

## Water Treatment and Corrosion protection for the Offshore Industry

Antifouling • Desalination • Cathodic Protection



Guldager offers solutions for the Offshore sector. Experience, knowledge and highly qualified staff members ensure the supply of plants of consistent, high quality.

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## Compliance with standards and international legislation

During the past 20 years Guldager has delivered several antifouling and potable water units to the off-shore oilindustry. The plants are constructed to fulfill the very high quality requested by international and company standards and legalisation, e.g. ATEX and PED directive in the EU, or API and required local standards.

The equipment is designed to work safely and reliable in harsh weather conditions and under the special safety conditions on a platform where accidentally leaks of gas may under no circumstances ignite and lead to a fire or explosion.

## Antifouling

Thousands of species of algae, mussels, polyp, and other seawater organisms, will propagate, develop, get attached to, and grow on surfaces, where the environment provides favourable conditions.

Shellfish will enter into a cooling system as larvae. They are microscopically small, and wherever the conditions of life are favourable – i.e. temperature, water circulation, nourishment etc. – they will attach and develop. The marine growth may be seen both growing in a colony as well as single animals. After some time, parts of the colony may fall off and establish colonies elsewhere and may cause inconvenience, e.g. by fouling pumps and pipes. Also, the construction material is exposed for bioinduced corrosion, where the growth has been situated.

The marine growth, especially mussels, may double within less than a day at favourable conditions of life. Therefore even big pipes may be clogged by mussels etc. after a short elapse of time.

The clogging of sea water pipes on a platform is serious. In the best scenery production may be disturbed leading to significant losses, but more seriously the fire water pipes may be clogged, which potentially can lead to an accident on the platform.



### The Effect of Copper

To prevent marine growth, 5-10 µg/l copper is sufficient in cold waters like the North Sea, whereas higher concentrations may be applied in warmer waters.

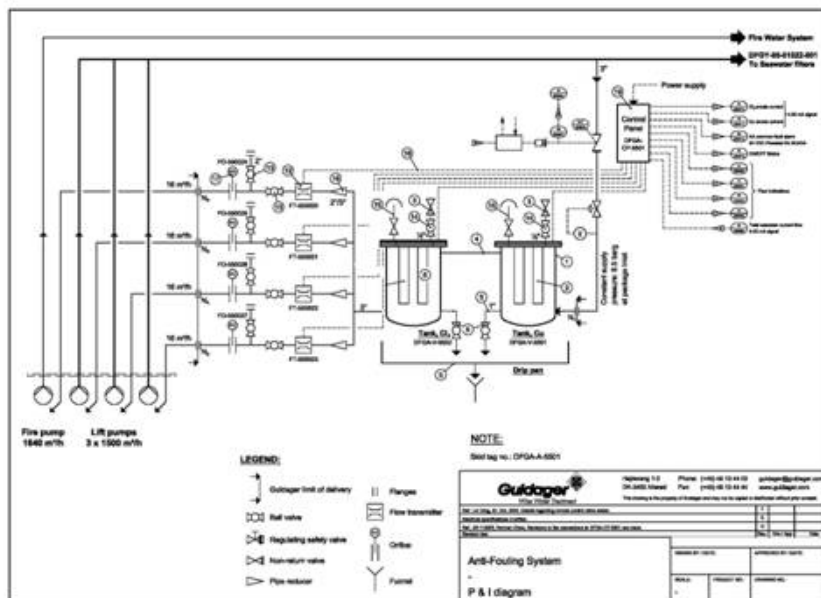
Monovalent copper ions  $Cu^+$  are released around the anode. The ions react with the dissolved oxygen in the seawater and builds monovalent copper oxide. This copper compound is especially effective for the prevention of marine growth. The compound is unstable and will convert into the less efficient copper dioxide that is practically indissoluble in seawater with neutral pH. The natural copper content in seawater is 10-25 µg per litre and consist of the divalent copper oxide.

