th>
<th>S</th>
<th>Ni</th>
<th>Cr</th>
<th>Mo</th>
</tr>
</thead>
<tbody>
<tr>
<td>KA-STBA24J1</td>
<td>0.04~0.10</td>
<td>0.50max.</td>
<td>0.10~0.60</td>
<td>0.030max.</td>
<td>0.010max.</td>
<td>—</td>
<td>1.90~2.60</td>
<td>0.05~0.30</td>
</tr>
<tr>
<td>ASME CC2199</td>
<td>ditto</td>
<td>ditto</td>
<td>ditto</td>
<td>ditto</td>
<td>ditto</td>
<td>0.4max.</td>
<td>ditto</td>
<td>ditto</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Standard</th>
<th>W</th>
<th>V</th>
<th>Nb</th>
<th>Ti</th>
<th>Al</th>
<th>B</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>KA-STBA24J1</td>
<td>1.45~1.75</td>
<td>0.20~0.30</td>
<td>0.02~0.08</td>
<td>—</td>
<td>0.003max.</td>
<td>0.005</td>
<td>0.030</td>
</tr>
<tr>
<td>ASME CC2199</td>
<td>ditto</td>
<td>ditto</td>
<td>0.010~0.060</td>
<td>ditto</td>
<td>0.0020~0.0050</td>
<td>ditto</td>
<td>ditto</td>
</tr>
</tbody>
</table>

**Comparison of allowable tensile stress**

Calculated with pressure: 24.1 MPa, steam temperature: 550°C, and internal diameter: 300 mm

- **Steel grade**
  - KA-STBA24J1
  - STPA24

- **Allowable tensile stress** (580°C, MPa)
  - Tube size: φ408×154
    - KA-STBA24J1: 84
    - STPA24: 48
  - Tube size: φ504×1102
    - KA-STBA24J1: 102
    - STPA24: 102

- **Weight ratio**
  - KA-STBA24J1: 47
  - STPA24: 100

**Comparison of conventional steel regarding cost efficiency**

**Comparison of 9Cr ferrite steel tube performance**

**Chemical composition (mass%)**

<table>
<thead>
<tr>
<th>C</th>
<th>Cr</th>
<th>Mo</th>
<th>W</th>
<th>Ni</th>
<th>V</th>
<th>Nb</th>
<th>N</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.07~0.13</td>
<td>6.50~9.50</td>
<td>0.30~0.60</td>
<td>1.50~2.00</td>
<td>0.40</td>
<td>0.15~0.25</td>
<td>0.004~0.09</td>
<td>0.030~0.070</td>
<td>0.001~0.006</td>
</tr>
</tbody>
</table>

**Comparison of cost efficiency**

**Creep rupture strength of Gr.92 (NF616)**

Average NISA life formula

\[ t = 35 \times \text{lower confidence bound} \]

Hollow Tube

L: Large-diameter thick-wall tube

<table>
<thead>
<tr>
<th>Steam condition</th>
<th>Tube size</th>
<th>Allowable stress</th>
</tr>
</thead>
<tbody>
<tr>
<td>25.0MPa×1130°F (610°C)</td>
<td>Inside diameter 325 mm assumed P92 ASME SC-1 CC2170-5</td>
<td>P91 ASME SC-2 D</td>
</tr>
</tbody>
</table>
Introduction to high-function steel grades

**TP347HFG**

High steam oxidation resistance austenitic stainless steel tube based on proprietary grain refining technology

18Cr-12Ni-0.6Nb. Equivalent steel gradesASTM A213 TP347HFG, ASME SA213 TP347HFG

- Fine-grained microstructure by Thermo-Mechanical Process, which contribute to superior steam oxidation resistance to conventional coarse grained TP347H.
- Weldability is equivalent to TP347H and matching welding consumable is available.
- Good phase stability proven by long term creep-rapture tests and actual uses.
- Global shipments of more than 7 thousand tons, for USC and biomass boilers.

