

A steel for all seasons: duplex expands its range

The Helix Bridge in Singapore was made with carbon steel and duplex stainless steel grade 2205.

The proliferation of new grades of duplex stainless steel and new modes of processing and fabrication has not yet led to an increase in the market share of duplex grades. Yet a number of industries that are stable or growing provide numerous opportunities for duplex stainless steel use. These include ships and boats, architecture, wind power and above all offshore oil and gas. Consumption of duplex is likely to pick up and gain market share once Europe's economy recovers and if China's growth rate resumes.

By James Chater

Introductory

For reasons that are hard to explain, consumption of duplex stainless steels remains stuck at only about 1% of the total stainless steel consumed. This is despite its intrinsic qualities, new and growing applications, new grades coming onto the market, and new manufacturing techniques.

Demand led by offshore

Demand for duplex grades continues to be led by the offshore oil and gas industry. A number of suppliers are positioning themselves to take advantage of the offshore boom. Much of this activity is taking place in the UK, where the North Sea is the focus of attention.

Recent projects involving duplex

ABJ has completed fabrication of two multistage flash-type evaporators for Takreer's Carbon Black & Delayed Coker project in Abu Dhabi. The evaporators were made of duplex stainless steel.

Outokumpu secured a contract to deliver 22,000t of duplex 2205 to a natural gas field project in Oman, the largest duplex contract in the company's history.

Technip Umbilicals has awarded Vallourec a contract for Total's Edradour project in the UK North Sea. Part of this order consists of super duplex welded tubes for umbilicals.

Civmec has been awarded a contract by Technip in Australia for the fabrication and testing of 68 subsea jumper spools for the Chevron-operated Wheatstone Project. This contract consists of the fabrication of pipe spools of various materials such as CRA Inconel clad pipe, super duplex and carbon steel.

Stalatube has selected Outokumpu's LDX 2101® duplex stainless steel as one of the main construction material for its new StalaWind wind power towers.

Outokumpu delivered 40 tonnes of duplex grades 2507 and 2205, and 254 SMO® and 316L stainless steel grades for two flue-gas desulphurization units designed by Valmet (formerly Metso) to reduce sulphur emissions on ships.

Outokumpu delivered about 4,000tns of LDX 2404 duplex stainless steel for the Husab uranium mine project in Namibia, Africa.

PVI Industries selected Outokumpu's lean duplex grade LDX 2101 to replace carbon steel in its water heaters.

Baosteel Special Steel supplied Shanghai electric with duplex stainless steel plates for desalination equipment. It is the first Chinese desalination desalination project to use domestically produced materials.

Here, John Bell Pipeline Equipment Company invested in a significant order of duplex and super duplex pipe, fittings and flanges to satisfy the demands of the subsea oil and gas market. British pipe manufacturer IPP Group has completed a new Tee press with 7,000 tonnes of forming capacity that can make wall tees from seamless and welded pipe and hollows in duplex, super duplex, nickel alloy and all stainless materials. Another British company, PipXtra, has added seamless duplex pipe in UNS 31803 from ½"NB to 8"NB to its stock. Finally, the UK North Sea saw Vallourec win an award from Technip for umbilicals made in super duplex stainless steel for the Total-operated Edradour project.

Pipe fabrication at Sosta

Other offshore hotspots include Australia and Brazil. In Australia, the booming LNG industry is stimulating duplex sales. Civmec has started to build a specialised subsea facility for exotic materials at its waterfront facility located in Henderson, Western Australia. The same company won a contract from Technip for 68 subsea jumper spools for the Chevron-operated Wheatstone Project. The pipe spools will be fabricated in various materials, such as CRA Inconel clad pipe, super duplex and carbon steel with pipe sizes ranging from 6" up to 44" in diameter. Shell's Prelude FLNG project will make use of coated duplex (see box).



Pipe fabrication at Sosta: (1) forming on the press brake, (2) welding the inside and (3) finished pipes. Sosta manufactures welded stainless steel pipe for the oil and gas market. Its pipes are used in gas exploration and liquefied natural gas plants and terminals.



Sandvik corrosion-resistant products displayed at the Rio Oil and Gas Expo and Conference 2014.

In Brazil, Raccortubi recently set up a subsidiary. Petrobras has just awarded the company with approval of its butt weld fittings.

