1.4057, X17CrNi16-2, 1.4044, Z15CN17-03

Stainless steel grade 1.4057, also known as X17CrNi16-2 (EN designation), 1.4044 (alternative EN number), and Z15CN17-03 (French AFNOR standard), is a high-performance martensitic stainless steel specifically designed for demanding applications requiring an optimal balance between mechanical strength and corrosion resistance. This steel grade falls under the specifications of EN 10088-1, AIR 9160/C, ASNA 3138, ASNA 3299, and ASNA 3126 standards, making it suitable for critical components in machinery and industrial equipment .

Compared to conventional 13% chromium steels (1.4000-1.4034 series), 1.4057 exhibits superior corrosion resistance due to its optimized chemical composition featuring increased chromium content (15-17%) and the addition of nickel (1.5-2.5%). This alloy combination results in enhanced mechanical properties while maintaining good resistance to corrosive environments .

The material is typically supplied in various forms including peeled bars, forged bars, hexagonal bars, and sheets. Depending on the heat treatment condition, hardness levels up to 45 HRC can be achieved, making it particularly suitable for heavily loaded components in aerospace, marine, food processing, and chemical industries .

Applications

Equivalent or Similar Grades - Chemical Composition

Element	1.4057 (EN)	X17CrNi16-2 (EN)	1.4044 (EN)	Z15CN17-03 (AFNOR)
Carbon (C)	0.12-0.22%	0.12-0.22%	0.12-0.22%	0.12-0.22%
Silicon (Si)	≤1.00%	≤1.00%	≤1.00%	≤1.00%
Manganese (Mn)	≤1.50%	≤1.50%	≤1.50%	≤1.50%
Phosphorus (P)	≤0.040%	≤0.040%	≤0.040%	≤0.040%
Sulfur (S)	≤0.030%	≤0.030%	≤0.030%	≤0.015%
Chromium (Cr)	15.00-17.00%	15.00-17.00%	15.00-17.00%	15.00-17.00%
Nickel (Ni)	1.50-2.50%	1.50-2.50%	1.50-2.50%	1.50-2.50%
Molybdenum (Mo)	-	-	-	-
Vanadium (V)	-	-	-	-

Note: Small variations may occur depending on specific manufacturer standards and product forms .

The controlled carbon content (0.12-0.22%) ensures good hardenability while maintaining adequate toughness. The chromium content (15-17%) provides the essential corrosion resistance, and the nickel addition (1.5-2.5%) further enhances both corrosion resistance and mechanical properties .

Mechanical Properties

The mechanical properties of 1.4057/X17CrNi16-2 vary significantly depending on the heat treatment condition. Below are the typical mechanical properties for different delivery conditions:

Annealed Condition (+A)

- **Tensile Strength (Rm):** <950 MPa
- **Hardness (HB):** <295
- **Yield Strength (Re):** Not specified (typically around 600 MPa)
- **Elongation (A):** Not specified (typically >10%)

This condition is suitable for further machining and forming operations .

Quenched and Tempered Condition (+QT800)

- **Tensile Strength (Rm):** 800-950 MPa
- **Yield Strength (Re):** >600 MPa
- **Hardness (HB):** Approximately 250-300
- **Elongation (A):** 10-14% (longitudinal), 8% (transverse)
- **Impact Energy (KV):** 15-25 J at +20°C (longitudinal)

This condition offers a good balance between strength and toughness .

Quenched and Tempered Condition (+QT900)

- **Tensile Strength (Rm):** 900-1050 MPa
- **Yield Strength (Re):** >700 MPa
- **Hardness (HB):** Approximately 270-330
- **Elongation (A):** Slightly lower than QT800 condition
- **Impact Energy (KV):** Slightly lower than QT800 condition

This high-strength condition is suitable for highly stressed components .

High Temperature Mechanical Properties and Creep Resistance

While 1.4057/X17CrNi16-2 is primarily used at moderate temperatures, its performance at elevated temperatures is important for certain applications:

- **Maximum Service Temperature:** Approximately 600°C for short-term exposure
- **Continuous Service Temperature:** Up to 400°C (depending on stress levels)
- **Creep Resistance:** Moderate - not typically specified as a creep-resistant grade
- **Oxidation Resistance:** Good up to about 750°C in air

For applications requiring sustained loading at elevated temperatures, careful evaluation of creep deformation and stress rupture properties is recommended. The material shows better high-temperature strength than standard 13% chromium steels due to its higher chromium and nickel content .

Physical Properties

The physical properties of 1.4057/X17CrNi16-2 stainless steel are important for design and application considerations:

- **Density:** 7.7 g/cm^3
- **Melting Range:** 1420-1460°C
- **Thermal Expansion Coefficient:** 10-10.5 × 10^{-6}/K (20-400°C)
- **Thermal Conductivity:** 25 W/m·K at 20°C
- **Specific Heat Capacity:** 460 J/kg·K at 20°C
- **Electrical Resistivity:** 0.7 Ω·mm^2/m at 20°C
- **Magnetic Properties:** Ferromagnetic (exhibits magnetic response)

Note: These values may vary slightly depending on heat treatment condition and specific composition .

Heat Treatment

Proper heat treatment is essential to achieve the desired mechanical properties in 1.4057/X17CrNi16-2 stainless steel. The following heat treatment procedures are commonly applied:

Annealing (+A Condition)

- **Process:** Heat to 680°C, hold for appropriate time, then cool in air
- **Purpose:** To soften the material for machining or cold working
- **Resulting Structure:** Ferrite with carbides

Hardening

- **Temperature Range:** 950-1050°C
- **Quenching Medium:** Water or oil
- **Purpose:** To achieve maximum hardness and strength
- **Resulting Structure:** Martensite

Tempering (for QT800 Condition)

- **Temperature Range:** 750-800°C (primary tempering)
- **Additional Tempering:** 650-700°C (if required)
- **Special Note:** For compositions with nickel at the lower range (1.5%), single tempering at 620-720°C may be sufficient
- **Purpose:** To achieve optimal combination of strength and toughness

Tempering (for QT900 Condition)

- **Temperature Range:** 600-650°C
- **Purpose:** To achieve higher strength while maintaining adequate toughness

Processing Performance

Machinability

In the annealed condition (+A), 1.4057/X17CrNi16-2 has fair machinability (approximately 60% of free-cutting steel 1214). Recommended practices include:

- Use of sharp tools with positive rake angles
- Moderate cutting speeds with ample cooling
- Chip breakers for continuous chip control
- Appropriate tool materials (carbide or high-speed steel)

After hardening and tempering, machinability decreases significantly, requiring more robust tooling and reduced cutting parameters .

Forming

Cold forming operations should generally be performed in the annealed condition:

- **Bending:** Possible with adequate radius (minimum 2× thickness)
- **Drawing:** Moderate drawability with proper lubrication

- **Stretch Forming:** Limited due to high strength after heat treatment

Hot working (forging, rolling) can be performed in the range of 1100°C with slow cooling afterward .

Welding

Welding of 1.4057/X17CrNi16-2 requires special considerations:

- **Preheating:** 200-300°C recommended to reduce cracking risk
- **Post-Weld Heat Treatment:** Essential to restore corrosion resistance and mechanical properties
- **Filler Metals:** Typically matching composition or austenitic grades (e.g., 309L)
- **Welding Processes:** SMAW, GTAW, and GMAW are commonly used

The welded joints typically require full heat treatment (hardening and tempering) after welding to achieve optimal properties .