MACSTEEL VRN

STAINLESS STEEL PLATE, SHEET & COIL

3CR12 Technical Data

General Information

3CR12 is a chromium containing corrosion resisting steel developed as an alternative material of construction where the mechanical properties, corrosion resistance and fabrication requirements of other materials such as mild steel, galvanised or aluminized steel, aluminium or pre painted steels are unsuitable.

3CR12, containing approximately 12% chromium, was designed as a corrosion resisting steel and, as such, will exhibit staining when exposed to aggressive atmospheric conditions. In applications where aesthetic appearance is important, it is recommended that the 3CR12 be painted or that a stainless steel such as AISI Grade 304 be used.

3CR12 is designed with ease of fabrication in mind and its composition and properties result in good forming, drawing, blanking and punching characteristics. The steel is easily welded by any of the recognized welding processes and provided post weld pickling/cleaning and passivation is undertaken, no loss of corrosion resistance in the weld and adjacent areas will result.

As 3CR12 is a recent development, it is not included in any standard structural or vessel design codes. In general, structural design rules for stainless steels are appropriate for 3CR12. When replacing carbon steel with 3CR12, it is necessary to redesign mild and constructional steel components using the improved mechanical and corrosion resisting properties of 3CR12 in order to gain full advantage of potential material and fabrication savings.

3CR12 has good scaling resistance up to 600^{O}C and useful mechanical properties up to about 450^{O}C.

Applications for 3CR12 exist in the following industries:

- **mining and minerals processing**
- **sugar**
- **civil engineering**
- **chemical and petro-chemical**
- **pulp and paper**
- **sewerage and waste treatment**

Properties of 3CR12
Chemical Composition

%C	%Si	%Mn	%P	%S	%Cr	%Ni	Other
0.03 Max	1.0 Max	1.5 Max	0.04 Max	0.03 Max	11.0 12.0	1.5 Max	

1. Mechanical Properties

Ultimate Tensile Strength (Transverse)	460 MPa Min
0.2% Offset Proof Strength (Transverse)	< 3 mm thick - 280 MPa Min > 3 mm thick - 300 MPa Min
Elongation (Transverse)	< 4.5 mm thick - 18% Min
	> 4.5 mm thick - 20% Min
Hardness	< 12.0 mm thick - 220 Brinell Max
	> 12.0 mm thick - 250 Brinell Max
Impact Toughness at 20^{O}C Charpy V	35 J Min

2. Properties at Elevated Temperatures

3CR12 contains 11-12% chromium and thus has reasonably good oxidation resistance at moderately high temperatures. Although not designed as a high temperature steel, 3CR12 does have useful mechanical properties at temperatures where mild or carbon manganese steels would be unsuitable.

The recommended maximum service temperatures, for 3CR12 are:

Continuous 600^{O}C

Intermittent 750^{O}C

3CR12 is suitable for use only under oxidising or neutral conditions and is not suited to reducing atmospheres. Up to 500^{O}C, creep can be ignored with 3CR12 but over 500^{O}C there is a rapid fall off in mechanical properties. At these higher temperatures the standard heat resisting grades of steel should be considered. Macsteel VRN Technical staff should be contacted for further information.

3. Fatigue Strength

The fatigue strength of 3CR12 is similar to that of carbon manganese steels for similar joints. The attention of designers is drawn to good fatigue design practice and adequate care should be taken to avoid stress raisers, sudden thickness changes, etc. It is strongly recommended that standard codes be used (such as British Standard BS 5400 - 1980) for the design of fatigue loaded structures.

Cognisance must be taken of 3CR12's heat affected zone properties, when using a welded assembly under cyclic loading conditions.

4. Physical Properties

All values given are for 20^{o}C unless otherwise specified.

Density		7 740 kg/m^{3}
Elastic Modulus (Tension)		200 GPa
Poisson's Ratio		0.3
Specific Heat Capacity		480 J/kg K
Thermal Conductivity	200^{o}C	31.0 W/m K
	300^{o}C	32.0 W/m K
	400^{o}C	32.1 W/m K
	500^{o}C	31.5 W/m K
Electrical Resistivity		66 x 10^{-9}Wm
Mean co-efficient of	0-100^{o}C	10.8 mm/mK
thermal expansion	0-300^{o}C	11.3 mm/mK
	0-700^{o}C	12.5 mm/mK
Melting Range		1430 - 1510^{o}C
Relative Permeability		Ferromagnetic

5. Corrosion Resistance

3CR12, with 12% chromium as its major alloying element, is not intended as a material for use in contact with process solutions such as acids, salts, etc. It is more suited to applications involving ancilliary equipment on process plants such as cable racking, stairways, flooring, handrailing, etc. 3CR12 is a "corrosion resistant" rather than "stainless" steel and as such, will tend to form a light, surface rust or discolouration when exposed to aggressive environments. This patina is superficial and does not affect the mechanical properties of the steel.

