Duplex Stainless Steel Submersible Pumps

There has been a great deal of discussion regarding the use of stainless steel in seawater and corrosive water applications. When applied to submersible pumps it must first be recognised that there are two distinct methods of manufacture employed for the production of these pumps.

Many smaller pumps from mass manufacturers are fabricated from pressed stainless steel sheet. These pressed sections are welded together to form the impellers and diffusers. Typically these pumps are available in 304ss, 316ss and in some cases 904L. The 904L material was added to address pitting and crevice corrosion in seawater but because of the construction of the pressed metal pumps they are still susceptible. Pitting corrosion is also an issue on this style of pump due to the thin wall sections of the pressed material.

Larger pumps are generally cast construction, the impeller and diffusers are made from one piece castings and machined. Wall sections are generally significantly heavier with greater corrosion allowance. With the advent of the duplex ranges of stainless steel many offshore companies have moved to Duplex 2205 and SDSS (Super Duplex Stainless Steel) 2507.

904L is a wrought material, there is no casting version. Duplex 2205 is the closest equivalent for corrosion resistance where both materials have a PRE of 34.

Typical PRE values for a range of stainless steels. (source Atlas Technical Handbook)

AtlasCR12 Ferritic 11
430 Ferritic 17
439 Ferritic 18
303 Austenitic 18*
304/L Austenitic 18
316/L Austenitic 24
444 (F18MS) Ferritic 25
2304 Duplex 26
2205 Duplex 34
904L Austenitic 34
S31254 Austenitic 43
S32750 Duplex 43
S32520 Duplex 43

PRE is the Pitting Resistance Equivalent number. The higher the number the more resistance to pitting corrosion. S32750 is the equivalent to SDSS 2507

The corrosion rate of stainless steel is observed using a corrosion test. The most commonly used test is ASTM G48, which measures resistance to a solution of 6% ferric chloride. The results of this test and the calculated PRE of the stainless steel is used in the selection. The PRE (Pitting Resistance Equivalent), calculated according to: PRE = %Cr+3.3%Mo+16%N.

The first chart below provides a comparison of stainless steels according to PRE (the higher the PRE number, the better resistance to pitting corrosion), the second chart provides a comparison of strength.

We have found that in saline water Duplex 2205 and Super Duplex 2507 are the best selection, these materials have become the standard for offshore oil and gas industries.

Table 1. Typical chemical composition, wt%, and PRE numbers* for some duplex stainless steels. Austenitic and ferritic grades included for comparison

Steel grade	UNS	Cr	Ni	Mo	N	Other	PRE
LDX 2101®	S32101	21.5	1.5	0.3	0.22	5Mn	26
2304	S32304	23	4.8	0.3	0.10	-	26
2205	S32205	22	5.7	3.1	0.17	-	35
2507	S32750	25	7	4	0.27	-	42
304L	S30403	18.1	8.1	-	-	-	18
316L	S31603	17.2	10.1	2.1	-	-	24
317L	S31703	18.2	13.7	3.1	-	-	28
904L	N08904	20	25	4.3	-	1.5Cu	34
254 SMO®	S31254	20	18	6.1	0.2	Cu	43
430	S43000	16.5	-	-	-	-	16.5
444	S44400	18	-	2	-	Ti, Nb	25

Table 2. Mechanical properties, cold rolled coil, minimum values at room temperature. Austenitic and ferritic grades included for comparison

Steel grade	UNS	ASTM A240, min values			Hardness, Outokumpu typical values [HB]
		Proof strength, Rp0.2, [MPa]	Tensile strength, RM, [MPa]	Elongation in 2" or 50mm [%]	
LDX 2101®	S32101	530	700	30	230
2304	S32304	400	600	25	225
2205	S32205	450	655	25	250
2507	S32750	550	795	15	255
304L	S30403	170	485	40	165
316L	S31603	170	485	40	165
317L	S31703	205	515	40	195
904L	N08904	220	490	35	190
254 SMO®	S31254	310	690	35	220
430	S43000	205	450	22	170
444	S44400	275	415	20	-

Tables from Outokumpu

Corrosion of Stainless Steel

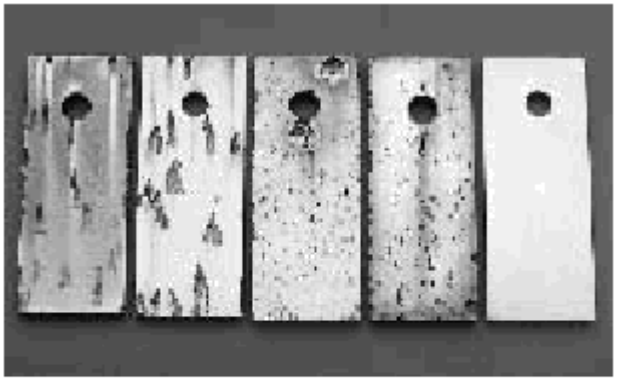

Figure 7. Test coupons after pitting corrosion test according to ASTM G48. From the left to the right: Sandvik 3R60, Sandvik 2RK65, SAF 2304, SAF 2205 and SAF 2507.

Sandvik 3R60 is 316 st/st and Sandvik 2RK65 is 904L st/st.

As can clearly be seen from these pictures, SDSS 2507 has been unaffected by the test.

If we look at the attached ASSDA article on crevice corrosion we can see that the temperature required to initiate crevice corrosion on 904L is 12^{o} C and for SDSS 2507 it is 38^{o} C which is a significant improvement.

Also attached are Atlas Tech Note 3, ASSDA Tech Data Page 4 and Atlas Grade Data Sheet 2507 for light reading. We believe this information clearly shows the superiority of Super Duplex 2507 over 904L in corrosive environments.

In order that we can move forward to supply these high quality pumps and motors we propose a special price for a small quantity (1 to 5) of pumps in Super Duplex Stainless Steel for trial purposes. This price represents the normal price for 20 off pumps once supply is established. Please see quotation attached.

We would be delighted to discuss this further and are certainly happy to answer any questions you may have.

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