INTERNATIONAL MOLYBDENUM ASSOCIATION
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Lighter and safer offshore platforms

Offshore oil and gas platforms see some of the most demanding environmental conditions for construction materials anywhere. Exposed to extreme weather, wind and waves, these structures must operate safely for decades. The most challenging sites are located in or near the Arctic oceans, where frequent storms intensify the extremely corrosive exposure to seawater. Molybdenum-containing alloys, especially duplex and super duplex stainless steels, last longer than almost all other materials in these difficult situations. One small but critical example is super duplex bolts.

Offshore platforms produce and process oil and gas from a well in the seabed. They are basically chemical plants placed in the middle of the ocean. They often contain all the equipment necessary to make them self-sufficient, including power generation, water desalination and crew accommodations. All of this is squeezed into the smallest amount of space possible. Platforms should also be as light as possible, to minimize the size of support and anchor structures. The pumping and processing of oil and gas requires many miles of pipes in addition to the processing equipment itself. The pipes are typically flanged together, using hundreds of thousands of bolts. Traditionally, these bolts have been made of hot dip galvanized (HDG) steel.

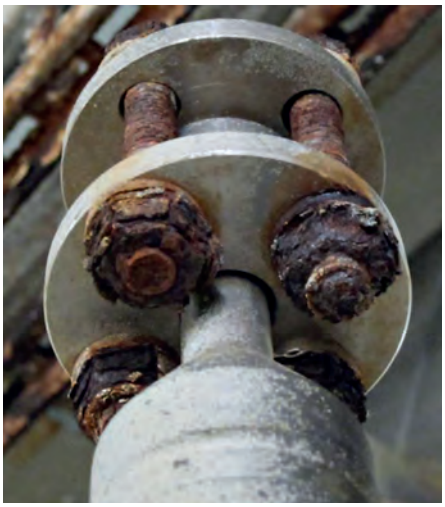
The Johan Sverdrup riser platform jacket being installed. © Jan Arne Wold/Statoil

Material selection for oil platforms

The Norwegian oil company Statoil is currently developing the Johan Sverdrup oil field on the Norwegian Continental Shelf. It is one of the region's largest oil field discoveries in recent times and will become by far the North Sea's largest producing oil field when both phases are operational from 2022 on. The oil field has a life expectancy of 50 years. This long expected life and the need to keep the platforms as compact and light as possible, drive the material selection for the project's structures, equipment and piping.

The company's experience with other oil fields in the North Sea showed that traditional bolting, in particular, suffered from corrosion problems and the lifetime of these HDG steel fasteners turned out to be limited. The protective zinc coating typically lasts about 8 to 10 years, after which the steel fasteners themselves begin to corrode. The total lifetime of this type of fastener, when exposed to marine environment, is therefore only about 15 years, but properly working fasteners are crucial for safe, reliable, and environmentally secure operation of the complex piping systems.

Because of this, and because the expected useful life of older platforms has been extended thanks to improvements in technology and oil recovery, thousands and thousands of fasteners have to be replaced, as they come to their end of life. ›



Hot dip galvanized bolts suffer from corrosion when exposed to the severe marine environment on a platform. © Statoil

The Johan Svertrub oil platform is scheduled to start production in 2019. © Statoil

Super duplex bolts and nuts of different sizes. © Bumax

This is a huge undertaking, extremely expensive and disruptive for the operation of the platform. To avoid similar work in the future, Statoil is replacing the HDG bolts on the older platforms with super duplex stainless steel bolts.

For the Johan Sverdrup project, with its 50-year life expectancy, duplex stainless steels were specified from the beginning. Lean duplex stainless steel is used for a variety of structural elements such as cable trays, pipe supports and other secondary structures which are not exposed to high temperatures. Its benefits include longevity, low maintenance and weight reduction. Weight management is the most cost-critical issue when building platforms. Higher weight on the topside of the platform requires the use of crane ships with higher lifting capacity, which increases the cost significantly. Conversely, a lighter topside also allows for a smaller, lighter, and therefore lower-cost support structure underneath.

Standard 2205 duplex stainless steel is used for piping that carries condensate, oil and gas; super duplex alloys, meanwhile, have been selected for pipes carrying seawater as well as for caissons and umbilical tubing. The duplex stainless-steel piping in this enormous project spans diameters from 50 to 500 millimeters. The super duplex fasteners which connect the flanged joints range from 12 to 36 millimeters in diameter.

Super duplex stainless steel

Super duplex alloys provide high strength and very good resistance to several different forms of corrosion. The latter can be largely attributed to the 3.5% molybdenum typically contained in these grades. As a result, super duplex stainless steels are found in seawater environments, fluids with high chloride contents, and acidic chemical processes. They are increasingly used in oil and gas, desalination, power generation, marine industries and other corrosive applications.

Duplex and super duplex stainless steels have twice the yield strength of solution annealed austenitic stainless steels such as Type 304 or 316 and are stronger than the work hardened versions of these grades, which are typically used in offshore applications. They also have good ductility and toughness down to temperatures as low as -80 °C, an important consideration in the Arctic or far North.

Beyond the oil field and into the future

Super duplex fasteners have recently also found application in energy projects beyond oil and gas, in the emerging field of offshore wind turbines. At the Greater Gabbard Wind Farm, located in the North Sea, 23 kilometers off the coast of England, 140 offshore wind turbines have UNS S32760 super duplex fasteners. The Humber Gateway Wind Farm, also located in the North Sea, uses over 50,000 of these bolts to fasten turbine components. These operations encounter many of the same problems facing offshore oil: a corrosive marine environment and the need for high-strength alloys to reduce weight, maximize efficiency, and guard against environmental disasters.

Offshore technology is evolving to supply the world's energy needs with greater efficiency, safety, and environmental protection. At the same time, the different types of duplex stainless steels have become an ever more important factor in the design decision. They have excellent resistance to multiple kinds of corrosion, high strength, and good ductility and toughness. They therefore last throughout the life of a project with minimal maintenance and enable lighter, more cost-efficient designs, more than recouping their higher initial cost. In these technologies, molybdenum shows its merit by helping to create the unique properties that makes these sophisticated materials so desirable. (Nancy Baddoo, John Shields)

Super duplex bolts are also used on offshore wind turbines. © West Special Fasteners