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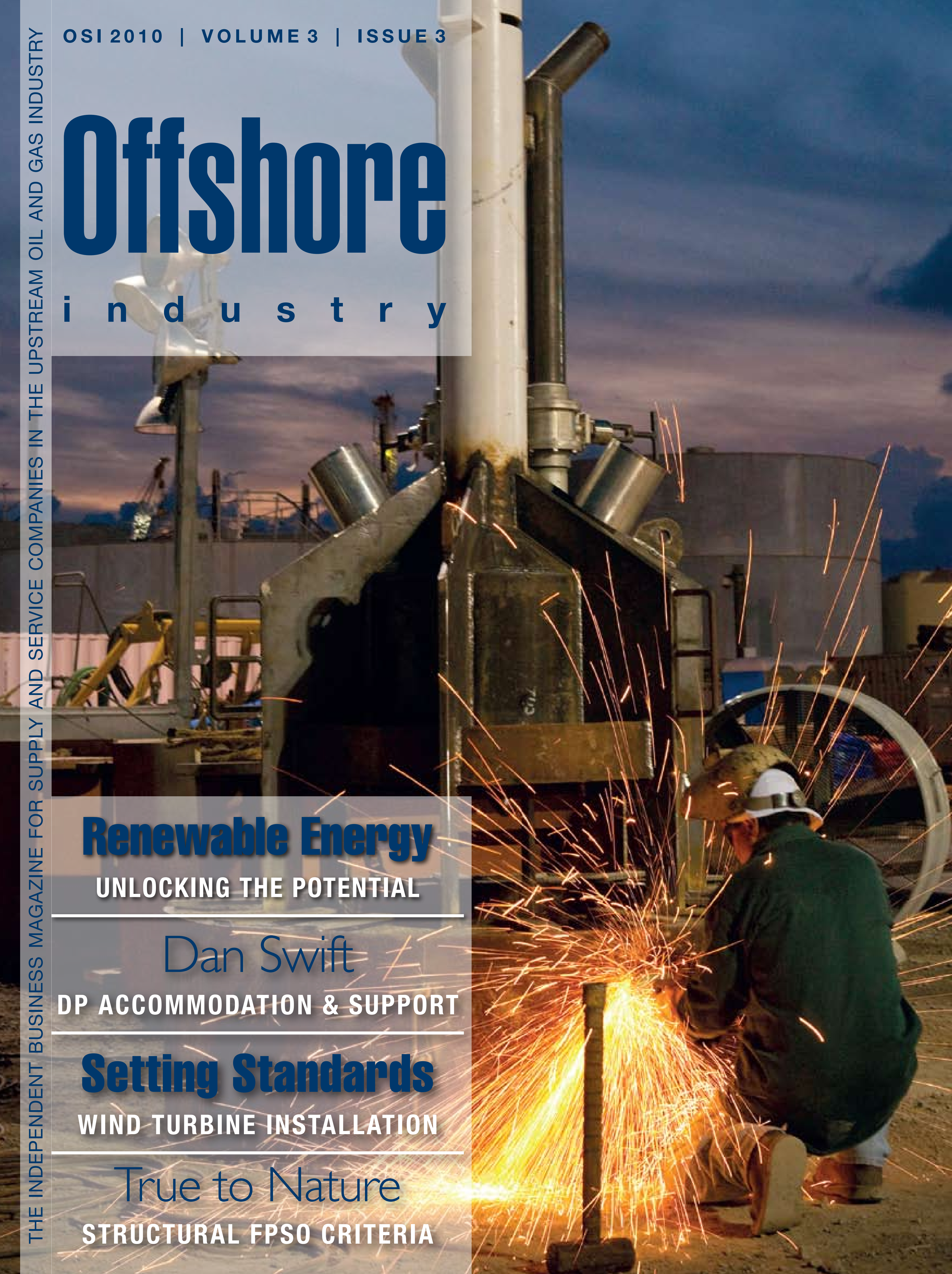
Offshore industry

THE INDEPENDENT BUSINESS MAGAZINE FOR SUPPLY AND SERVICE COMPANIES IN THE UPSTREAM OIL AND GAS INDUSTRY



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Corrosion Protection

The Intelligent Way

Cathodic protection is a familiar technique for controlling the corrosion of metals. It has been used successfully for more than 100 years. It does, however, require the presence of a conductive fluid, such as water, known as an electrolyte. A well-known example of this type of protection is the attachment of zinc anodes to a ship's hull in order to protect the steel from seawater. The anodes sacrifice themselves for the benefit of the steel as the electric potential of zinc is lower than that of carbon steel. This is in fact a desirable way of galvanic corrosion.