Should aesthetic or hygienic qualities be of prime importance, stainless steels rather that 3CR12 should be considered, although 3CR12 can be successfully painted with a number of paint systems.

Aqueous Corrosion

It is recommended that consultations be held with technical staff on the use of 3CR12 in water, 3CR12 performs quite satisfactorily in domestic waters or where chloride contents are fairly low. However in applications involving high chloride levels detailed testing of the water may be necessary and technical staff should be consulted.

At the design stage, efforts must be made to avoid crevices, sedimentation, stagnancy, high operating temperatures etc., as these facts will have a negative impact on the performance of the steel.

3CR12 is not recommended for use in hot water systems unless detailed testing has previously been carried out.

Atmospheric Corrosion

A long term atmospheric corrosion programme conducted over 10 years by the CSIR has shown 3CR12 to have very good atmospheric corrosion resistance. Data on the performance of various materials at different test sites is available from Macsteel VRN Technical staff.

6. Fabrication of 3CR12

Note: A detailed 3CR12 fabrication guideline is available.

Cutting

For general fabrication requirements, the most effective cutting methods are:

Abrasive disc
- **use dedicated discs**
- **avoid overheating**
- **vitrified or resinoid aluminium oxide discs recommended**

Plasma
- **oxygen-free nitrogen is the most economical primary cutting gas.**

  (Other gasses can be used)
- **heat discolouration must be removed prior to use in a corrosive**

  environment

Guillotine
- **use well sharpened and correctly alligned and set blades to avoid sheared**

  breaks and rollover.
- **capacity of guillotine (rated in terms of mild steel thickness) must**

  be downrated by 40% of 3CR12.

Forming

It is important to note that due to the higher proof strength of 3CR12, more power is required for most forming operations, than would be needed for mild steel.

When bending 3CR12 it is important to maintain a minimum inner bend radius equal to twice the material thickness. Reverse bending at ambient temperatures is not recommended - the bend area should be preheated to +- 150^{O}C . Edge cracks can be avoided by placing the cut face on the outside radius of the bend and the sheared face on the inside. This type of cracking can also be prevented by grinding the outside radius point of bending into a rounded profile, thus eliminating the natural stress concentration point.

Welding

Manual metal arc, metal inert gas and tungsten inert gas are the common procedures used. All welding procedures must ensure that heat inputs are kept to a minimum. Down-hand welding is the preferred welding position and bead runs rather than weaving should be used. Austenitic stainless steel filler metals such as AWS ER 309L, 308L, or 316L should be used.

In order to ensure adequate corrosion resistance in weld zones, it is necessary to remove all heat tint by pickling or by some mechanical means and passivating with a cold 10% nitric acid solution after cleaning. Thorough washing with clean, cold water pickling and passivating is essential.

Machining

In the annealed condition, 3CR12 has machining characteristics similar to AISI 430 i.e. a machinability rating of 60. The reduced extent of work-hardening compared to austenitic stainless steel eliminates the need for special cutting tools and lubricants. Slow speeds and heavy feeds with sufficient emulsion lubricant will prevent machining problems.

Fastening

Where 3CR12 sections are to be bolted, stainless feel fasteners such as type 304 or 431 are preferred. If bolted structures are to be used in humid or wet environments, it is strongly recommended that compressible, non-absorbant gaskets such as rubber be used.

Thermal Processing

Annealing

3CR12 is supplied in the annealed condition, its softest and most ductile state. After severe cold forming operations or after hot forming operations above 750^{O}C, annealing may be required. Annealing is carried out at 700-750^{O}C followed by air cooling.
Soaking times are 12 hours per 25mm section.

Stress Relieving

Stress relieving is not recommended for 3CR12. If it is essential, temperatures of not more than 450^{O}C should be employed.

Hot Working

Any hot forming should preferably be conducted at temperatures between 900 and 1000^{O}C with a finishing temperature of below 800^{O}C Annealing is essential after hot working operations.