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.

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