The European market for duplex stainless steels: rapid growth expected

The economic downturn has affected duplex stainless steel producers along with producers of other kinds of CRAs. However, rapid growth is expected in the future based on the properties of duplex and the fact that duplex stainless steels represent only a very small proportion of all stainless steels produced, so there is plenty of scope for increasing market share. With new lean duplex, super duplex and hyper duplex grades being developed, European producers are poised to benefit from this future growth.

By James Chater

Effects of downturn

The effect of the current recession on the duplex stainless steel sector is hard to gauge. It is nonetheless clear that producers of duplex semi-finished products and manufacturers of duplex tubes have suffered along with stainless steel producers in general. Sandvik and Outokumpu are among the companies whose first- and second-quarter results were weaker than the year before. According to Per Eklund, Manager of Business Development Tubular Products at Sandvik Materials Technology, the duplex market has performed better for Sandvik than has the average stainless steel business. This must provide grounds for optimism that its recently introduced super duplex and hyper duplex grades will perform well. In contrast, Outokumpu believes that in 2009 the duplex stainless steel market has declined more than for standard grades, mainly because of a lack of projects during the financial crisis. However, the company's faith in duplex is unshaken, and it is continuing its policy of creating new markets for duplex grades based on the conviction that the market for these grades will rise faster than for other grades. This assumption is shared by SMR, which estimates that the duplex market will grow by 16% per annum between 2008 and 2014, outperforming all other grades (1).

Rapid rise of duplex

Already, the growth of the duplex stainless steel market in recent years has been remarkable. Research from the ISSF reveals that production soared from 6,000 metric tonnes a month in 2004 to 10,000 by 2005, and in 2008 reached 22,000. It is especially interesting to compare the standard grade, 2205, with the lean duplexes. Although production of grade 2205 increased in absolute terms, its market share decreased from around 67% in 2004 to around 47-48% in 2007-8. By contrast the market share of lean grade S32304 stood at 5% in 2006 and leapt to 13% in 2007 and to 17% in 2008. (Figures for Outokumpu's LDX 2101

Unfortunately this famous European monument was not built from lean duplex type 2304. If it had been, at least 30% of its weight and millions of hours of maintenance would have been saved.

StatoilHydro's Oseberg oil platform, offshore Bergen, Norway. Photo: Harald Pettersen / StatoilHydro.

lean duplex grade are confidential.) Of the two super duplexes included in the ISSF survey, the share of S32750 (SAF 2507) is always under 5%, while that of S32760 (ZERON® 100) is even smaller (2).

Clearly, then, the emergence of lean duplex grades is the most significant development of the duplex stainless steel market in recent years. Soaring nickel and molybdenum prices created a demand for alloys with corrosion resistance properties similar to 316L but having a higher yield strength that allows weight savings. This would explain the success of lean duplexes in architecture and in process industries where the opportunity exists to reduce plate thickness.

Reduction in weight and thickness is important in all grades of duplex. The importance that end users attach to this advantage can be seen in the fact that 62% of duplex production is quarto plate, and this segment accounts for 10% of all stainless steel produced (3). This concerns plates with a minimum width of 2 metres and a minimum thickness of 6mm. These are precisely the types of product that can deliver substantial weight savings without compromising corrosion resistance in a number of applications, in offshore, (petro)chemical, pulp & paper, desalination and other industries.

Apart from possible price and strength-to-weight advantages, resistance to stress corrosion cracking is another characteristic that virtually guarantees that duplex is here to stay, whatever the price of nickel and molybdenum is doing. Suppliers of duplex insist that it is the innate properties of duplex grades, not just their price, that accounts for their rise and will assure their future success.

Another important trend to emerge in recent years is that the duplex success story is still largely – and with notable exceptions – a European one. This is not surprising if one knows the history of stainless steels, in which European companies like Avesta, Creusot-Loire and Sandvik took the lead. Euro-African production was 17,000 tonnes per month (tpm) in 2008, up from 2,500 tpm in 2000. US production for 2008 was 1,300 tpm, about the same as for 2000; in Asia, production increased steadily from under 1,000 tpm in 2000 to 2,500 tpm in 2008, a larger share than the US, but still tiny compared with Euro-Africa (4).

This, though, is only half the story. The major European producers (ArcelorMittal, Outokumpu and Sandvik) are all world-wide exporters and have a global presence. Sandvik has noticed a large increase in duplex consumption in the Americas in just the last five years, and there is expectation of steady growth in the Asia-Pacific region as well. The duplex market took one more step towards globalisation in late 2008 when the UK firm of Weir Materials was bought up by the multinational Rolled Alloys. One of Weir's products had been the super duplex ZERON® 100, used mainly for pipes fitting and flanges in the oil & gas, desalination and chemical industries. And sure enough, in March 2009 Rolled Alloys announced it had added ZERON® 100 to its North America inventory.

