METALLURGICA VENETA
ACCIAI SPECIALI

Certified Company

AISI 416

Quality	**X12CrS13**	**Martensitic Stainless Steel**
Number	**1.4005**	

Chemical composition

C%	**Si%** max	**Mn%** max	**P%** max	**S%**	**Cr%**	**Mo%** max	
0,06-0,15	1,00	1,50	0,040	0,15-0,35	12,0-14,0	0,60	EN 10088-1: 2005
± 0.01	+ 0.05	± 0.04	+ 0.005	± 0.02	± 0.15	± 0.03	

Product deviations are allowed

Temperature °C

Melting range	**Hot-forming**	**Recrystallization**	**Soft annealing**	**Full annealing**
1530-1480	1150-900	not suitable	780-750 air	870-840 cooling 15 °C/h to 590, then air

Isothermal annealing	**Quenching**	**Tempering**	**Stress-relieving**
885-830 controlled cooling to 720, then air	1010-980 oil/polymer air	680- 660 air	250-210 air

MMA **welding** – AWS electrodes

pre-heating 300

after welding stress-relieving 600

joint with steel

carbon	CrMo alloyed	stainless
E309	E309	E309-E308

cosmetic welding E410 - E309

Transformation temperature during heating **Ac1** ~ 820, **Ac3** ~ 930 and during cooling **Ms** ~ 330, **Mf** ~ 180

Mechanical properties

Hot-formed EN 10088-3: 2005 in conditions 1C, 1E, 1D, 1X, 1G, 2D

size mm		Testing at room temperature					
		R	**Rp** 0.2	**A%**	**Kv** +20 °C	**HB** a)	a) for information only
from	to	N/mm²	N/mm² min	min	J min	max	
		730 max				220	+A annealed material
	160	650-850	450	12			+QT650 quenched and tempered

Cold-processed EN 10088-3: 2005 in conditions 2H, 2B, 2G, 2P

size mm		Testing at room temperature							
		R	**HB** a)				**R**	**Rp** 0.2	**A%**	**Kv** +20 °C
from	to	N/mm² max	max				N/mm²	N/mm² min	min	J min
	10 b)	880	280				700-1000	550	8	
10	16	880	280				700-1000	500	8	
16	40	800	250				650-930	450	10	
40	63	760	230				650-880	450	10	
63	160	730	220				650-850	450	12	
		+A annealed material					+QT650 quenched and tempered material			

a) for information only

b) In the range of 1 mm ≤ d < 5 mm, values are valid only for rounds – the mechanical properties of non round bars of < 5 mm of thickness have to be agreed at the time of request and order

Forged (ASTM A 473-99 steel ASTM 416)

size mm		Testing at room temperature							
		R	**Rp** 0.2	**A%**	**C%**	**Kv** +20 °C	**HB**	**HRC**	
from	to	N/mm² min	N/mm² min	min	min	J min	max	min	
		485	275	20	45		223		+A annealed material
								35	Quenching at 955 °C in air

Table of tempering values at room temperature on rounds of Ø 10 mm after quenching at 980°C in oil

R	N/mm²	1490	1450	1420	1410	1430	1450	1420	1150	860	740	690
Rp 0.2	N/mm²	1210	1170	1150	1150	1160	1180	1140	870	650	550	500
A	%	10.8	10.8	10.9	12.0	12.5	13.0	16.0	16.5	18.0	20.0	21.5
Kv	J	25	30	26	19	18	17	18	20	31	49	90
Tempering	**°C**	**200**	**250**	**300**	**350**	**400**	**450**	**500**	**550**	**600**	**650**	**700**

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Effect of **cold-working** (hot-rolled +QT+C). Approximate values

R	N/mm^2	720	740	760	770	780	785	800	820	830	835	840
Rp 0.2	N/mm^2	480	625	630	650	660	680	700	730	735	750	760
A	%	19	18	18	16	16	16	15	15	14	14	14
Reduction	**%**	**0**	**7**	**8**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**

X12CrS13 **n° 1.4005** martensitic stainless steel

Thermal expansion	$10^{-6} \cdot K^{-1}$	►	10.5	11.0	11.5	12.0	12.2	12.7
Modulus of elasticity	longitudinal GPa	215	212	205	200	190		
Poisson number	*v*	0.235	0.210					
Electrical resistivity	$\Omega \cdot mm^2/m$	0.60						
Electrical conductivity	$Siemens \cdot m/mm^2$	1.67						
Specific heat	$J/(Kg \cdot K)$	460						
Density	Kg/dm^3	7.70						
Thermal conductivity	$W/(m \cdot K)$	30						
Relative magnetic permeability	μr	900 [1)]						
Temperature	**°C**	**20**	**100**	**200**	**300**	**400**	**600**	**800**

The symbol ► indicates temperature between 20 °C and 100 °C, 20 °C and 200 °C …..

[1)] max 900 for material in its natural state; max 750 for full annealed material

Corrosion resistance	Atmospheric		Chemical			**x** steam, gasoline, fuel oil, alcohol, ammonia
Fresh water	*industrial*	*marine*	*medium*	*oxidizing*	*reducing*	
x						

Magnetic	yes
Machinability	high
Hardening	by quenching
Service temperature in air	continuous service up to 675 °C;intermittent service up to 760 °C

Europe	**USA**	**USA**	**China**	**Russia**	**Japan**	**India**	**Republic of Korea**
EN	UNS	ASTM	GB	GOST	JIS	IS	KS
X12CrS13	S41600	**416**	Y1Cr13		SUS 416		STS 416

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AISI 416 steel – T.T.T. diagram (Transformation – Time – Temperature)