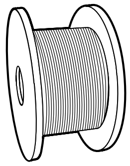
WIRELINES | SLICKLINES
ZAPP MP35N (UNS R30035)

ZAPP QUALITY SYSTEM CERTIFIED TO ISO 9001.2015



Alloy ZAPP MP35N (UNS R30035)

- For armoring applications on electromechanical cables
- Wirelines for down hole service applications

Multiphase ZAPP MP35N (UNS R30035) is a special quaternary alloy offering excellent corrosion resistance in a wide variety of aggressive, down hole environments. It is especially suitable for sour well conditions. The nominal composition of the alloy is: nickel 35%, cobalt 35%, chromium 20% and molybdenum 10%. The alloy is vacuum induction melted and consumable vacuum arc remelted. Residual elements such as carbon, nitrogen, silicon, sulfur, and phosphorous are maintained at as low a level as possible. Billets are hot rolled to rod, shaved to remove surface defects, annealed, pickled, and then supplied to Zapp for drawing to wire.
The ZAPP MP35N alloy was developed as a high strength, ductile material which provides excellent corrosion resistance. It has been found to have outstanding resistance to sour well conditions. The alloy offers excel-lent 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 ZAPP MP35N. 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.

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For Comparison Purposes, PREN and CPT Numbers* are Represented for These Alloys

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

* PREN = Cr + 3.3 Mo + 30N
** CPT (°C) = 2.5 Cr + 7.6 Mo + 31.9 N – 41

It should be noted that the PREN value for ZAPP MP35N doesn't reflect the true comparative corrosion resistance compared to ZAPP 27-7MO. ZAPP MP35N contains about 35% cobalt. Cobalt is a critical factor in terms of corrosion resistance and break strength. However, cobalt percenttages are not included in the PREN formula and thus tend to skew the relative corrosion resistance results in this instance. Corrosion tests would confirm that ZAPP MP35N is superior to ZAPP 27-7MO.

Chemistry standards:

- UNS R30035
- ASTM F562
- NACE MR0175
- Alloy No. 909035

Limiting Chemical Composition of ZAPP MP35N

Ni	Co	Cr	Mo	C	Mn	Ti	Fe	N
33.00 – 37.00	balance (typically around 33.00)	19.00 – 21.00	9.00 – 10.50	0.025 max.	0.15 max.	1.00 max.	1.00 max.	0.007 max

The chemical balance (especially the nickel and cobalt) provides significantly better resistance to chloride ion stress corrosion cracking than lower nickel alloys. ZAPP MP35N wire produces high mechanical properties. Tensile strengths in the order of 270/300,000 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 400°F - 500°F conditions. This wrap or bend test shows no surface cracking or failure in either condition.

ZAPP MP35N is also identified as UNS R30035. Wire products are partially covered by ASTM F562 and also referenced in the NACE Standard MRO175. Material produced to the UNS R30035 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-9001:2015.

Physical Properties of ZAPP MP35N in Annealed Condition at Room Temperature

Density	0.309 [lb/in³]/ 8.55 [g/cm³]
Melting Range	2,400 – 2,625 [°F]/ 1,315 – 1,440 [°C]
Electrical Resistivity	621 [ohm·circ mil/ft]/ 1.03 [μΩ·m]
Magnetic Permeability	1.0009
Specific Heat	0.12 [Btu/lb·°F]/ 500[J/kg·°C]
Young´s Modulus	33.76 [10^3 Ksi]/ 232.8 [GPa]
Thermal Expansion	7.1 [in/in·°F x 10^{-6}]/ 12.78 [cm/cm·°C x 10^{-6}]

Zapp Technical Data

Alloy Chemistry

Alloy	UNS	C	Mn	Cr	Ni	Mo	Cu	N	Co	Ti	Fe
ZAPP 316	S31600	.08	2.0	16.0 - 18.0	10.0 - 14.0	2.0 - 3.0	-	-	-	-	bal.
ZAPP 2205	S32205	.03	2.0	21.0 - 23.0	4.5 - 6.5	2.5 - 3.5	-	0.18	-	-	bal.
ZAPP XM19	S20910	.06	4.0 - 6.0	20.5 - 23.5	11.5 - 13.5	1.5 - 3.0	-	0.20 - 0.40	-	-	bal.
ZAPP 2507	S32750	.03	1.2	25.0	7.0	4.0	-	0.30	-	-	bal.
ZAPP 25-6MO	NO8926	.02	2.0	19.0 - 21.0	24.0 - 26.0	6.0 - 7.0	0.5 - 1.5	0.15 - 0.25	-	-	bal.
ZAPP 27-7 MO	S31277	.02	3.0	20.5 - 23.0	26.0 - 28.0	6.6 - 8.0	0.5 - 1.5	0.30 - 0.40	-	-	bal.
ZAPP MP35N	R30035	.02	0.1	19.0 - 21.0	33.0 - 37.0	9.0 - 10.5	-	-	bal.	1.0	1.0
ZAPP 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	ZAPP 316	ZAPP XM19	ZAPP 25-6MO	ZAPP 27-7MO	ZAPP MP35N
0.020" - 0.029"	230/265	250/280	245/275	255/280	275/300
0.030" - 0.066"	225/260	245/280	240/275	255/280	275/300

