Classification and Applications of Stainless Steel

Introduction to Grades and Uses of Stainless Steel

Stainless steel grades can be divided by chemical composition into Cr- Ni series (300 series), Cr- Mn- Ni series (200 series), Cr series (400 series), and precipitation- hardening series (600 series).

I. Classification of Stainless Steel by Metallographic Structure

1. Austenitic Stainless Steel (200- series & 300- series)

Austenitic stainless steel retains an austenitic microstructure at room temperature. It contains 8%- 10% nickel, approximately 18% chromium, around 0.1% carbon, plus small amounts of molybdenum, titanium, nitrogen and other elements. It delivers comprehensive performance and resists corrosion from various media.

Representative grades: 201, 202, 301, 304, 316L, 316Ti, 310S, 309S, 321, 317, 347, 904L (super- austenitic grade), etc.

Typical Applications: Chemical equipment and pipelines, food and medical industries, high- temperature industrial facilities.

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2. Martensitic Stainless Steel (Partial 400- series)

The mechanical properties of martensitic stainless steel can be adjusted via heat treatment. It achieves high hardness after quenching, and different combinations of strength and toughness can be obtained at different tempering temperatures.

Standard martensitic stainless steel grades: 410/1Cr13, 420J1/2Cr13, 420J2/3Cr13, 403/1Cr12, 431, 440A, 440B, 440C, 414, 416, 416(Se).

Typical Applications: Cutting tools and bearings, petrochemical valves and pump shafts, military and marine components.

3. Ferritic Stainless Steel (400- series)

Besides decent corrosion resistance, ferritic stainless steel features excellent oxidation resistance and stress- corrosion resistance. It also offers good thermal conductivity and a very low coefficient of

thermal expansion. However, it has relatively poor ductility, so it is mainly used for corrosion-resistant components.

Common grades: 430, 409, 434, 442, 444.

Typical Applications: Automotive exhaust systems (430), architectural decoration (430 / 444), home appliances and kitchenware (409 for water heaters), chemical heat exchangers (molybdenum-alloyed 444).

4. Duplex Stainless Steel (Austenite-Ferrite)

Duplex stainless steel possesses a microstructure with roughly equal proportions of austenite and ferrite. It combines the advantages of both austenitic and ferritic stainless steels. Compared with ferritic grades, it has better plasticity and toughness. Compared with austenitic grades, it provides superior thermal conductivity and a lower thermal expansion coefficient.

Common grades: 2205 / S32205; super-duplex grade: 2507 / S32750.

Typical Applications: Marine environments and desalination, chemical plants, oil-gas platforms, wellhead equipment and separators.

5. Precipitation-Hardening Stainless Steel

Precipitation-hardening stainless steel is produced by adding various strengthening elements to the base stainless-steel composition. Through the precipitation-hardening process, different carbides, nitrides, carbonitrides and intermetallic compounds precipitate out, increasing strength while maintaining sufficient toughness.

According to the metallographic structure of its matrix, precipitation-hardening stainless steel falls into three categories: martensitic type (17-4PH / 630), semi-austenitic type (aluminum as the main precipitation-hardening element), and austenitic type (GH36 carbide-forming type / GH132 intermetallic-compound type).

Typical Applications: Aero-engine parts, nuclear-power equipment, precision mold steel.

II. Relationship Between Chemical Composition and Stainless-Steel Performance

1. **Carbon (C)**: Increases hardness and strength; excessive carbon reduces ductility and corrosion resistance.
2. **Chromium (Cr)**: Improves corrosion resistance and oxidation resistance; refines grain structure; boosts strength, hardness and wear resistance.
3. **Nickel (Ni)**: Enhances high-temperature strength and corrosion resistance; lowers the rate of cold-work hardening.
4. **Molybdenum (Mo)**: Improves strength; delivers excellent resistance to oxide corrosion and seawater corrosion.
5. **Copper (Cu)**: Facilitates cold forming and reduces magnetism.

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