### The Effect of Chlorine

Chlorine is a bactericide and fungicide, and in combination with copper these are conducive to prevent marine growth from getting attached as well as growing. Chlorine possesses a special ability to penetrate areas with an already existing growth. The concentrations used are normally 50 µg/l in cold waters and more in warm waters.

### Synergy

Tests reveal that the combined dosing of both copper and chlorine has an enhanced effect which is more than just the addition of the effect of copper and chlorine. Thus a synergetic effect exists between copper and chlorine which the antifouling units from Guldager are taking advantage of. In this way, the same effect can be achieved with smaller antifouling units.



## Description of the antifouling unit - standard application

For a typical installation, the antifouling unit is placed topside, and is fed by a comparably small flow of seawater in a side stream from the main seawater pumps. The seawater flows through a tank equipped with copper anodes and subsequent a tank with surface treated titanium anodes, where the chlorine is produced. The concentrate from the antifouling unit is fed directly to the suction site of the main seawater pumps in the caissons, thereby keeping them free of fouling.

## Solution of Copper and Chlorine

The dissolving of copper is obtained by applying a constant current to the copper anodes. In principle, the current to the anodes is kept on a constant level during the entire operation period to obtain a constant copper concentration. During operation, typically after a year, the copper anodes are exhausted and will have to be replaced.

In the chlorine tank, the chlorine is formed by electrolytical oxidation of the chlorides naturally occurring in the seawater. Different species of chlorine in different oxidation states are formed, like e.g. chlorite and hypochlorite.

## Configuration

The plant is skid based and is delivered as one complete unit. The skid contains all necessary equipment, i.e. GRP vessels for the anodes, tubing, all necessary valves and instruments. The unit may be heat traced, insulated with e.g. glass foam and clad in SS316, as is the case for units delivered to the production platforms in the North Sea, but adaptation to the actual conditions e.g. warmer climate will be made in accordance with the actual requirements. The wet parts will typically be made in SMO 354 or GRP. The control panels may be placed on the skid or in a remote control room.

## Potable and Technical Water

Guldager has delivered several units for the treatment of potable and technical water for offshore platforms. The plants are made according to international and customer standards. The units are delivered as skid mounted plug and play units.

The potable water is made from the seawater in a desalination process, which includes several process steps:

- Sieve or rough filter in order to remove objects on makro scale that naturally occurs in the water.
- Chlorine treatment to reduce the microbiological activity in the water, as this otherwise will have a negative influence on the lifetime of the membranes.
- 25 µm filter to remove particles from the water.
- Carbon filter to neutralize surplus of chlorine as this will otherwise reduce the lifetime of the membranes.
- 5 µm filter as a police filter for avoidance of particles from carbon filter to enter the membranes and clog the fine channels in the membranes.
- Reverse osmosis unit where the water is passed through a membrane allowing only the water molecules to pass. The filtration takes place under relatively high pressure, 60 bars.
- The desalinated water is then typically treated with chlorine and/or a UV light aggregate in order to maintain a good hygienic quality.
- In order to improve the experienced quality of the water, it is often treated with dolomite chalk and CO<sub>2</sub> in order to adjust the hardness and pH of the water.



## Cathodic Protection

Steel structures can be protected from corrosion either with sacrificial anodes or by cathodic protection. By Cathodic protection a current at low voltage is applied to the steel thereby altering the potential of the steel and preventing it from corroding. The potential of the steel is continuously monitored by a patented reference electrode and the current is controlled by a full electronic power supply. This is important because the current needed to protect the steel varies according to local conditions and also changes with the age of the steel.

It is actually the same principal process that happens when a sacrificial anode is used. When the anode is dissolved it acts as a battery that produces a weak current, and it is the current that protects the steel. However, like a battery the anode will have to be replaced after some time and the current during operation cannot be controlled. The exchange of used anodes is often troublesome.

The advantage of cathodic protection is that the current can be controlled continuously using the reference electrode and that exchange of anodes is saved.

Cathodic protection can be used at all places where steel is in constant contact with water, e.g. steel structures, monopiles, vessels and water tanks.