

MARTENSITIC STAINLESS STEELS

Martensitic stainless steels are used extensively in sweet (CO₂) environments where carbon and low alloy steels experience general corrosion

13Cr-L80 is the most commonly used martensitic stainless for OCTG. The standard mechanical properties and quality requirement for this alloy are provided by API 5CT & ISO 11960. 13Cr-L80 can be used in mild sour environments (H₂S pp <1.5 psi), within the guidelines of NACE MR0175 & ISO 15156. Where chlorides or oxygen are present, 13 Chrome alloys are prone to pitting corrosion so higher alloys are required.

Modified 13 Chrome and **Super 13 Chrome** Alloys provide improved pitting corrosion resistance along with higher strength and toughness. API 5CRA & ISO 13680 provide standard mechanical properties and quality requirements for Super 13 Chrome Alloys at 95 ksi & 110 ksi yield strength. At 95 ksi these alloys are considered acceptable for mild sour service, within the guidelines of NACE MR0175 & ISO 15156.

Where higher strength and temperature resistance are required, **15 Chrome** and **17 Chrome** Alloys should be considered. These alloys are available with 125 ksi yield strength, however they are not recommended for sour service.

Alloy Type	API Category	Trade Names	UNS number	Chemical composition								PREN
				maximum % mass fraction or range, unless otherwise indicated								
				C	Cr	Ni	Mo	Cu	Ti	V	N	
13 Chrome	5CT 13Cr L80	13CR	S42000	0.15	12.0							12
		420 Mod		to	to	0.5	—	0.25	—	—	—	to
		13Cr L80		0.22	14.0							14
Modified 13 Chrome	N/A	13CRM	N/A	0.03	11.0	4.0	0.2					12
				to	to	to	—	—	—	—	—	to
Super 13 Chrome	5CRA Group 1 13-5-2 PSL 1 & 2	13CRS	S41426		11.5	4.5	1.5		0.01			16
		CR13S		0.03	to	to	to	—	to	0.5	—	to
			S41425	0.05	12	4.0	1.5				0.06	17
					to	to	to	0.03	—		to	to
					15	7.0	2.0				0.12	22
		5CRA Group 1 13-5-2 PSL 1	SCR13	S41427	0.03	11.5	4.5	1.5		0.01	0.1	—
				to	to	to	—	—	to	—	—	to
				13.5	6.0	2.5			0.5			22
		HP2	N/A	0.04	12.0	4.5	1.8					18
				to	to	to	—	—	—	—	—	to
				14.0	5.5	2.5						22
15 Chrome	N/A	15 Cr	S42500	0.08	14.0	1.0	0.3					15
				to	to	to					0.2	to
				0.2	16.0	2.0	0.7					18
		UHP-15CR	N/A	0.04	14.0	6.0	1.8					20
		Super 15Cr		to	to	to	1.5	—	—	—	—	to
				16.0	7.0	2.5						24
17 Chrome	N/A	17CRS	N/A		16.0	4.0	2.0	2.0				23
		Super 17Cr		0.03	to	to	to	to	—	0.1	—	to
				18.0	5.5	3.0	3.0	3.0				28

DUPLEX STAINLESS STEELS

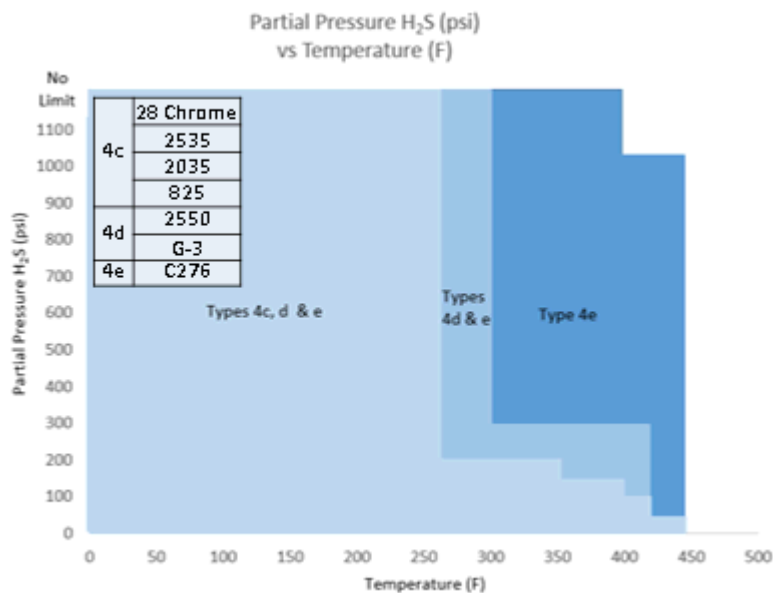
Duplex stainless steels are used extensively in high chloride environments where pitting and crevice corrosion are of concern, and sweet HPHT environments where martensitic stainless steels won't provide sufficient resistance to the combination of temperature and CO₂. Duplex Stainless Steel tube is most commonly supplied in the cold worked condition with 110 ksi or 125 ksi yield strength. At these strength levels they are suitable for mild sour service, within the guidelines of NACE MR017 & ISO 15156. API 5CRA & ISO 13680 provide standard mechanical properties and quality requirements for these alloys up to 140 ksi yield strength, however they are not recommended for sour service in this highest strength condition.

