CORROSION RESISTANT MATERIALS AND SOLUTIONS

FACTS ABOUT STAINLESS STEEL

Definition: Stainless Steel is an alloy containing a minimum of 11% chromium (chrome)

The Role of Chrome:

- Chrome imparts corrosion resistance to an alloy through the formation of a chrome oxide film on the surface
- This oxide is less than 5 nanometers thick
- The chrome makes the steel relatively brittle, especially after welding

The Role of Nickel:

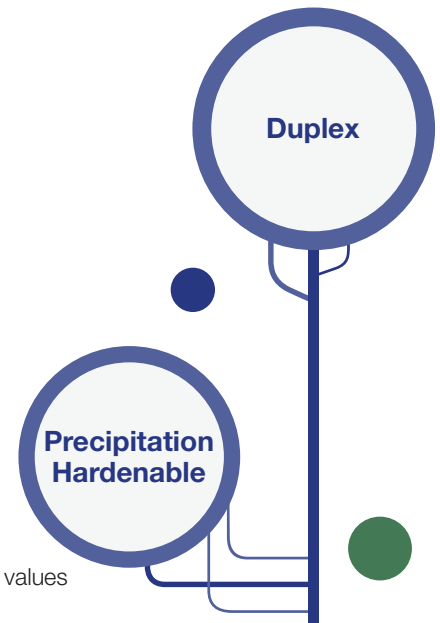
- Nickel austenitises the steel, making it more ductile particularly after welding
- Lower levels of nickel can result in a duplex crystal structure of ferrite and austenite
- Nickel does not play a major role in the corrosion resistance of the alloy

Corrosion Resistance:

- Stainless steel, unlike mild steel, experiences several types of corrosion
- Corrosion Resistance is due to a very thin Chrome oxide film on the surface of the steel
- The oxide film integrity and its ability to repair itself depends on the presence of oxygen in the medium

Key Considerations:

Stainless Steel is not a panacea for all types of corrosion and care should be taken when selecting the appropriate grade



Duplex Stainless Steels

Selected Grades: - LDX2101, LDX2404, 2205, 2507, 2304

Properties:
- Excellent mechanical properties
- High resistance to stress corrosion cracking
- Excellent fatigue life
- Good weldability
- Good resistance to pitting corrosion
- Magnetic

Common Uses:
- Structural applications (Lean Duplex)
- Rebar (LDX2101)
- Heat exchanger tubing
- Chemical and Petrochemical industries
- Mining process eg. CCD tanks
- Desalination plants
- Off-shore rigs
- Road tanker chassis

Limitations: - Temperature range limitation

Precipitation Hardenable Stainless Steels

Selected Grades: - 17-4PH, 15-5PH

Properties:
- High strength and hardness
- Moderate weldability
- Good corrosion resistance
- Can be strengthened and hardened with heat treatment

Common Uses:
- Shafts, spindles
- High strength fabrications

Limitations: - Cannot be hardened to the same values as Martensitic Stainless Steels

Ferritic Stainless Steels

Selected Grades: - 409, 430, 439, 3CR12

Properties:
- Moderate to good corrosion resistance
- Poor weldability
- Good strength
- Magnetic

Common Uses:
- Sinks, troughs
- Cutlery
- Architectural
- Catalytic converters
- Dust and fume extractors
- Chutes
- Evaporator tubes
- Exhaust pipes
- Storage tanks and fabrications (3CR12)

Limitations:
- Due to welding difficulties usually only available in tube and sheet up to 2mm thick except 3CR12 which is available and weldable up to 30mm thick
- Cannot be used for pressure vessels

High Performance Alloys

Selected Grades: - 904L, Alloy 825, Alloy C276, 254 SMO

Properties: - Because these alloys were developed for specific corrosion conditions the properties can vary considerably

Uses: - Various aggressive conditions

Austenitic Stainless Steels

Selected Grades: - 304/304L/321, 316/316L/316Ti

Properties:
- Good corrosion resistance. Improved with the addition of Mo
- Excellent weldability
- Non magnetic
- Can be used over a large temperature range
- Easily cleaned
- Can be hardened by cold work

Common Uses:
- Hygienic applications e.g. Food and Beverage, Breweries etc
- Chemical and Petrochemical industries
- Pulp and paper industry
- Pressure vessels, process vessels and fabricated tanks
- Pipes and fittings
- Architectural

Limitations:
- Low strength
- Susceptible to various types of corrosion e.g. pitting, crevice corrosion and stress corrosion cracking
- Problem with reducing acid medium

Super Ferritic Stainless Steels

Selected Grades: - 18/2, 26/1

Properties:
- Improved weldability
- High pitting resistance
- Resistant to stress corrosion cracking
- Magnetic

Common Uses:
- Condenser / evaporator tubes
- Solar heaters
- Hot water heaters

Limitations: - Normally only available in thin gauges

Heat Resistant Stainless Steels

Selected Grades: - 304H/321, 309/309S, 310/310S, 253MA

Properties:
- Resistant to scaling at high temperatures
- Good strength at high temperature
- Good creep properties

Common Uses:
- Furnace equipment
- Muffle liners
- Radiant tubes

Limitations:
- Can form inter-metallics
- Susceptible to sigma-phase embrittlement

Martensitic Stainless Steels

Selected Grades: - 410, 420, 431, 440A/B/C

Properties:
- High strength and hardness after quench and temper
- Poor weldability
- Moderate corrosion resistance
- Magnetic

Common Uses:
- Surgical instruments
- Knife blades
- Shafts, spindles
- Impellers
- Fasteners

Limitations:
- Normally only available in bar
- Fairly brittle

FAMILY TREE OF
STAINLESS STEELS

Conclusion:

There are over 500 grades and finishes of Stainless Steel capable of fulfilling many functions. The importance of correct material selection and design for optimum results cannot be overstated. Correct selection at the outset not only offers the possibility of up-front savings and reduced lifetime costs, it is crucial in preventing corrosion and mechanical failure. NDE offers technical advice and support to assist customers with design and material selection in order to achieve the optimum outcome for the success of any project.