Protection Current

The object to be protected is known as the cathode and the anode supplies the required protection current. The anode can be either a sacrificial anode or an impressed current one connected to a power supply that is also known as an impressed current cathodic protection (ICCP) system. The design principles for both systems are the same. If the voltage or potential and resistance of the system are known, the protection current can then be calculated using Ohm's law. With sacrificial anodes, the potential is measured by inserting a voltmeter between the cathode and a reference electrode. The most commonly known standard for calculating the resistance and the design for cathodic protection is the Norsok RP B401 standard. The calculated protection current can vary from a few dozen milliamperes for small anodes to several amperes for large anodes. The latter are used, for example, to protect offshore constructions or quay walls. The service life of an anode can be calculated on the basis of the capacity of the anode and the protection current. A sacrificial anode usually has a design life of between 10 and 30 years.

Intelligent Anodes

In addition to the above known anodes, intelligent or self-switching anodes have been developed that are able to deliver an exceptional, controlled performance. Although these anodes are classified as sacrificial anodes, electronic circuits and semiconductors enable them to do precisely what is expected of them. This means that no over protection or under protection can occur as is the case with ordinary anodes. This makes it possible, for example, to apply cathodic protection to the systems of ships, which sometimes sail in fresh water and sometimes in brackish water or seawater. This would be impossible using conventional methods. Another advantage is the absence of malfunctions or broken wiring which are regular occurrences with impressed current systems. It is also considerably cheaper than impressed current systems and also requires no maintenance. At present, thousands of intelligent anodes have already been successfully used in the protection of duplex stainless steel as well as to protect austenitic, ferrite and martensitic stainless steel. As there is

Cathodic protection is applied to control metal corrosion. A well-known example is the attachment of zinc anodes to a ship's hull to protect it from corrosion. Ko Buijs outlines the procedure of corrosion protection of the cathode (the object to be protected) by using either a sacrificial anode or an impressed current – a kind of protection that can also be adapted for protection of offshore structures.

no risk of over protection, hydrogen embrittlement cannot occur, which is often the case with conventional methods. Even when cathodic protection methods are used on steel constructions at sea, such as steel caissons with seawater lift pumps made of bronze or stainless steel, care must be taken to avoid over protection as undesirable hydrogen development can ultimately cause nearby duplex welds to crack. The same applies to undersea duplex pipes, which can be subject to excessive negative polarisation due to the protection system of the steel platform. All these problems are completely eliminated if intelligent or self-switching anodes are used. In addition, there is no risk of under protection, which in turn can also lead to undesirable corrosion.

Control of Fouling

Allowing the current of the intelligent anodes to pulsate causes the pH value (degree of acidity) to fluctuate. This helps prevent micro-organisms from settling on metal surfaces. In this way, fouling can be controlled and microbiological corrosion prevented. This method is already being used successfully with impressed currents on underground pipelines. The effectiveness of using pulsating anodes in seawater coolers in order to control fouling is currently being studied. The results that have already been obtained are more than encouraging. It has already been proven that pulsating anodes perform well when it comes to corrosion protection. As stated earlier, these intelligent anodes have also been shown to work well with less conductive types of water. A system has been developed for river water and swimming pool water to protect appliances manufactured from AISI 316L stainless steel. It is also extremely convenient with these types of applications to eliminate the need for high-maintenance wiring, which also means no maintenance. Apart from an annual check, the sacrificial anodes only need to be replaced at very long intervals of years. Intelligent sacrificial anodes can also play an important part in providing protection where water conductivity levels vary, which is the case in most seaports.

Cost Saving Potential

Studies are currently being conducted into whether pulsating anodes could also save on costs. Quay walls and tubular poles often involve projects that can sometimes require investments amounting to millions of euros. As a consequence, doubling the service life or halving the weight of the anode could work out particularly advantageous in terms of cost price. In principle, these aspects can be achieved with the use of intelligent anodes. This method of cathodic protection is patented and is registered in the name of Corrodium b.v. For the sake of convenience, the anodes are also known as Corrodium anodes. To sum up, it can be said that these types of anodes offer tailor-made protection. As a result, there is no over or under protection, which both have significant disadvantages. A good example is a seawater lift pump with a conventional protection system, which is subject to over protection when idle and under protection as soon as it is put into operation. This is not the case with intelligent anodes as the correct current density is constantly supplied for optimum protection against corrosion. The system also adapts itself to variable conductivity levels of the water type, which may vary from fresh water to seawater without causing problems such as hydrogen blistering under the coating. This is often the case with ships that frequently sail in coastal waters.