**Quality property**

- Mechanism for improving steam oxidation resistance using innovative grain refining technology
- Creep rupture strength
- Creep rupture strength
- Steam oxidation in actual boilers

**Chemical composition (mass%)**

<table>
<thead>
<tr>
<th></th>
<th>C</th>
<th>Si</th>
<th>Mn</th>
<th>P</th>
<th>S</th>
<th>Cr</th>
<th>Ni</th>
<th>Nb</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASME TP347HFG</td>
<td>0.06~0.10</td>
<td>1.00max.</td>
<td>2.00max.</td>
<td>0.045max.</td>
<td>0.030max.</td>
<td>17.0~19.0</td>
<td>9.0~13.0</td>
<td>8%C</td>
</tr>
</tbody>
</table>

**New manufacturing process**

- High-temperature softening heat treatment
- NiC fine precipitation
- Product solution heat treatment
- Fine-grained structure

**Conventional process**

- Normal softening heat treatment
- Fine-grained structure

**Process of fine grained structure**

- Grain size number 4 to 5

**TP347HFG, SUPER304H™**

**Superior weldability to TP347H due to smaller amount of niobium, PWHT is not mandatory, and matching welding consumable is available.**

**Global shipments of more than 70 thousand tons, mainly for USC boilers.**

**Good phase stability proven by long term creep-rapture tests and actual operational results in USC boilers.**

**Chemical composition (mass%)**

<table>
<thead>
<tr>
<th></th>
<th>C</th>
<th>Si</th>
<th>Mn</th>
<th>Ni</th>
<th>Cr</th>
<th>Cu</th>
<th>Nb</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>METI KA-SUS304J1HTB</td>
<td>0.07~0.13</td>
<td>0.30max.</td>
<td>1.00max.</td>
<td>7.5~10.5</td>
<td>17.0~19.0</td>
<td>2.5~3.5</td>
<td>0.30~0.60</td>
<td>0.05~0.12</td>
</tr>
</tbody>
</table>

**Quality property**

- Strength and corrosion resistance and the effect of fine precipitation

**Nanoprecipitation of copper**

- Three times higher strength
- Uniform ultra-fine grained composition

**Superior creep rupture strength**

**Steam oxidation in actual boilers**

**SUPER 304HTM**

High-strength, high steam oxidation-resistance, austenitic stainless steel tubes

18Cr-9Ni-3Cu-Nb - Equivalent steel grades METI KA-SUS304J1HTB, ASTM A213 S30432, ASME SA213 Code Case 2328

- Hightest strength among 18Cr-8Ni austenitic stainless steels utilizing Cu-rich phase.
- Fine-grained microstructure by Thermo-Mechanical Process, which contribute to superior steam oxidation resistance to conventional coarse grained TP347H.
- Superior weldability to TP347H due to smaller amount of niobium, PWHT is not mandatory, and matching welding consumable is available.
- Good phase stability proven by long term creep-rapture tests and actual operation results in USC boilers.
- Global shipments of more than 70 thousand tons, mainly for USC boilers.
**XA704**  High creep strength austenitic stainless steel tubes

18Cr-9Ni-2W-Nb-V-N / Equivalent steel grade  KA-SUS347J1TB, ASTM A213 TP347W, ASME SA213 Code Case 2475

1. Creep rupture strength is much higher than SUS347HTB due to V, N, and W contents.
2. Excellent intergranular corrosion resistance due to lower C content.
3. Good steam oxidation resistance due to fine-grained microstructure.
4. Enough thermo stability for boiler tube application.
5. Better weldability at elevated temperature than TP304H due to good phase stability.

**Chemical composition (mass%)**

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<thead>
<tr>
<th></th>
<th>C</th>
<th>Si</th>
<th>Mn</th>
<th>Ni</th>
<th>Cr</th>
<th>W</th>
<th>V</th>
<th>Nb</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard value</td>
<td>0.05max.</td>
<td>1.00max.</td>
<td>2.00max.</td>
<td>8.00~11.00</td>
<td>17.00~20.00</td>
<td>1.50~2.60</td>
<td>0.20~0.50</td>
<td>0.25~0.50</td>
<td>0.10~0.25</td>
</tr>
</tbody>
</table>

**Quality property**

- **Creep rupture strength**
- **Intergranular corrosion resistance:** Sulfuric acid and copper sulfate corrosion test
- **Weldability:** Varestraint test

**Comparison of allowable tensile stress**

(Examples of the thermal power house technical standard)

- Allowable tensile stress (MPa)
- Temperature (℃)

**NF709**  High-strength and high-corrosion-resistance austenitic stainless steel tubes

22.5Cr-25Ni-1.5Mo-Nb-N / Equivalent steel grades  KA-SUS310J2TB, ASTM A213 TP310MoCbn, ASME SA213 Code Case 2581

1. Highest creep rupture strength among austenitic stainless steel.
2. Good steam oxidation resistance due to higher Cr, Ni content.
4. Applicable as superheater and reheater for coal fired boiler and waste to energy boiler.

