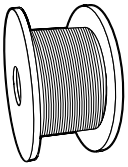
ZAPP PRECISION WIRE
ALLOY XM19 (UNS S20910)

QUALITY SYSTEM CERTIFIED TO ISO 9001:2015



ALLOY XM19 (UNS S20910) WIRE FOR:

_ Armoring applications on electromechanical cables
_ Wirelines for down hole service applications

CHARACTERISTICS

Alloy XM19 (UNS S20910) is a nitrogen strengthened austenitic stainless steel that provides a good combination of corrosion resistance and tensile strength. It contains about 22% chromium, 12.5% nickel, and about 2.25% molybdenum, which readily enables it to replace conventional austenitic steels such as Type 316. The alloy offers very good resistance to pitting and crevice corrosion. Performance in these areas is often measured using Critical Pitting Temperatures (CPT), Critical Crevice Temperatures (CCT), and Pitting Resistance Equivalent Numbers (PREN). Data is available to show superior values for alloy XM19 compared to AISI 316. ASTM Standard Test Methods G 48 is also referenced. It covers the procedures for the determination of the resistance of various alloys to pitting and crevice corrosion.

CHEMISTRY STANDARDS

UNS S20910
Alloy-No. 9.9550
ASTM A580

For comparison purposes, PREN and CPT numbers are presented for these alloys:

PREN AND CPT NUMBERS*

Alloy	PREN	CPT (°F)	CPT (°C)
316	26	72	22
Alloy 2205	36	108	42
XM19	38	106	41
Alloy 2507	41	143	61
Alloy 28	40	129	54
25-6MO	47	149	65
27-7MO	56	176	80
MP35N®	53	183	84
C276	68	>302	>150

*PREN = Cr + 3.3 Mo + 30N

*CPT (°C) = 2.5 Cr + 7.6 Mo + 31.9 N – 41

WEIGHT PER FOOT (LBS.) FOR WIRELINES

Alloy	.082"	.092"	.108"	.125"	.140"	.150"	.160"
316	0.018	0.023	0.031	0.042	0.053	0.060	0.069
2205	0.018	0.022	0.031	0.041	0.052	0.059	0.068
XM19	0.018	0.023	0.031	0.042	0.053	0.060	0.069
2507	0.018	0.022	0.031	0.041	0.052	0.059	0.068
25-6MO	0.018	0.023	0.032	0.043	0.054	0.062	0.070
27-7MO	0.018	0.023	0.032	0.043	0.054	0.062	0.070
MP35N®	0.020	0.025	0.034	0.046	0.057	0.066	0.075
C276	0.018	0.022	0.031	0.041	0.052	0.059	0.068

LIMITING CHEMICAL COMPOSITION OF ALLOY XM19

Ni	Cr	Mn	Mo	N	C	Si	Nb	V	Fe
11.50 – 13.50	20.50 – 23.50	4.00 – 6.00	1.50 – 3.00	0.20 – 0.40	0.06 max.	1.00 max.	0.10 – 0.30	0.10 – 0.30	remainder

This chemical composition provides significantly better resistance to chloride ion stress corrosion cracking than lower alloyed materials such as AISI 316 stainless steel. The alloy XM19 wire produces higher mechanical properties than AISI 316. Tensile strengths in the order of 225/280,000 psi are achieved through cold drawing.

At these strength levels, the wire is ductile and able to successfully pass the wrap test in the as drawn condition as well as the as drawn plus exposed to temperatures as high as 350°F conditions. This wrap or bend test shows no surface cracking or failure in either condition.

PHYSICAL PROPERTIES OF XM19 AT ROOM TEMPERATURE ARE AS FOLLOWS

Density	0.285 [lb/in^3] / 7.89 [g/cm^3]
Melting range	2,500 – 2,550 [°F] / 1,370 – 1,400 [°C]
Specific heat	0.12 [Btu/lb·°F] / 500 [J/kg · °C]
Electrical resistivity	493 [ohm·circ mil/ft] / 0.82 [µΩ · m]
Permeability at 200 oersted (15.9 kA/m)	1.02 max. [annealed]
Young´s modulus at 70 °F (21 °C)	28.00 [10^{3}ksi] / 193.0 [GPa]
Thermal Expansion at 200 °F (100 °C)	9.00 [in/in/°F · 10^{-6}] / 16.20 [cm/cm/°C · 10^{-6}]