Wireline Minimum Break Strength**

Size	ZAPP 316	ZAPP 2205	ZAPP XM19	ZAPP 2507	ZAPP 25-6MO	ZAPP 27-7MO	ZAPP MP35N	ZAPP C276
0.082"	1150#	1345#	1215#	1345#	1175#	1300#	1300#	1280#
0.092"	1500#	1690#	1540#	1690#	1500#	1650#	1690#	1615#
0.108"	2000#	2240#	2200#	2240#	2150#	2250#	2300#	2210#
0.125"	2700#	2945#	3000#	2975#	2800#	3000#	3100#	2935#
0.140"	3300#	3540#	3540#	3694#	3480#	3670#	3725#	3680#
0.150"	3750#	3975#	4065#	4150#	3950#	4155#	4240#	4205#
0.160"	4225#	4425#	4625#	4665#	4350#	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)**
ZAPP 316	.287	26	72	22
ZAPP 2205	.287	36	108	42
ZAPP XM19	.285	38	106	41
ZAPP 2507	.281	41	144	62
ZAPP 25-6MO	.290	47	149	65
ZAPP 27-7MO	.289	56	176	80
ZAPP MP35N	.309	53	183	84
ZAPP C276	.321	68	>302	>150

* PREN = Cr + 3.3 Mo+30 N

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

Examples of Theoretical Acceptable Well Environments for MP35N® Wire*

Chlorides	Temp °F	H_2S	CO_2	Pressure (PSI)	Req. Minimum Pitting Index (PI)	ZAPP MP35N (PI)	ZAPP MP35N (PREN)
200,000 ppm	445	15 %	15 %	15,000	50.00	52.18	53
28,000 ppm	435	30 %	25 %	13,000	50.00	52.18	53
120,000 ppm	440	20 %	35 %	15,000	50.00	52.18	53
150,000 ppm	445	30 %	30 %	15,000	50.00	52.18	53
50,000 ppm	449	35 %	45 %	20,000	50.00	52.18	53
20,000 ppm	425	1 %	10 %	15,000	50.00	52.18	53
150,000 ppm	425	3 %	11 %	15,000	50.00	52.18	53
120,000 ppm	425	20 %	30 %	15,000	50.00	52.18	53

* 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, H2S, chlorides, elemental sulphur, aeration, gas to oil ratio and water to gas ratio water cut. Stress corrosion cracking, hydrogen embrittlement cracking, sulphide 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 sulphur, aeration, gas to oil ratio and water to gas ratio water cut.

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

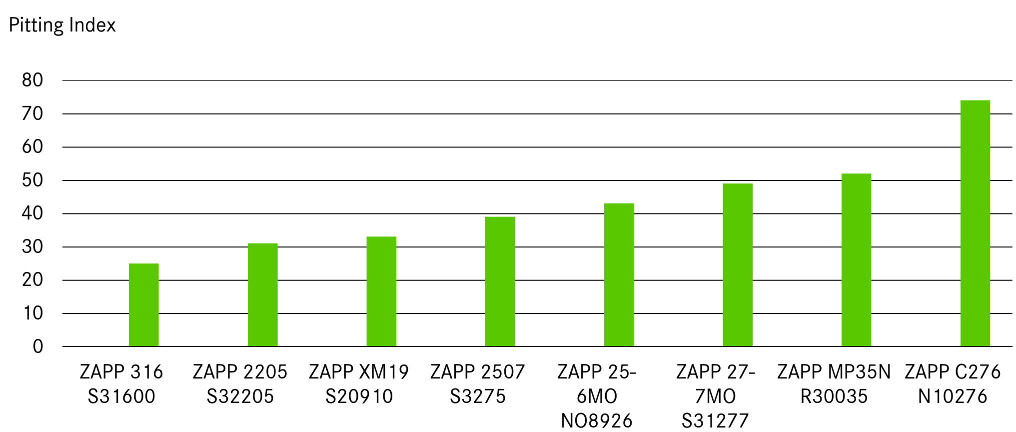
PREN = Cr + 3.3Mo + 30N
It should be noted that the PI and PREN values of ZAPP MP35N® do not totally reflect its true corrosion resistance because these formulas do not address the cobalt content of ZAPP MP35N®.

Note: The information in the Socrates summary report does not represent a commitment by Honeywell InterCorr International or Zapp Precision Wire, Inc. The information contained in this document and the Socrates software is purely advisory in nature. In no event shall Honeywell InterCorr, Zapp Precision Wire, Inc., or their employees or agents have liability for damages, including but not limited to, consequential damages arising out of or in connection with any person's use or inability to use the information in this document.

Nominal Chemical Composition Comparison

Chemical Element	ZAPP 316	ZAPP 2205	ZAPP XM19	ZAPP 2507	ZAPP 25-6MO	ZAPP 27-7MO	ZAPP MP35N	ZAPP 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



Weight per Foot (lbs.) for Wirelines

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

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 ductility quality assurance program.
3. All wirelines and armor wires have full traceability.
4. All ZAPP MP35N wirelines and armor wires are produced using shaved, defect free rod material

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
WIRE I BAR I PROFILE I FLAT WIRE
Zapp Precision Wire, Inc.
475 International Circle
Summerville, South Carolina 29483
U.S.A.
Phone 1 843 851-0700
Fax 1 843 851-0010
Toll-free 1 888-777-3962
Precisionwire-usa@zapp.com
www.zapp.com

Further information regarding our products and locations are available in our image brochure and under www.zapp.com

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