**Chemical composition (mass%)**

<table>
<thead>
<tr>
<th></th>
<th>C</th>
<th>Si</th>
<th>Mn</th>
<th>Ni</th>
<th>Cr</th>
<th>Mo</th>
<th>Nb</th>
<th>Ti</th>
<th>B</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard value</td>
<td>0.10max.</td>
<td>1.00max.</td>
<td>1.50max.</td>
<td>22.00~28.00</td>
<td>19.00~23.00</td>
<td>1.00~2.00</td>
<td>0.10~0.40</td>
<td>0.20max</td>
<td>0.002~0.010</td>
<td>0.10~0.25</td>
</tr>
</tbody>
</table>

**Quality property**

- **Creep rupture strength of NF709 base material**
- **Creep rupture strength of TIG weld joint**
- **Steam oxidation test** (500h)
- **Comparison of corrosion resistance in a corrosive environment where chloride is rich**

- **Welding conditions**
  - TIG, plate thickness: 5 mm, amount of strain: 4%, current: 80 A, speed: 8 cm/min, heat input: 5 kJ/cm

**Matching filler**

<table>
<thead>
<tr>
<th></th>
<th>650℃</th>
<th>700℃</th>
<th>750℃</th>
<th>800℃</th>
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</thead>
<tbody>
<tr>
<td>XA704</td>
<td></td>
<td></td>
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<tr>
<td>Type310</td>
<td></td>
<td></td>
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<tr>
<td>Alloy625</td>
<td></td>
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</tr>
</tbody>
</table>

**Maximum corrosion depth (μm)**

<table>
<thead>
<tr>
<th></th>
<th>NF709</th>
<th>Type310</th>
</tr>
</thead>
<tbody>
<tr>
<td>Na2CO3, KO, CaCl2, MgSO4, 7-H2O</td>
<td>1.9~3.3</td>
<td>1.0~5.0</td>
</tr>
<tr>
<td>Maximum intergranular corrosion depth</td>
<td>35H2O+100g/L H2SO4</td>
<td>35H2O+100g/L H2SO4</td>
</tr>
<tr>
<td>Corrosion depth</td>
<td>650℃</td>
<td>700℃</td>
</tr>
</tbody>
</table>
HR3C 25Cr high corrosion-resistance austenitic stainless steel tubes

25Cr-20N-Nb-N / Equivalent steel grades: KA-SUS310J1TB, ASTMA213 TP310HCbN, ASME SA213 TP310HCbN

1. Much higher strength than conventional 310 stainless steels utilizing finely dispersed NbC and NbCrN.
2. Much better steam oxidation resistance than 18Cr-8Ni austenitic stainless steels due to 25Cr-20Ni chemical composition.
3. Weldability is equivalent to TP347H, and matching welding consumable is available.
4. Global shipments of more than 20 thousand tons for USC, Biomass, and Waste to energy boilers.

Chemical composition (mass%)

<table>
<thead>
<tr>
<th></th>
<th>C</th>
<th>Si</th>
<th>Mn</th>
<th>Cr</th>
<th>Ni</th>
<th>Nb</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASME</td>
<td>0.04~0.10</td>
<td>1.50max.</td>
<td>2.00max.</td>
<td>24.0~26.0</td>
<td>19.0~22.0</td>
<td>0.20~0.60</td>
<td>0.15~0.35</td>
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<tr>
<td>TP310HCbN</td>
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</tr>
</tbody>
</table>

Quality property

YUS™170 High-strength and pitting-resistant austenitic stainless steel tubes

25Cr-13Ni-0.8Mo-0.3N / Equivalent steel grades: KA-SUS309J1TB / Stainless steel plate: JIS G 4304-G 4305 SUS317J2

Features

1. These exhibit pitting resistance and clearance corrosion resistance superior to SUS316 and SUS317L.
2. They show superior sulfuric and hydrochloric acid resistance and can be used at higher concentration and temperature than Type316 and Type317L.
3. They feature austenitic composition and superior workability and weldability. The strength at room temperature is about 1.5 times higher than that of normal austenitic stainless steel.

Application

Seawater resistance tubes and superheater tubes of black liquor recovery boilers and refuse incineration boilers.

