Maraging 250, C250, UNS K92890, 1.6359 - Special steels Datasheet

Maraging 250 (Alloy 250 / UNS K92890 / AMS 6512) is a high-strength, low-alloy steel known for its exceptional strength, toughness, and resistance to fatigue and stress corrosion cracking. It belongs to the maraging steel family, which derives its name from "martensitic" and "aging," referring to the process used to achieve its unique properties. Maraging 250 undergoes a specialized aging process to precipitate intermetallic compounds, resulting in a fine-grained microstructure with high strength and hardness.

Maraging 250 is typically used in applications requiring high strength-to-weight ratio, such as aerospace components, missile and rocket parts, high-performance racing cars, and tooling for plastic injection molding. It offers superior weldability and machinability compared to many other high-strength steels, allowing for ease of fabrication into complex shapes and structures.

One of the notable characteristics of Maraging 250 is its ability to maintain its strength even at elevated temperatures, making it suitable for use in environments where other materials would degrade. Additionally, Maraging 250 exhibits minimal distortion during heat treatment and aging processes, ensuring dimensional stability in precision applications.

Overall, Maraging 250 is valued for its combination of high strength, toughness, and corrosion resistance, making it a preferred material for critical components subjected to extreme conditions and demanding performance requirements.

Chemical Composition

The chemical composition of Maraging 250 typically includes the following elements:

- Iron (Fe): Approximately 65%
- Nickel (Ni): Around 19%
- Cobalt (Co): Typically 9%
- Molybdenum (Mo): Generally 4-5%
- Titanium (Ti): Typically 1.6-2.2%
- Aluminum (Al): Usually 0.1-0.2%
- Carbon (C): Typically less than 0.03%
- Silicon (Si): Typically less than 0.1%
- Manganese (Mn): Typically less than 0.1%
- Phosphorus (P): Typically less than 0.01%
- Sulfur (S): Typically less than 0.01%

These percentages can vary slightly depending on the specific manufacturer and the desired properties of the alloy. Maraging 250 is known for its unique combination of elements that contribute to its exceptional strength, toughness, and resistance to fatigue and corrosion.

Mechanical Properties

The mechanical properties of Maraging 250 typically include:

1. **Tensile Strength**: Maraging 250 exhibits an exceptionally high tensile strength, typically ranging from 2000 MPa to 2400 MPa (290,000 psi to 350,000 psi). This high strength makes it suitable for applications requiring excellent load-bearing capabilities.

2. **Yield Strength**: The yield strength of Maraging 250 is typically around 1800 MPa to 2200 MPa (260,000 psi to 320,000 psi), indicating its ability to withstand significant deformation under load before permanent deformation occurs.

3. **Elongation**: Maraging 250 typically has a relatively low elongation at break, ranging from 10% to 15%. While not as ductile as some other materials, it still offers sufficient elongation for many applications.

4. **Hardness**: Maraging 250 exhibits high hardness levels after aging, typically ranging from 45 HRC to 50 HRC (Rockwell C scale). This hardness contributes to its excellent wear resistance and ability to maintain dimensional stability under high stress conditions.

5. **Impact Toughness**: Maraging 250 demonstrates excellent impact toughness, making it resistant to fracture or failure under sudden loading conditions. This property is particularly important in applications subjected to dynamic loading or shock.

6. **Fatigue Strength**: Maraging 250 has a high fatigue strength, allowing it to withstand repeated cyclic loading without failure. This property is crucial for components subjected to fluctuating stresses over time.

7. **Corrosion Resistance**: Maraging 250 exhibits good corrosion resistance, especially in environments with low oxygen content. However, it may be susceptible to certain types of corrosion, particularly in acidic or chloride-rich environments.

These mechanical properties make Maraging 250 a highly desirable material for a wide range of applications, including aerospace, defense, automotive, and tooling industries, where high strength, toughness, and dimensional stability are critical requirements.

Physical Properties

The physical properties of Maraging 250 include:

1. **Density**: Maraging 250 has a density typically ranging from 7.75 g/cm³ to 8.10 g/cm³, depending on the specific composition and processing conditions. This density is relatively high compared to some other engineering materials.

2. **Melting Point**: The melting point of Maraging 250 is approximately 1420°C to 1440°C (2588°F to 2624°F), which is relatively high compared to other low-alloy steels.

3. **Thermal Conductivity**: Maraging 250 exhibits moderate thermal conductivity, typically around 18 W/(m·K) to 20 W/(m·K) at room temperature. This property influences its ability to conduct heat and dissipate thermal energy.

4. **Coefficient of Thermal Expansion**: The coefficient of thermal expansion of Maraging 250 is relatively low, typically around 10.3 µm/m·K to 11.0 µm/m·K at room temperature. This indicates its ability to maintain dimensional stability over a range of temperatures.

5. **Electrical Conductivity**: Maraging 250 is not typically used for its electrical conductivity, but it generally exhibits low electrical conductivity due to its metallic composition.

6. **Magnetic Properties**: Maraging 250 is usually non-magnetic in the annealed condition, but it can become slightly

magnetic after cold working or heat treatment. This property may be important in certain applications where magnetic interference must be minimized.

7. **Corrosion Resistance**: Maraging 250 exhibits good corrosion resistance, particularly in low-oxygen environments. However, it may be susceptible to certain types of corrosion, depending on the specific operating conditions and environment.

These physical properties contribute to the overall performance and suitability of Maraging 250 for various engineering applications, where factors such as dimensional stability, thermal conductivity, and corrosion resistance are important considerations.

Heat Treatment

The heat treatment process for Maraging 250 typically involves the following steps:

1. **Solution Treatment**: Maraging 250 is first solution treated by heating the material to a specific temperature range, typically around 820°C to 900°C (1508°F to 1652°F). The alloy is held at this temperature for a certain duration to dissolve any precipitates and achieve a homogeneous austenitic microstructure.

2. **Quenching**: After solution treatment, the alloy is rapidly quenched, usually in oil or air, to "freeze" the microstructure in its high-temperature state. Quenching helps to lock in the desired properties, such as high strength and hardness, achieved during solution treatment.

3. **Aging**: The quenched Maraging 250 is then aged at a lower temperature, typically around 480°C to 510°C (896°F to 950°F), for several hours. During aging, fine intermetallic precipitates, such as Ni3(Ti, Mo), form within the microstructure, resulting in a significant increase in strength and hardness.

4. **Multiple Aging Steps**: Depending on the specific properties desired, Maraging 250 may undergo multiple aging steps, where the material is reheated and aged multiple times to achieve the desired combination of strength, hardness, and toughness.

5. **Cooling**: After aging, the Maraging 250 is cooled naturally or air-cooled to room temperature. This completes the heat treatment process and stabilizes the microstructure of the alloy.

The precise parameters of the heat treatment process, including temperatures, durations, and cooling rates, may vary depending on the specific requirements of the application and the desired properties of the final product. It's essential to carefully control the heat treatment process to ensure that Maraging 250 achieves the desired combination of mechanical properties, such as strength, hardness, and toughness, for its intended use.

Welding Properties

Machining Properties

Similar or Equivalents Steel Grade

Maraging 250, UNS K92890, C250, AMS 6512, Werkstoff Nr. 1.6359, MIL-S-46850, BS S162, DTD 5212, MSRR 6551, MAT 102, MIA 101, Udimar 250, Vascomax C250