APM 2377, UNS S31803 HOT ISOSTATIC PRESSED (HIP) PRODUCTS

Material Data Sheet

APM 2377 is a powder metallurgical duplex (austenitic-ferritic) stainless steel manufactured by Hot Isostatic Pressing (HIP). It is characterized by high strength and good corrosion resistance. Applications include for example offshore components.

STANDARDS & APPROVALS

- ASTM: A988
- UNS: S31803
- EN Number: 1.4462
- NACE MR0175/ISO 15156
- Qualified according to NORSOK M650 (D44). Maximum thickness 325 mm

CHEMICAL COMPOSITION (NOMINAL)

C	Cr	Mo	Ni	N
<0.03	22	3,2	5	0.18

Balance Fe.

FORMS OF SUPPLY

Components can be supplied in a wide range of dimensions and shapes because of the flexibility provided by powder metallurgy and near net shape technology. The products are supplied in the solution annealed and water quenched condition.

APPLICATIONS

Thanks to its excellent corrosion properties, APM 2377 is a highly suitable material for service in environments containing chlorides and hydrogen sulphide. The material is suitable for topside and subsea offshore components, such as valve bodies, manifolds, swivels and headers. The steel is also suitable for use in dilute sulphuric acid solutions and for handling organic acids, e.g. acetic acid and mixtures.

The high strength of APM 2377 makes the material an attractive alternative to austenitic steels in structures subjected to heavy loads.

The good mechanical and corrosion properties make APM 2377 an economical choice in many applications by reducing the life cycle cost of equipment

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MECHANICAL PROPERTIES

Hot isostatic pressed components have isotropic properties, meaning the mechanical properties are similar in all directions.

Mechanical properties at 20ºC (68ºF)

	Minimum*	Typical
Proof strength, $R_{p0,2}$, MPa (ksi)	450 (65)	540 (78)
Tensile strength, R_m, MPa (ksi)	655 (95)	770 (111)
Elongation, A	25%	40%
Reduction of area, Z	45%	75%
Hardness, HRC	<25	
Impact strength CVN at -46ºC, J (ft lb)	>45 (33)	

** Minimum values according to ASTM 988. Impact toughness values valid for wall thicknesses up to 325mm(round bar) at T/4.*

Proof strength at elevated temperatures

Temperature	Minimum
ºC	MPa (ksi)
50	415 (60)
100	360 (52)
150	335 (48)
200	310 (45)