Chemical composition (mass%)

<table>
<thead>
<tr>
<th></th>
<th>C</th>
<th>Si</th>
<th>Mn</th>
<th>P</th>
<th>S</th>
<th>Ni</th>
<th>Cr</th>
<th>Mo</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard value</td>
<td>0.06max.</td>
<td>1.50max.</td>
<td>2.00max.</td>
<td>0.040max.</td>
<td>0.030max.</td>
<td>12.00~16.00</td>
<td>23.00~26.00</td>
<td>0.50~1.20</td>
<td>0.25~0.40</td>
</tr>
</tbody>
</table>

Mechanical property

Pitting corrosion resistance

50g/l FeCl₃ + 1/20N HCl (50℃ × 48h)

Corrosion speed (g/m²/H)

Corrosion

No corrosion

Sulfuric acid resistance
**MN25R**

High corrosion-resistance stainless steel tubes for soda recovery boilers

25Cr-14Ni-0.8Mo-0.3N-LC-Low Si/
Equivalent steel grades: KA-SUS309J3LTB, ASTM A213 TP309LMoN, ASME SA213 Code Case 2639

**Features**
The MN25R steel tube is a high corrosion-resistance steel tube for the superheater tubes of black liquor recovery boilers.

**Application**
Superheater tubes and reheater tubes of black liquor recovery boilers

**Chemical composition (mass%)**

<table>
<thead>
<tr>
<th>C</th>
<th>Si</th>
<th>Mn</th>
<th>P</th>
<th>S</th>
<th>Ni</th>
<th>Cr</th>
<th>Mo</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.025max.</td>
<td>0.70max.</td>
<td>2.00max.</td>
<td>0.040max.</td>
<td>0.030max.</td>
<td>13.00~16.00</td>
<td>23.00~26.00</td>
<td>0.50~1.20</td>
<td>0.25~0.40</td>
</tr>
</tbody>
</table>

**Quality property**

- **Creep rupture strength**

- **High-temperature Corrosion resistance**
  
  Ash (synthetic ash): 76%Na2SO4+17%K2SO4+8%NaCl
  
  Gas: 6.2%O2+5%O2+10%CO2+bal.N2
  
  Temperature: 590℃
  
  Test time: 100h

- **Allowable tensile stress**

**HR6W**

High-strength and high corrosion-resistance Ni-based alloy tubes and pipes for next-generation 700℃ steam A-USC boilers

23Cr-45Ni-7W-Ti-Nb / Equivalent steel grades ASTM B167-UNS N06674, ASME SB167 Code Case 2684

1. Stability of long term creep strength and superior creep rupture ductility.
2. Much better corrosion resistance than 18Cr-8Ni austenitic stainless steels.
3. Microstructural phase stability at elevated temperature, which contributes to superior stress relaxation properties and enough fatigue properties for various applications.
4. Better formability, welder available size range, and better weldability than γ' phase present Ni based alloys.

**Chemical composition (mass%)**

<table>
<thead>
<tr>
<th>C</th>
<th>Si</th>
<th>Mn</th>
<th>Cr</th>
<th>Fe</th>
<th>W</th>
<th>Ti</th>
<th>Nb</th>
<th>B</th>
<th>N</th>
<th>Remnant</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1max.</td>
<td>1.0max.</td>
<td>1.50max.</td>
<td>21.5~24.5</td>
<td>20.0~27.0</td>
<td>6.0~8.0</td>
<td>0.05~0.20</td>
<td>0.10~0.35</td>
<td>0.005~0.006</td>
<td>0.02max.</td>
<td>Ni</td>
</tr>
</tbody>
</table>

**Features**

- **Creep rupture strength**

- **Creep fatigue property**

- **High-temperature corrosion property**

**Steel grade**

Type347H

- SA-213 TP347
- SA-213 TP347HT

Type310

- SA-213 TP310
- SA-213 TP310H

**Steel grade**

HR6W

- HR6W large-diameter, thick-wall tubes

- HR6W 700℃, CP test

**Test temperature**

650℃ 700℃ 750℃ 800℃ 850℃ 900℃ 1000℃

**Synthetic ash**

1.5MNa2SO4-1.5MK2SO4-1MFe2O3

**Gas**

1.5%SO2-5%O2-15%CO2-residual N2

**Life, Nf (cycle)**

108 107 106 105 104 103 102 101

**Δεt (%)**

0.1 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5

**Strain wave shape (CP wave)**

Time 0.8%/s 0.01%/s

**Strain**

Average line 95% lower confidence bound line
### Available Size Range (Example)