Super Duplex Stainless Steels are alloyed to achieve a PREN (Pitting Resistance Equivalence) > 40, which is necessary to prevent pitting corrosion in high temperature + high chloride environments. These alloys are also used in water handling systems where dissolved oxygen may result in pitting corrosion. They are suitable for mild sour service with a partial pressure of H₂S < 3.0 psi.

Alloy Family	Alloy Type	API Category	Trade Names	UNS number	Chemical composition							PREN
					maximum % mass fraction or range, unless otherwise indicated							
					C	Cr	Ni	Mo	Cu	W	N	
Duplex Stainless Steels	22 Chrome Duplex	5CRA Group 2 22-5-2 PSL 1 & 2	22Cr	\$31803	0,03	21.0	4.5	2.5	—	—	0.08	35
			2205			to	to	to			to	0.20
	25 Chrome Duplex	5CRA Group 2 25-7-3 PSL 1 & 2	25Cr	\$31260	0,03	24.0	5.5	2.5	0.2	0.10	0.10	37
			2507			to	to	to	to	to	to	to
	Super Duplex	5CRA Group 2 25-7-4 PSL 1 & 2	SAF 2507	\$32750	0,03	24.0	6.0	3.0	—		0.24	40
						to	to	to			to	0.32
			25CRS Z100	\$32760	0,03	24.0	6.0	3.0	0.5	0.50	0.20	40
						to	to	to	to	to	to	to
				\$39274	0,030	24.0	6.0	2.5	0.2	1.5	0.24	40
			25CRW			to	to	to	to	to	to	to
			26.0	8.0	3.5	0.8	2.5	0.32	45			

SOLID SOLUTION NICKEL BASE ALLOYS

Solid solution nickel base alloys are used primarily in sour environments where the partial pressure of H₂S exceeds 3 psi. Nickel Base Alloy tube is most commonly supplied in the cold worked condition. API 5CRA & ISO 13680 provide standard mechanical properties and quality requirements for these alloys up to 140 ksi yield strength. NACE MR0175 & ISO 15156 provide the guidelines for sour service. Within these documents the cold worked nickel based alloys are grouped by alloy content. A range of sour service limits are provided for each group (designated as Types 4c, 4d and 4e). Types 4d and 4e are also recommended where high chlorides or dissolved oxygen necessitate a high pitting resistance.



NACE MR0175/ISO 15156 Sour Service Limits for Nickel Base Alloys Tube

Alloy Family	Alloy Type	API Category	Trade Names	UNS number	Chemical composition										PREN	
					maximum % mass fraction or range, unless otherwise indicated											
					Cr	Ni	Fe	Mo	Co	Cu	Ti	Nb+Ta	W	Al		
Solid Solution Nickel Base Alloys	28 Chrome	5CRA Group 3 27-31-4 PSL 1 & 2	28 Chrome Alloy 28	N08028	26.0 to 28.0	30 to 33	bal.	3.0 to 4.0	—	0.6 to 1.4	—	—	—	—	—	36 to 41
	2535	5CRA Group 3 25-32-3 PSL 1 & 2	2535	N08535	24 to 27	29 to 37	bal.	2.5 to 4	—	1.50	—	—	—	—	—	32 to 40
	2035	5CRA Group 3 22-35-4 PSL 1 & 2	2035	N08135	20.5 to 23.5	33 to 38	bal.	4 to 5	—	0.70	—	—	—	0.2 to 0.8	—	34 to 41
	825	5CRA Group 4 21-42-3 PSL 1 & 2	825 2242	N08825	19.5 to 23.5	38.0 to 46.0	bal.	2.5 to 3.5	—	1.5 to 3.0	0.6 to 1.2	—	—	—	0.2	28 to 35
	G3	5CRA Group 4 22-50-7 PSL 1 & 2	G3	N06985	21.0 to 23.5	bal.	18.0 to 21.0	6.0 to 8.0	5.0	1.5 to 2.5	—	0.50	1.5	—	—	41 to 50
	G2	5CRA Group 4 25-50-6 PSL 1 & 2	G2	N06975	23.0 to 26.0	47.0 to 52.0	bal.	5.0 to 7.0	—	0.70 to 1.20	0.70 to 1.50	—	—	—	—	40 to 49
	2550	2550 CRA 2550E	G2	N06255	23.0 to 26.0	47.0 to 52.0	bal.	6.0 to 9.0	—	1.20	0.69	—	—	3.0	—	43 to 56
	G50	5CRA Group 4 20-54-9 PSL 1 & 2	G50 Alloy 050	N06950	19.0 to 21.0	50.0 min. to 20.0	15.0 to 20.0	8.0 to 10.0	2.5	0.5	—	0.50	1.0	—	—	45 to 54
	C276	5CRA Group 4 15-60-16 PSL 1 & 2	C276	N10276	14.5 to 16.5	bal.	4.0 to 7.0	15.0 to 17.0	2.5 i	—	—	—	—	3.0 to 4.5	—	69 to 80
	C22	N/A	Alloy 22	N06022	20.0 to 22.5	2.0 to 6.0	13 to 15	2.5 to 15	—	—	—	—	2.5 to 3.5	—	—	65 to 76