XM19 is also identified as UNS S20910. Wire products are covered by ASTM 580. Material produced to the UNS S20910 chemistry ranges and manufactured into armor wire or wirelines by Zapp Precision Wire will provide an excellent quality product. Zapp Precision Wire technology, quality, and superior wire drawing capabilities will make the difference for these critical applications. The Zapp Precision Wire quality system is registered to ISO-9001:2008. For additional information on this or any other Zapp Precision Wire product, please contact the Customer Service Department at 843-851-0700 or fax your inquiry to 843-851-0010, or e-mail the inquiry to sales@zapp.com.

ZAPP TECHNICAL DATA

ALLOY CHEMISTRY

Alloy	UNS	C	Mn	Cr	Ni	Mo	Cu	N	Co	Ti	Fe
316	S31600	.08	2.0	16.0 – 18.0	10.0 – 14.0	2.0 – 3.0	-	-	-	-	bal.
2205	S32205	.03	2.0	21.0 – 23.0	4.5 – 6.5	2.5 – 3.5	-	.18	-	-	bal.
XM19	S20910	.06	4.0 - 6.0	20.5 – 23.5	11.5 – 13.5	1.5 – 3.0	-	.20 - .40	-	-	bal.
2507	S32750	.03	1.2	25.0	7.0	4.0	-	.30	-	-	bal.
25-6MO	NO8926	.02	2.0	19.0 – 21.0	24.0 - 26.0	6.0 – 7.0	0.5 – 1.5	.15 - .25	-	-	bal.
27-7 MO	S31277	.02	3.0	20.5 – 23.0	26.0 – 28.0	6.6 – 8.0	0.5 – 1.5	.30 - .40	-	-	bal.
MP35N®	R30035	.02	0.1	19.0 – 21.0	33.0 – 37.0	9.0 – 10.5	-	-	bal.	1.0	1.0
C276	N10276	.01	1.0	14.5 – 16.5	-	15.0 – 17.0	-	-	2.5	-	4.0 – 7.0

(Maximum values unless range specified)

ARMOR WIRE TYPICAL TENSILE STRENGTH RANGES (KSI)

Size	316	XM19	25-6MO	27-7MO	MP35N®
.020" - .029"	230/265	250/280	245/275	255/280	275/300
.030" - .066"	225/260	245/280	240/275	255/280	275/300

WIRELINE MINIMUM BREAK STRENGTH**

Size	316	2205	XM19	2507	25-6MO	27-7MO	MP35N®	C276
.082"	1150#	1345#	1215#	1345#	1175#	1300#	1300#	1280#
.092"	1500#	1690#	1540#	1690#	1500#	1650#	1650#	1615#
.108"	2000#	2240#	2200#	2240#	2130#	2250#	2250#	2210#
.125"	2700#	2945#	3000#	2975#	2750#	3000#	3100#	2935#
.140"	3300#	3540#	3540#	3694#	3250#	3670#	3725#	3680#
.150"	3750#	3975#	4065#	4150#	3750#	4155#	4240#	4205#
.160"	4225#	4425#	4625#	4665#	4250#	4650#	4825#	4785#

(** The recommended **safe working load** is 60% of minimum break strength)

DENSITY/CORROSION

Alloy	Density (lb/in³)	Corrosion (PREN)*	CPT (°F)	CPT (°C)**
316	.287	26	72	22
2205	.278	36	108	42
XM19	.285	38	106	41
2507	.281	41	144	62
25-6MO	.290	47	149	65
27-7MO	.289	56	176	80
MP35N®	.309	53	183	84
C276	.321	68	>302	>150

* PREN = Cr + 3.3 Mo + 30N

** CPT (°C) = 2.5 Cr + 7.6 Mo + 31.9 N - 41

EXAMPLES OF THEORETICAL ACCEPTABLE WELL ENVIRONMENTS FOR XM19 WIRE*

Chlorides	Temp °F	H_2S	CO_2	Pressure (PSI)	Req. Minimum Pitting Index (PI)	XM19 (PI)	XM19 (PREN)
20,000 ppm	325	0 %	6 %	12,000	16.50	33.03	38
20,000 ppm	380	1 %	9 %	5,000	31.50	33.03**	38
100,000 ppm	275	0 %	10 %	10,000	30.00	33.03	38
20,000 ppm	200	0 %	80 %	5,000	13.00	33.03	38
90,000 ppm	326	0 %	30 %	5,000	16.50	33.03	38