Diversification

Large shifts in duplex usage can be observed in the period between 2004 and 2007. Comparing non-US shipments for 2004 with those of 2007, we find that oil and gas, offshore and petrochemical declines from 27% (the largest share) to 7% – a surprising statistic that indicates at the very least a relative shift towards other uses. Indeed, there is a relative decline also in chemical, storage and transportation, while segments with increased market share include (waste)water (9% to 18%), construction and civil engineering (6% to 12%), power generation (1% to 7%) and other applications (presumably pulp & paper, ethanols, biofuels – 10% to 28%). Given the overall increase in duplex share, the statistics can be read as indicating the rapid penetration of duplex beyond the traditional domains of oil and gas and (petro)chemical into a more diverse range of industries.

Oil and gas

The so-called "second-generation" duplex grades, alloyed with nitrogen to stabile the HAZ and thereby ensure greater ease of welding, first emerged as solutions in those applications where weight saving and high corrosion resistance (especially in locations difficult to access for inspection) were important. Their main single market was the offshore oil & gas industry and, despite the mergence of other applications, this segment is likely to remain an important market given the greater depths and pressures (weight; high temperature!) and the increasing emphasis on sour gas fields (corrosion!). For many years type 2205 was the standard grade, but great depths and pressures, combined with the more corrosive conditions of the newer oil and gas fields, have created a market for the more highly alloyed super duplex grades that emerged in the 1980s. Belonging to this type are three relatively new alloys from Sandvik: the super duplex SAF 2507 SD and the hyper duplex grades SAF 3207 HD and SAF 2707 HD (see the coloured boxed information and Table 1).

Table 1
Chemical composition of super duplex and hyperduplex grades recently developed by Sandvik. SAF 2507 SD, SAF 3207 HD seamless tubes are both used in umbilical tubes on offshore oil and gas installations, but SAF 3207 HD was developed to meet the demand for a metal that could withstand most extreme conditions in terms of depth, temperature and pressure. SAF 2707 HD resists pitting at high temperatures and is considered suitable for demanding well applications and heat exchangers. Source: Sandvik.

Grade	C max.	Si max.	Mn max.	P max.	S max.	Cr	Ni	Mo	Others	PRE
SAF 2507 SD	0.030	0.8	1.2	0.035	0.015	25	7	4	N=0.3	42.5
SAF 3207 HD	0.030	0.8	1.5	0.035	0.010	32	7	3.5	N=0.5	50
SAF 2707 HD	0.030	0.5	1.5	0.035	0.010	27	6.5	4.8	N=0.4 Co=1.0	48

In Europe, the North Sea oil and gas fields are likely to remain important consumers of these types of grades in years to come as extraction is taken to greater depths and increasingly hostile environments. Of the ordinary duplex grades, significant quantities of 2205 made in Europe continue to be exported to the world's oilfields: Sosta has supplied over 300km of welded 2205 pipes to Germany, Nigeria, Oman and Pakistan. Butting, which manufactures process piping for offshore applications, has just opened an office in Brazil and is therefore well poised to take advantage of the opening up of the country's abundant deepsea oil reserves.

Emerging applications

Duplex stainless steels have recently made inroads into several other industries, including pulp & paper, (waste)water (especially desalination), storage tanks in the food, chemical and biofuel industries, shipping, pressure vessels, geothermal energy and architecture. One industry that seems set to expand in Europe is biofuels. The EU is committed to raising the proportion of biofuels used in transport. In July 2009 OPTFUEL, a European

Welded duplex line pipe manufactured by Sosta. These pipes are used for transportation of high-temperature, corrosive gas from the wellhead to the processing plant. Sosta has supplied over 300km of this pipe to oil projects in Oman, Nigeria, Germany and Pakistan. The pipes are manufactured in accordance with API5LC from duplex grade UNS S31803 (2205). These pipes are mostly coated with polypropylene coating.

research consortium developing second-generation biofuels, was set up. The world's first BioDME (heavy goods fuel) plant is being built in Sweden by Chemrec at Piteå. In 2007, the expansion of a biofuel ethanol plant on Händelö Island, Sweden called for LDX 2101 lean duplex steel sheets, plates, and piping products supplied by Outokumpu (5). Dutch tank fabricator Oostwouder Tank- & Silobouw BV chose lean duplex (LDX 2101 and 2304) for some biofuel storage tanks at the Port of Amsterdam (7).

Storage tanks in the biofuels, food & drink, and chemical industries are one application where the weight-saving advantages of lean duplex can be exploited to maximum effect. Cital of Italy chose LDX 2101 for bioethanol fermentation tanks solely on the basis of material reduction of more than 15% (7). The same material was also used to build a storage tank at a chemical company in the south-eastern USA (8). In shipping, more and more chemical tankers are using duplex grades.

A technician working in Shell's biofuel research laboratory in Amsterdam, the Netherlands (2007).