In July 2014 Deutsche Edelstahlwerke (DEW) inaugurated a new secondary metallurgy centre in Witten, Germany,

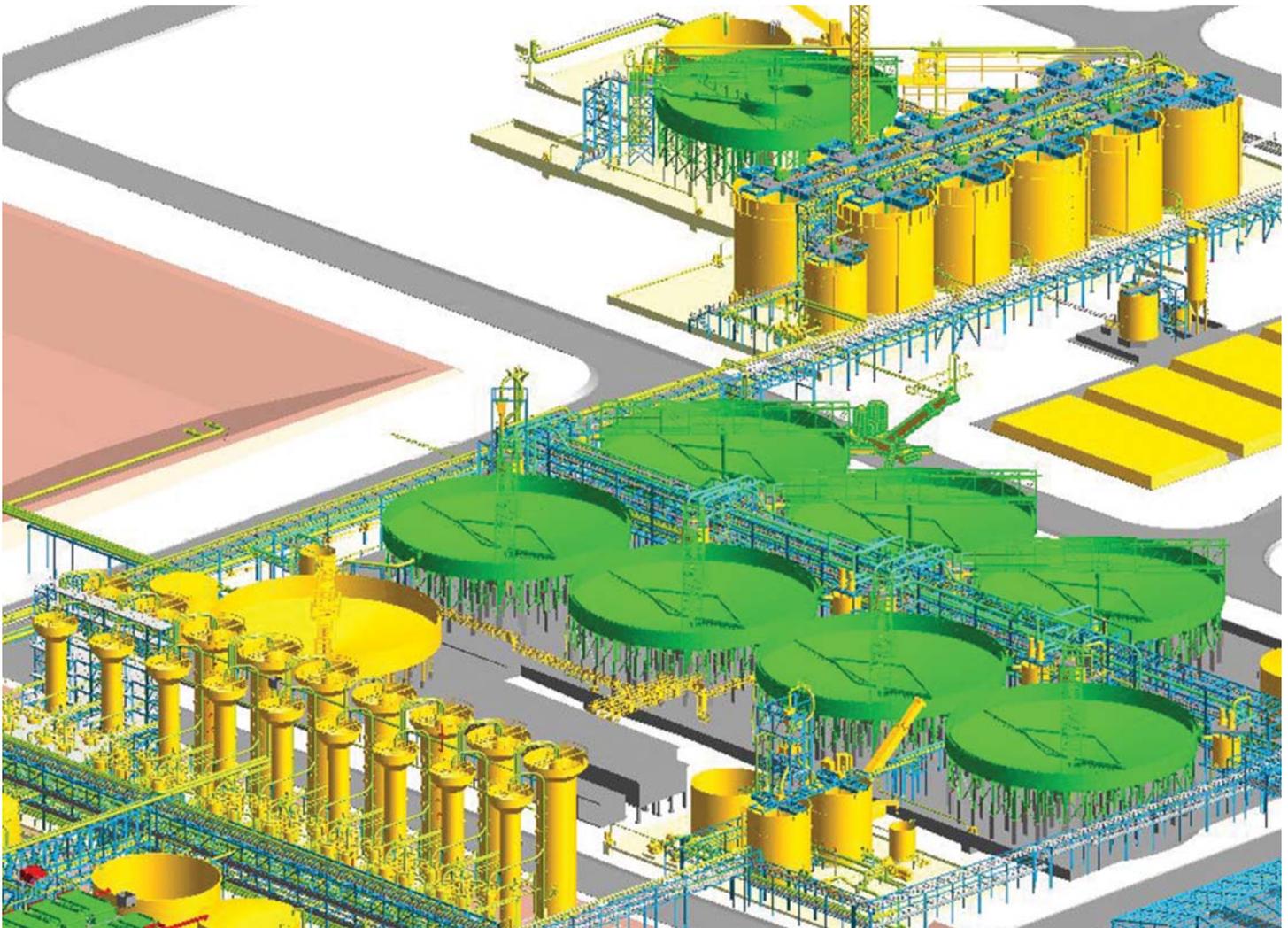
where duplex and super duplex goods for the offshore industry, among other products, are manufactured. Last October Sandvik established a new oil and gas business unit in order to market its duplex and nickel-alloy products for the offshore industry.

Other industries

Chemical tankers and boat construction are also areas where duplex use is expanding. Last year Japan approved use of duplex NSSC 2120 on chemical tankers, replacing austenitic grades. In Sweden, a small boat has been developed using with super duplex 2507 supplied by Sandvik and Outokumpu. The hull and superstructure of the boat weigh about a third compared to common steel boats. Because painting is unnecessary, no maintenance is required.

Duplex has also found use in wind turbines. These are being built to ever larger scales to increase efficiency and take advantage of the more powerful winds available at higher altitudes (1% increase in output for every metre over 100 metres high).

For this application Stalutube has designed a special StalaWind tower made of hollow tubes made of the lean duplex grade LDX 2101®. The structure is not only strong, but its lightness makes it easier to transport and instal.