** Marginally acceptable

PI= Cr + 3.3Mo + 11N + 1.5(W+Nb)

PREN = Cr + 3.3Mo + 30N

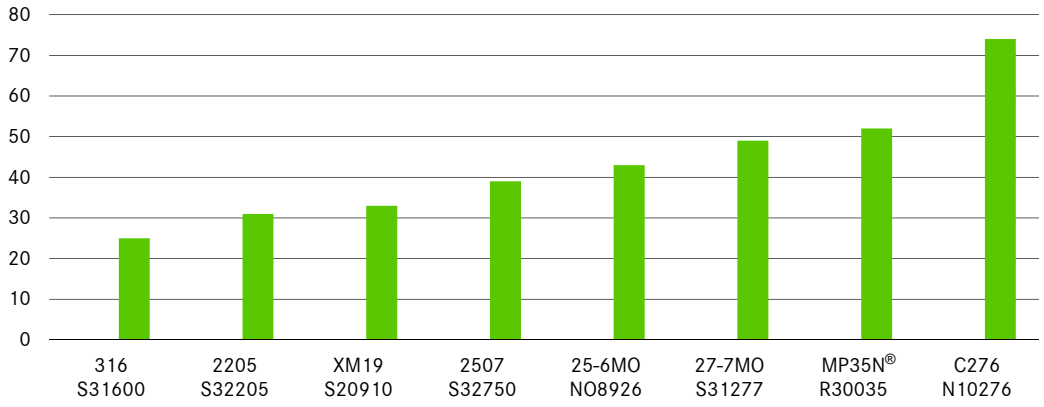
* The theoretical acceptable well environments are based on the SOCRATES software. SOCRATES is a comprehensive material selection tool for oil and gas applications that selects corrosion resistant alloys (CRA) through material evaluation based on mechanical strength parameters, heat treatment/cold work and hardness limitations. The program also evaluates the characterization of the environment in terms of operating pressure, temperature, pH, H_2S, chlorides, elemental sulfur, aeration, gas to oil ratio and water to gas ratio water cut. Stress corrosion cracking, hydrogen embrittlement cracking, sulfide stress cracking and resistance to pitting corrosion are also evaluated. The examples above are based on the environment listed and do not take into consideration the actual values of elemental sulfur, aeration, gas to oil ratio and water to gas ratio water cut.

NOMINAL CHEMICAL COMPOSITION COMPARISON

Chemical Element	316	2205	XM19	2507	25-6MO	27-7MO	MP35N®	C276
Fe	65.40	67.71	56.40	62.43	46.30	39.65	1.00	5.5
Mn	2.00	2.0	5.00	0.6	2.00	3.00	0.15	0.5
Ni	12.00	5.5	12.50	7.0	25.00	27.00	35.00	55.0 bal.
Co	*	*	*	*	*	*	32.90	2.0
Cr	17.00	22.0	22.00	25.0	20.00	21.75	20.00	15.5
Mo	2.50	2.5	2.25	4.0	6.50	7.25	9.75	16.0
W	*	*	*	*	*	*	*	*
Nb	*	*	0.20	*	*	*	*	*
N	*	0.12	0.30	*	0.20	0.35	*	*
* Trace								
PI	25.25	31.57	33.03	39.85	43.65	49.53	52.18	74,43

MATERIAL SELECTION OVERVIEW

Pitting Index



ZAPP PRECISION WIRE STANDARDS

1. All wirelines must pass an eddy current test as part of our NDT quality assurance program.
2. All wirelines and armor wires must pass an aged wrap test as part of our NDT quality assurance program.
3. All wirelines and armor wires have full traceability.
4. All XM19 wirelines are 100% weld free and supplied in continuous lengths.

ZAPP PRECISION WIRE QUALITY

The Zapp Precision Wire technology, quality, and superior wire drawing capabilities will make the difference for critical armor wire and wireline applications.

The Zapp Precision Wire quality system is registered to ISO 9001:2015.

ZAPP PRECISION WIRE
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