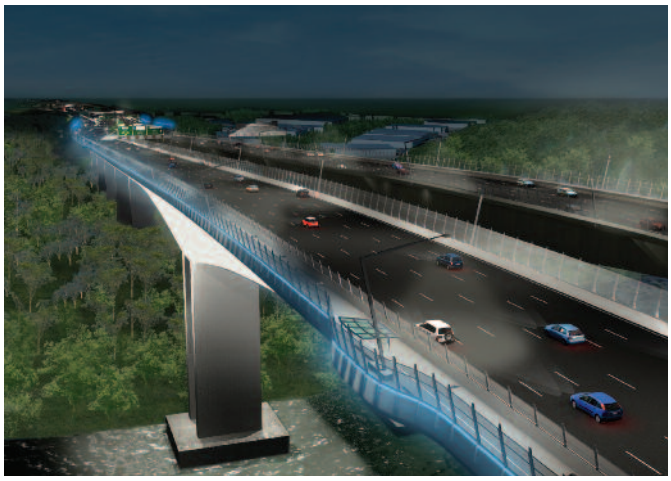
Prefabrication of the piping components for a seawater desalination plant. Photo © H. BUTTING GmbH & Co. KG.

Outokumpu provided duplex 2205 for tankers built by the Italian firm of Finbeta and for four ships, which will carry acids, to be built by China's Yangzi Shipbuilding Industry. On 3 September 2009 a new chemical tanker was launched in Indonesia built partly of super duplex.

One of the most remarkable recent developments in duplex has been the increased use of lean duplex in architecture. Bridges afford plenty of opportunities to exploit the load-bearing, weight-saving properties of lean duplex. LD has been used for pedestrian bridges in Bilbao in Spain's Basque region, Siena in Italy and Gaularfjell in Norway. Lean duplex rebar will be used in Brisbane's Gateway Upgrade Project, the first time LDX 2101 will be used as rebar. There is certainly good reason to expect the market for lean duplex grades to expand even further. For this reason Outokumpu has entered an agreement with Acciaierie Valbruna SpA allowing the Italian company to use LDX 2101 duplex stainless steel grade in all long products, such as bar, rebar and wire products in the EU, Norway and Switzerland.

Conclusion

Duplex stainless steels still comprise less than 1% of all stainless steels made, though this proportion is rising fast. For the duplex stainless steel sector is a growing industry with strong prospects for continued rapid growth. Having expanded away from its traditional oil & gas and (petro)chemical base, it is moving into other segments such as biofuels, architecture and (waste)water. The future growth of duplex depends largely on the health of these industries, and also on other factors, such as the performance of the high-growth "BRIC" economies and the spread of knowledge and development of technology, particularly with regarding to welding and fabrication. Even bearing these limiting factors in mind, the future for duplex looks promising.



Lean duplex rebar was used on the Gateway Upgrade Project in Brisbane, Queensland, Australia.

Duplex serendipity

The emergence of duplex stainless steel owes much to the work carried out by French metallurgists in the 1930s. One alloy was the result of a happy mistake. Some time in the mid-1930s a workman at J. Holtzer Steelworks was processing an austenitic steel when he accidentally added too much chromium. The result was the duplex alloy 21Cr-7Ni-2.5Mo, for which the company later obtained a patent.

Duplex, super duplex and hyper duplex

What is the difference between these three? It all has to do with the pitting resistance equivalent (PRE or PREN), which measures resistance to pitting corrosion. The usual way to calculate an alloy's PRE number is to apply the formula PRE = Cr + 3.3Mo + 16N, though variations of this formula exist.

Alloys with a PRE of more than 40 are considered super duplex; SAF 2507 SD has a PRE of 42.5. A grade is called "hyper duplex" if its PRE number is 48 or more; SAF 2707 HD has a PRE of 48, and SAF 3207 HD has a PRE of 50.

Notes

(1) Marcus Moll (SMR) "Stainless Steel End Use Analysis", www.outokumpu.com/43888.epibrw

(2) Figures supplied by the ISSF based on a poll of its membership, which represents 75-80% of world stainless steel production, presented in M. Kobayashi, "Duplex statistics 2008". My thanks to Jo Claes of the ISSF for allowing me to view me this document.

(3) Jean-Christophe Gagnepain, "Duplex stainless steels: success story and growth perspectives", paper presented at the Stainless Steel World America 2008 Conference & Expo, Stainless Steel World, December 2008. The other figures are: CMP (coils) 12%, cold rolled 12%, long 5%, tubes 5%, other 4%.

(4) Figures supplied by the ISSF poll of its membership, referred to above. It should be noted that the figures for non-members are not taken into account and that, according to Pascal Payet-Gaspard, Secretary General of the ISSF, the USA is under-represented in the ISSF's membership.

(5) www.outokumpu.com/pages/Page____40985.aspx.

(6) www.outokumpu.com/pages/Page____40983.aspx.

(7) www.outokumpu.com/pages/Page____41764.aspx

(8) www.rolledalloys.com/trc/viewdoc.aspx?n1=corrosion&n2=LDX2101_CH_USA.