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Comparison of Wilco 2507SDSS and 2205DSS alloys for use as slickline

Introduction

There are a number of 2205 Duplex Stainless Steel (DSS) alloys currently available for use as slickline and the typical composition of these are shown below. Several companies are marketing Standard Duplex alloys as a replacement for 2507 Super Duplex Stainless (SDSS) steel alloys, but these alloys are very different and have fundamental differences in properties that will affect their performance in service.
The 2205 alloys can comply with UNS S31803 or UNS S32205 grades with the difference being that the latter will have a slightly higher minimum PREN value and so has slightly improved corrosion resistance. It is therefore very important to fully understand the alloy type to assess the suitability for use and the table below shows the typical composition of both as compared to UNS S32750 (2507 SDSS).

Alloy	Typical Composition (wt.%)							PREN
	Fe	Cr	Ni	Mo	N	Cu	W	
UNS S31803 DSS	**Bal**	**22**	**5**	**3**	**0.14**	**-**	**-**	**34**
UNS S32205 DSS	**Bal**	**22**	**5**	**3.2**	**0.16**	**-**	**-**	**35**
Wilco 2507 SDSS	**Bal**	**25**	**7**	**3.7**	**0.24**	**-**	**-**	**42.5**

PREN = Cr% + 3.3Mo% + 1.65W%+ 16 N%

Composition and Corrosion Resistance

The corrosion performance of stainless steels has been shown on many occasions to be related to the Pitting Resistance Equivalent Number, (PREN), originally by Kovach and Redmond in 1993 (1). The current version of the equation is the PREN equation used in ISO 15156 (2) that includes tungsten and is shown in the above table. It is widely accepted as being a method to rank stainless steels for corrosion performance with the higher number giving better performance.
The 2205 DSS grades are either produced as UNS S31803 or UNS S32205 with different PREN values as seen in the table. Both versions have inferior corrosion resistance to the super duplex grade 2507SDSS which has a much higher PREN value.
The susceptibility of duplex alloys to stress corrosion cracking is mainly dependent on temperature, pH, chloride (Cl^-) and hydrogen sulphide (H2S) levels. In general, the higher the Cl^- then the less H2S can be tolerated. Lower pH values will decrease resistance and resistance is lowest at 90°C (194°F).
The ISO 15156 document lists the areas where stainless steels can be used in oilfield environments and lists both DSS and SDSS. The area of use is defined by the PREN value and 2507 SDSS has much better stress corrosion cracking performance.
Stress corrosion testing of actual SDSS wireline product has been carried out, validated and published so safe areas of use are known and this is not true for all other alloys.

Strength

Alloy	0.108”	0.125	0.140”	0.160”
2205 DSS	2258	3025	3795	4665
2507 SDSS	2550	3325	4100	5150

Comparison of breaking loads for various slickline diameters in lbf**.**

From the table above it can be seen that the 2507 SDSS wires give additional breaking load values of up to 13% over the 2205 DSS wires.

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The additional breaking loads of the SDSS wire will give much greater performance and it can be shown that a smaller diameter SDSS wire can do almost all the work of the next larger DSS wire. This will result in considerable cost savings with less size changes and consequently less downtime. Additionally a smaller diameter wire is less weight and will result in a lower initial capital costs as less wire is required at a lower weight and cost.

Advantages of SDSS

1) A SDSS wire has higher strength than a 2205 DSS wire with increases in breaking load (BL) of up to 13% size for size.
2) It can be shown that a 0.108" SDSS wire is capable of 87% of the work of a 0.125" 2205 DSS wire, a 0.125" SDSS wire is capable of 90% of the work of a 0.140" DSS wire and a 0.140" 2507 SDSS wire is capable of 75% of the work of a 0.160" 2205 DSS wire. This will give additional cost savings as less weight is being purchased and less stock.
3) A SDSS wire has improved corrosion resistance to a 2205 DSS wire across many applications and conditions and is therefore more flexible.
4) Safe conditions of use for 2507 SDSS wire are known as a result of laboratory testing.
5) Wilco have over twenty years' experience in the supply of Super Duplex SS slickline.
6) A SDSS will have better fatigue resistance as it has improved strength and the fatigue limits for all stainless steels are related to tensile strength.
7) Many operators use SDSS wires for fishing as they can take advantage of the higher strength and use the same size wire and again reduce equipment changes and downtime.
8) Operators have seen that a SDSS wire has given up to 3 times the overall life compared to other wires due to its excellent resilience in service.
9) This will give additional significant cost savings in downtime from less equipment changes.
10) A Wilco 2507 SDSS wire gives lower overall cost with lower capital cost and improved through life cost.

References

1) Kovachs & Redmond, Paper 267, Corrosion 93, NACE International.
2) ISO 15156 Petroleum, petrochemical and natural gas industries -Materials for use in H2S containing environments in oil and gas production, ISO, Geneva. Switzerland.
3) R Francis & G Warburton, Area of use of 2507 super duplex ss wireline, Eurocorr 2006, Maastricht, Netherlands, EFC.

The information included here is not exhaustive and further information is available on request from Wilco Oilfield Services to support the use of SDSS slicklines for operators.

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