#### Hot-finished seamless tubes and pipes

| Nominal diameter (A) & (B) (mm) | Outside diameter (mm) 2.8 | 3 | 3.5 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 17 | 20 | 25 | 30 | 35 | 40 | 45 |
|---------------------------------|---------------------------|---|-----|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| 25 1                            | 34.0                      |   |     |   |   |   |   |   |   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| 40 1½                          | 48.6                      |   |     |   |   |   |   |   |   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| 50 2                            | 60.5                      |   |     |   |   |   |   |   |   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| 65 2/1                          | 76.3                      |   |     |   |   |   |   |   |   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| 80 3                            | 89.1                      |   |     |   |   |   |   |   |   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| 90 3/4                          | 101.6                     |   |     |   |   |   |   |   |   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| 100 4                           | 114.3                     |   |     |   |   |   |   |   |   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
|                                | (120.0)                   |   |     |   |   |   |   |   |   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
|                                | 130.0                     |   |     |   |   |   |   |   |   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| 125 5                           | 139.8                     |   |     |   |   |   |   |   |   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
|                                | (150.0)                   |   |     |   |   |   |   |   |   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
|                                | 165.2                     |   |     |   |   |   |   |   |   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| 150 6                           | (170.0)                   |   |     |   |   |   |   |   |   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
|                                | 190.7                     |   |     |   |   |   |   |   |   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| 200 8                           | 216.3                     |   |     |   |   |   |   |   |   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| 250 10                          | 267.4                     |   |     |   |   |   |   |   |   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| 300 12                          | 318.5                     |   |     |   |   |   |   |   |   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| 350 14                          | 355.6                     |   |     |   |   |   |   |   |   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| 400 16                          | 406.4                     |   |     |   |   |   |   |   |   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |

#### Nominal diameter | Outside diameter | Wall Thickness (mm) | Outside diameter |
|---------------------|------------------|--------------------|------------------|

#### Seamless forged pipe (hot finished)

| Nominal diameter (A) & (B) (mm) | Outside diameter (mm) 2.8 | 3 | 3.5 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 17 | 20 | 25 | 30 | 35 | 40 | 45 |
|---------------------------------|---------------------------|---|-----|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| 150 6                            | 165.2                     |   |     |   |   |   |   |   |   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| 17                            | 190.7                     |   |     |   |   |   |   |   |   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| 200 8                           | 216.3                     |   |     |   |   |   |   |   |   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| 250 10                          | 267.4                     |   |     |   |   |   |   |   |   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| 300 12                          | 318.5                     |   |     |   |   |   |   |   |   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| 350 14                          | 355.6                     |   |     |   |   |   |   |   |   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| 400 16                          | 406.4                     |   |     |   |   |   |   |   |   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |

#### Nominal diameter | Outside diameter | Wall Thickness (mm) | Outside diameter |
|---------------------|------------------|--------------------|------------------|

**Remarks:**
1. Be aware that there is a range where manufacturing can be difficult, depending on the material properties.
2. Consult with us about ultra-thin items near the manufacturable limit beforehand.
3. Consultation regarding size for anything not in this table is also available.
### Available Size Range (Example)

**Cold-finished seamless tubes and pipes**

<table>
<thead>
<tr>
<th>Nominal diameter (A) (mm)</th>
<th>Outside diameter (B) (mm)</th>
<th>Wall Thickness (mm) 1.2</th>
<th>1.6</th>
<th>2</th>
<th>2.6</th>
<th>3.2</th>
<th>4</th>
<th>4.5</th>
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**Remarks:** Consultation regarding size for anything not in this table is also available.

### Example of Packing

- **Bare packing**
- **Polyethylene sheet packing**
- **Hollow plastic board packing**
- **Open wood box packing**
- **Closed wood box packing**

**Contents:**
- Resin-coated steel wire or PP rope
- Polyethylene sheet
- Hollow plastic board
Example of Indication

 Requests during orders

When ordering and inquiring about our tubes and pipes, you are requested to inform us about the following items.

1. Steel tube standard and type
2. Dimensions (outside diameter, thickness, and length)
3. Quantity
4. Delivery date and destination
5. Applications and usage condition
6. Packing type
7. Number of copies of the inspection certificate
8. With or without a witnessed inspection
9. Other and specially requested items