Modulus of elasticity

Temperature, ºC	GPa	Temperature, ºF	msi
20	190	68	27.6

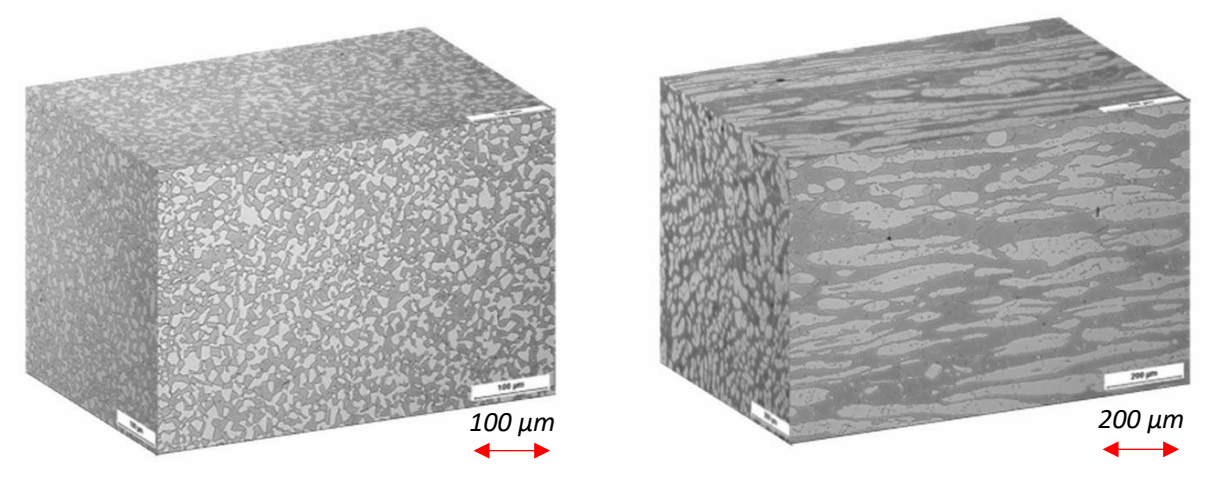
PHYSICAL PROPERTIES

Density: 7.8 g/cm3, 0.28 lb/in3

Mean coefficient of thermal expansion, 20-100 °C: 13.5x10-6/°C

MICROSTRUCTURE

Hot isostatic pressed components have isotropic properties, meaning the mechanical properties are similar in all directions.



Fine isotropic microstructure of HIPed material vs. forged bar. Note scale marker bar.

CORROSION RESISTANCE

In most media, APM 2377 possesses better resistance to general corrosion than steel of type ASTM 316L and 317L.

Pitting corrosion

Thanks to the high contents of chromium, molybdenum and nitrogen APM 2377 has good pitting and crevice corrosion resistance. A parameter for comparing the resistance of different steels to pitting corrosion is the PRE number (Pitting Resistance Equivalent). The PRE is defined as, in weight-%: PRE = % Cr + 3.3 x % Mo + 16 x % N. The critical pitting temperature of APM 2377 according to ASTM G48A is 25 °C.

Stress corrosion cracking

Duplex stainless steels are far less prone to stress corrosion cracking in chloride-bearing solutions at temperatures above 60°C (140°F) than for instance standard austenitic steels ASTM 304L and ASTM 316L.

In aqueous solutions containing hydrogen sulphide and chlorides, stress corrosion cracking can also occur on stainless steels at temperatures below 60°C (140°F). The corrosivity of such solutions is affected by acidity and chloride content.

APM 2377 possesses good resistance to stress corrosion cracking in environments containing chlorides as well as in those containing both chlorides and hydrogen sulphide. This has also been confirmed by available operating experience.

Hydrogen induced stress cracking (HISC)

Powder metal based, hot isostatic pressed duplex stainless steels generally have better resistance to hydrogen induced stress corrosion cracking than forged or cast material duplex stainless steel. One reason for this is smaller austenite spacing of the hot isostatic pressed material that is typically below 15 µm.

HEAT TREATMENT

Products are delivered in the heat-treated condition. If additional heat treatment is needed after further processing, the following is recommended:

Solution annealing 1020-1100°C (1870-2010°F) plus quenching in water.

WELDING

The weldability of APM 2327 is good. Suitable welding methods are manual metal-arc welding with covered electrodes or gas shielded arc welding. Welding should be undertaken within the heat input range 0.5-2.5 kJ/mm. Max. interpass temperature is 150°C (482·F), depending on the application. Preheating or post-weld heat treatment is normally not necessary.

Matching filler metals are recommended in order to obtain a weld metal with optimum corrosion resistance and mechanical properties. For gas-shielded arc welding we recommend ISO 14343 S 22 9 3 N L / AWS A5.9 ER2209.

For manual metal-arc welding, covered electrode ISO 3581 E 22 9 3 N L R / AWS A5.4 E2209-17 or ISO 3581 E 22 9 3 N L B / AWS A5.4 E2209-15 is recommended.

FABRICATION

Fabrication of all stainless steels should be done only with tools dedicated to stainless steel materials. Tooling and work surfaces must be thoroughly cleaned before use. These precautions are necessary to avoid cross contamination of stainless steel by easily corroded metals that may discolor the surface of the fabricated product.

MACHINING

Being a two-phase (austenitic-ferritic) material, APM 2377 will present a different tool wear profile from that of single phase steels of types ASTM 304/304L and 316/316L. The cutting speed must therefore be lower than that recommended for ASTM 304/304L and 316/316L. Built-up edges and chipping are to be expected. It is recommended that a tougher insert grade is used than when machining austenitic stainless steel.