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Architecture and infrastructure are also fields where use of lean duplex grades can be expected to increase. This is indicated by the fact that LDX 2101® (EN 1.4162) and LDX 2404® (EN 1.4662) were recently approved by the German national building authority, the DIBt. Manufacturers of building and construction components can now use lean duplex grades without applying for a specific approval for the manufactured component. The approval covers lean duplex coil and plate products up to and including 30mm thickness and bar products up to and including 40mm diameter as well as all components manufactured from these materials. In September of this year Taiyuan Iron & Steel (Tisco) won a 2014 Metallurgical Science and Technology Award for its duplex stainless bar for cross-sea bridges.

New duplex grades

Customer demand is driving at least some of the development of new grades. Outokumpu's customers who were already accustomed to duplex expressed the wish for a grade with corrosion resistance equal to or greater than PRE = 28, but with greater mechanical strength than lean duplex 2304 and a lower alloy content

than grade 2205. The solution was an enhanced 2304 called EDX 2304™, with improved corrosion resistance and increased strength. Applications include offshore topside structural components (fire, blast and relief walls and doors; structural pipes, pipe supports and clamps; cable trays and ladders) and process vessels in the chemical industry.

Name	C	N	Cr	Ni	Mo	Other	PRE
2304	0.02	0.10	23	4.8	0.3	-	26
EDX 2304™	0.02	0.18	23.8	4.3	0.5	-	28

Name	C	N	Cr	Ni	Mo	Other	PRE
FDX 25™	0.022	0.23	20.2	1.4	0.4	Mn, Cu	25
FDX 27™	0.023	0.18	20.1	3	1.25	Mn, Cu	27

Duplex and coatings

The cost of developing offshore oil & gas reserves is rising sharply. According to a senior vice president at Statoil, subsea project costs doubled in the period from 2003 to 2014. Highly alloyed duplex grades add to these costs, so some operators are considering coatings of milder grades as an alternative. Thermally Sprayed Aluminium (TSA) has been found to mitigate stress corrosion cracking, hydrogen-induced stress cracking, pitting and crevice corrosion of 22% and 25% Cr stainless steels. TSA-coating on duplex stainless steels is being used in Shell's Prelude FLNG project. The same technique, which has already been used on carbon steels and austenitic grades, could be used to extend the life of offshore facilities. Equipment that could benefit from TSA is located topside on an FPSO, such as gas compressors, with associated piping and valves.

Outokumpu has also come up with two grades designed to overcome the limited formability of most duplex grades. FDX 25™ and FDX 27™ have improved fatigue properties and greater elongation than other duplex grades. The FDX grades have high strength and improved formability due to Transformation Induced Plasticity (TRIP). They are designed for use in heat exchangers, flexible lines,



StalaWind wind power towers in winter.

pump components, auto components, domestic heater piping and beer kegs.

New fabrication techniques

The FDX materials were made possible thanks to TRIP, a technology already used in carbon steels to combine strength with ductility. Another technique that is affecting stainless steel fabrication is 3D printing (additive manufacturing). But whereas its impact on the fabrication of nickel alloys and titanium alloys is very evident, it is difficult to say if it will affect duplex stainless steels to the same extent. But the signs are encouraging. High density powder metallurgy duplex stainless steels can be produced by mixing water and gas atomized powders. Tests have shown that this process has a positive effect on density and strength. Advanced technology – electric arc furnace (EAF) in concert with Argon Oxygen Decarburization (AOD), High Performance Atomizing (HPA) and hydrogen annealing – allows greater quantities to be melted compared than

with an induction furnace, thereby improving the consistency of the product.

Super duplex flanges have been produced by means of 3D printing, and Sandvik produces various stainless steel goods using gas atomized metal powder designed for 3D printing. With this method Sandvik had made products in duplex 329 and 2507 SD, among other alloys and steels.

Conclusion

Given the expansion of applications that a wider range of duplex products and new fabrication techniques permit, it is surprising that duplex still accounts for a mere 1% of all stainless steel use – down from 1.1% in 2013 (Moll). Why is it not more?

Marcus Moll has identified some possible hurdles to growth, such as insufficient range of product forms and dimensions, limited price advantages and marketing failures (duplex still marketed as a “technical” product rather than a commercial solution).

Nevertheless, he expects duplex to grow by as much as 7-8% per year until 2018.

Another possible answer is that it is too soon to tell. Traditionally, interest in duplex has been much higher in Europe than in the Americas, and it is in Europe that the economy is especially stagnant. Once Europe recovers from its doldrums, the duplex share could increase. But it is equally possible that growth will be led by south-east Asia, where four out of the five top producers are located. When China’s growth rate picks up again, this will possibly trigger a rise in duplex consumption.

Sources consulted

Marcus Moll, “Development in the (European) STS Market: Focus on Duplex Steels”, Duplex Seminar & Summit 2014; Anthony Pearson, “Application of duplex stainless steel for floating LNG”, Duplex Seminar & Summit 2014; www.outokumpu.com; www.sandvik.com; www.sassda.co.za