APM 9980
HOT ISOSTATIC PRESSED (HIP) PRODUCTS

DATASHEET

APM 9980 is a low carbon martensitic stainless steel. The grade is specially designed to combine high mechanical properties including toughness and improved corrosion resistance properties when compared to other martensitic stainless steels, like 13 Cr and 13 Cr 4 Ni grades.

The alloy has been primarily designed to resist to erosion-corrosion or cavitation encountered in hydraulic applications. The alloy is also used for offshore structures and fluid/gas control systems where the combined mechanical and corrosion resistance properties are needed. Mining, cement plants, and hydraulic applications take also advantage of its combined abrasion-corrosion resistance properties.

STANDARDS

- ASTM: S165M
- EN Number: 1.4418
- EN Name: X4CrNiMo16-5-1
- SS: 2387

CHEMICAL COMPOSITION (NOMINAL) %

Chemical composition (nominal) %

C	Cr	Mo	Ni
<0.045	16	1	5

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 in the quench and tempered condition.

APPLICATIONS

For any application requiring high strength, high hardness, and corrosion resistance similar to 304 stainless. Many applications can be found in fields like automotive, industrial, and others, where a combination of high mechanical properties and a good corrosion resistance is critical.

APM 9980 is a martensitic stainless steel specially designed for those applications requiring high mechanical properties combined with improved corrosion resistance relative to traditional martensitic steels.

MECHANICAL PROPERTIES

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

Mechanical properties at 20°C (68°F)

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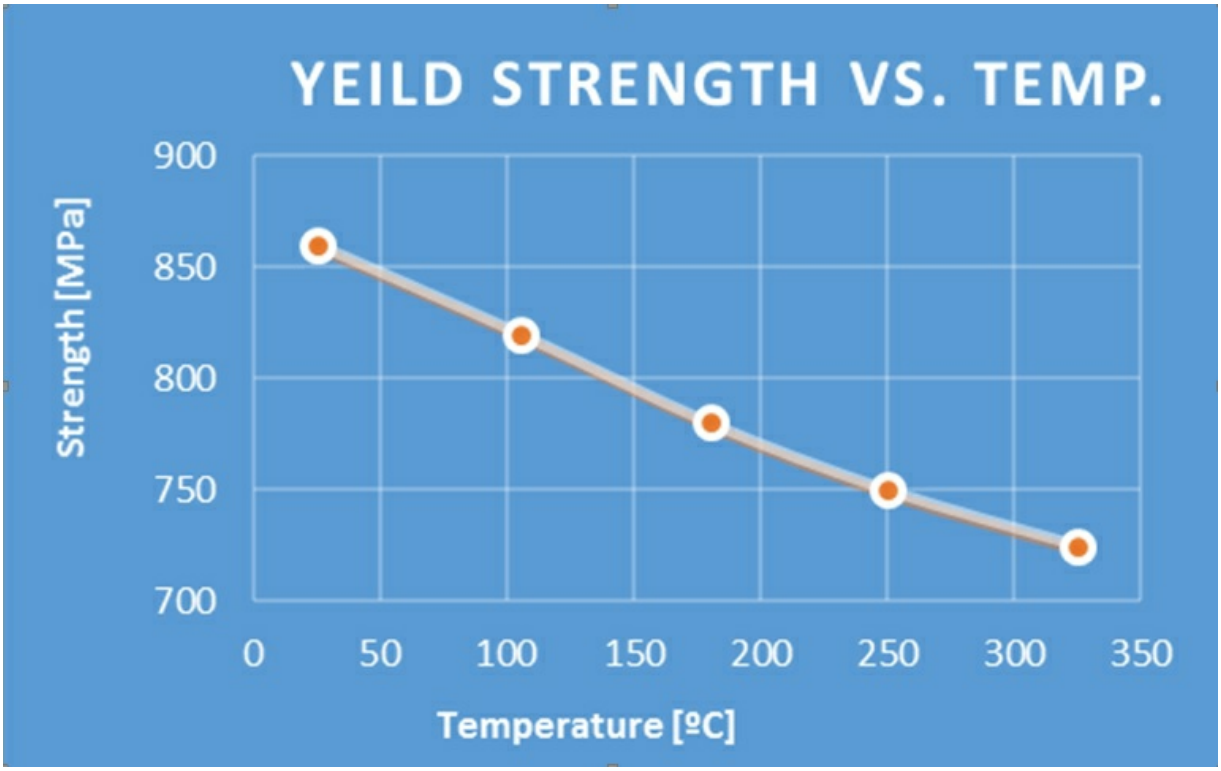
	Minimum	Typical
Proof strength, $R_{p0.2}$, MPa (ksi)	860 (125)	>900 (>130)
Tensile strength, R_m, MPa (ksi)	1000 (145)	>1020 (>148)
Elongation, A	>18 %	>20 %
Reduction of area, Z	>50 %	>65 %
Impact strength CVN at -46ºC, J (ft lb)	≥40 (30)	≥50 (37)
Hardness, HRC	<35	<35