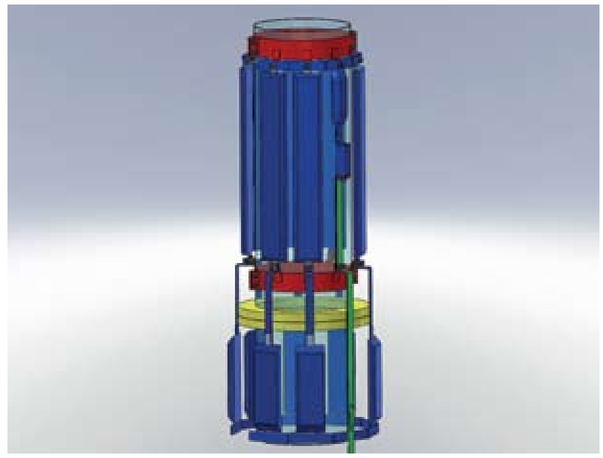
Offshore Environment

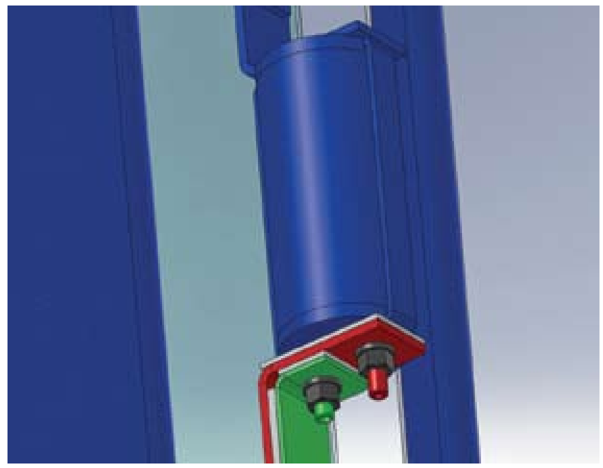
Severe galvanic corrosion of seawater lift pump caissons is a problem that is recognised worldwide. This kind of material damage leads to high cost for repair. On FPSOs the oil tanks are contaminated with seawater in the suction side and the seawater will be contaminated with oil in the pressure side. Also the corrosion can lead to structural disfunctioning. One of the images in this article shows a duplex stainless steel seawater lift pump. During operations the pump hangs on the duplex stainless steel riser, vertically in a steel caisson. Cathodic protection with ICCP in this case is very expensive and can be very unreliable. Cathodic protection with sacrificial anodes leads either to under protection when the pumps are running, or in stagnant condition to over protection, leading to hydrogen embrittlement of the duplex stainless steel. Also pitting corrosion of duplex stainless steel or nickel aluminium bronze near the hypochlorite injection point often occurs.

Corrodium Intelligent Anodes

Corrodium anodes control themselves on a set-potential, depending on situation, adjustable from -400 - 1000 mV SCE (Saturated Calomel Electrode). The system does not require a power supply, or batteries, as the anode itself is the battery. If welded to the construction, or if installed with static components such as a resistor or diode, the protection potential always will fluctuate. Corrodium intelligent anodes have been tested intensively and work under all circumstances. Automatic potential control will occur at changing conductivity of the water (in coastal areas), changing flow regime (e.g. seawater lift pumps On or Off), changing temperature (seasonal change) or any other resistance change: the anode will always maintain the ideal protection potential.
On growing human activity in coastal areas and offshore at sea, applications are numerous:
- seawater lift pumps – the caisson is protected, cracking of (stainless steel) welds will not occur;
- ROVs and other robotic subsea systems;
- subsea Christmas trees;
- complex structures on and around FPSOs;
- protection in ‘dead ends’, not reached by the existing impressed current system.

Today applications of this unique method of corrosion protection can be found in all sectors of the offshore industry. They are frequently encountered on oil and gas platforms. Typical examples include the protection of heat exchangers, pumps, valves, tanks, vessels and also pipeline systems. This method of protection has been used to stop corrosion mechanisms in the cooling systems of vessels and in seawater-cooled ammonia coolers to cool the casings of blast furnaces. These applications also take advantage of pulsating currents to counteract the formation of dreaded bio films. Other applications can mainly be found in systems cooled with freshwater, swimming pools and in sewage purification installations. Due to the lower conductivity level of the water, switched magnesium anodes are usually used in these cases.





Multifunctional

In other words, galvanic corrosion is also controlled here, since there is a relatively large potential difference between carbon steel and duplex stainless steel. Moreover, this type of protection system also uses a so-called reference electrode. When this electrode acts as a sensor, the electronics maintain the potential at an ideal level under all conditions, without loss of power or capacity of the anode. If a variable system needs to be protected, such as a ship that sails in both freshwater and seawater, magnesium anodes are chosen as the conductivity of river water is relatively low. Normally, this type of anode would get out of control in seawater as magnesium is such a base metal. This would then lead to significant hydrogen formation at the cathode, resulting in the development of blisters under the coatings. This phenomenon is known as ‘hydrogen blistering’. As intelligent anodes are smart, the electronic circuit will cut off the current, allowing the magnesium anode to continue functioning normally in seawater. In other words, as soon as the resistance changes, the electronics regulate a constant current. This is exactly why these types of anodes are so multifunctional.

i. www.corrodium.nl
i. www.innomet.nl