Proof strength at elevated temperatures

Temperature	$R_{p0.2}$	
	Minimum	Typical
ºC	MPa (ksi)	MPa (ksi)
21	860 (125)	920 (133)
105	820 (119)	890 (129)
180	780 (113)	840 (122)
250	750 (109)	810 (117)
325	725 (105)	780 (113)



The mechanical properties of APM 9980 can be customized in a wide range by varying heat treatment. If properties listed here does not meet your requirements, please contact Sandvik Powder Solutions for more information.

PHYSICAL PROPERTIES

Density: 7.7 g/cm³, 0.278 lb/in³

Mean coefficient of thermal expansion, 20-200°C: 10.8 x 10^{-6}/°C, 6x10^{-6}/°F

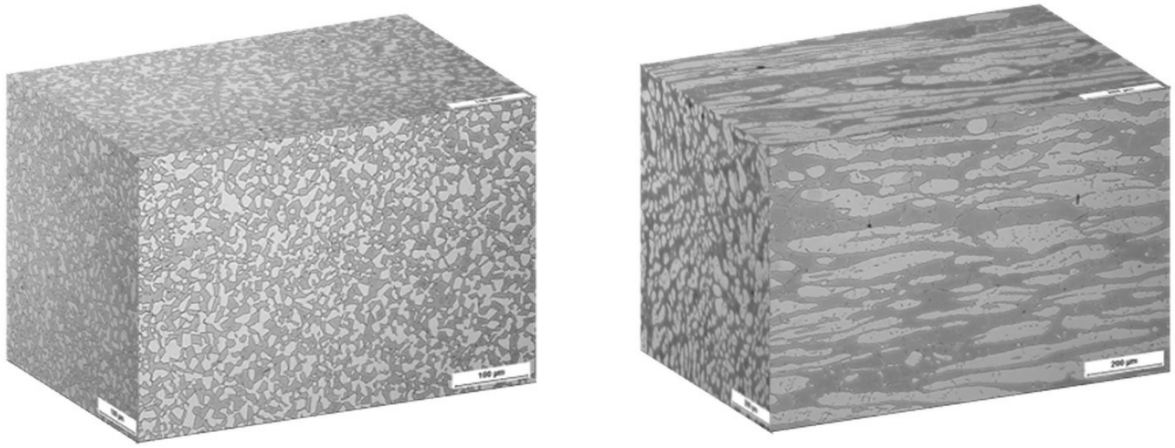
Modulus of elasticity*

Temperature, ºC	MPa	Temperature, ºF	ksi
20	200	68	29

* (x10³)

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 micrographs show duplex material for illustration.

CORROSION RESISTANCE

Due to its high nickel, chromium and molybdenum content, and its low carbon concentration, APM 9980 has a good resistance to atmospheric corrosion. It has same resistance to seawater atmosphere, as 304 and higher 13% Cr grades. APM 9980 has a low resistance to pitting corrosion (chloride attack when considering stagnant water). The alloy is extremely resistant to intergranular corrosion, corrosion fatigue and stress corrosion cracking.

HEAT TREATMENT

The products are delivered in the heat-treated QT condition. If additional heat treatment is needed due to further processing, the following is recommended. Austenizing at 950-1050 ◦C (1740-1920 °F) + oil or air quench. Tempering at 515-600 ◦C (960-1110°F).

WELDING

The weldability of APM 9980 is better compared to common martensitic stainless steels. This because of the beneficial properties of the tempered structure containing low carbon martensite and finely dispersed austenite. Welding should preferably be made using Avesta Sheffield 248 SV welding consumables. Austenitic material of T316L type can be used provided lower tensile strength of the weld is allowed. Preheating is normally not necessary except for heavy structures and in special cases. Heat treatment after welding is normally not necessary. After welding using welding consumables similar to the parent material a tempering at 580 - 590ºC (1075-1095°F) 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

Martensitic-austenitic stainless steels such as EN 1.4418 are quite similar to duplex steels regarding machining. Machinability is of course dependent on heat treatment condition, if material is annealed or hardened and tempered. Machinability depends to a great extent on material hardness.

COLD FORMING AND STRAIGHTENING

The elevated strength and the pronounced work hardening of the steel calls for special care during cold forming. Tools and presses must be very rigid and able to withstand high powers. In comparison to austenitic stainless steels APM 9980 may require an intermediate annealing operation at extreme cold forming work. Tempering is recommended after cold working operations, which exceed 5% stretching of the material. Tempering or a full quenching and tempering operation should be made after extensive cold forming.

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