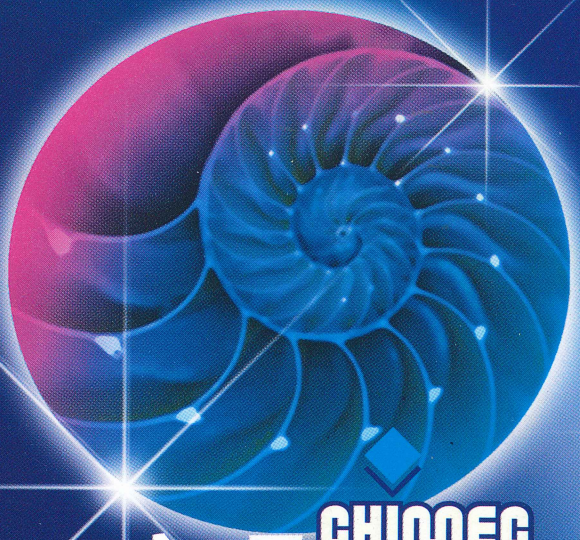

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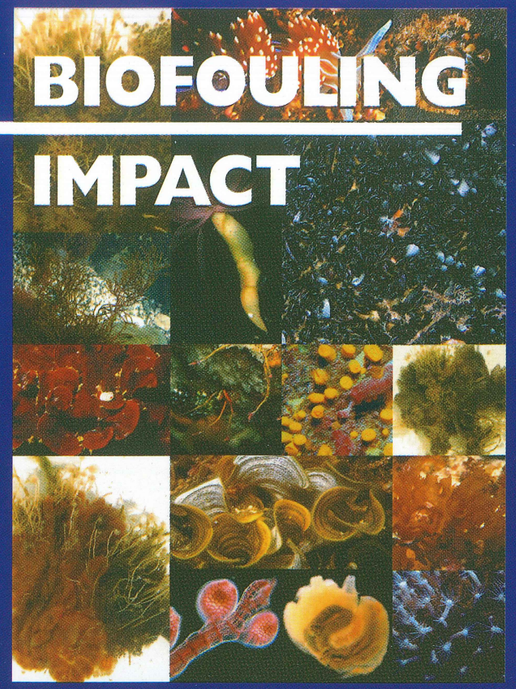
BIOFOULING IMPACT

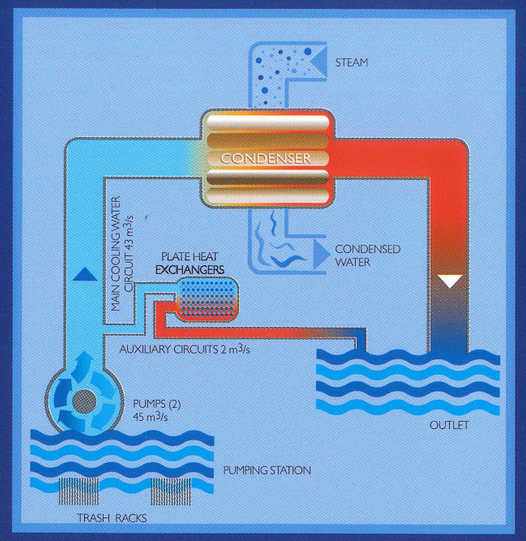


Many industries close to the sea use once-through or low-cycle cooling systems that draw seawater directly through intake bays, using a series of stationary or travelling screens with a 5-10 mm mesh to avoid the entrainment of small animals and fish.
But mussels and other planktonic larvae still manage to get through and attach themselves to the walls, pipes and heat exchanger surfaces of cooling sytems, which provide an ideal environment for marine organisms, owing to:

- **continuous water flow**
- **continuous food supply**
- **warm temperatures**

Biofouling in turn gives rise to:

- **a higher corrosion tendency**
- **increased heat transfer resistance**
- **a decrease in effective pipe or conduit diameter**
- **the blocking of heat exchanger tubes**



Biofouling control methods are based on the use of two different classes of antimicrobial or biocidal products:

- **oxidizing biocides** (chlorine compounds, bromine, ozone)
- **non-oxidizing biocides** (quaternary amine compounds, surfactants)

Chlorine compounds are widely used to control biofouling in sea-water systems, mainly owing to their low cost. Their function is to oxidize organic matter, causing toxic and lethal effects. Chlorine use is limited because of its negative impact on the environment involving the formation of **undesirable by-products** such as trihalomethanes and chloroamines.
Mussels detect chlorine and protect themselves by closing up for days or weeks, meaning that chlorine has to be dosed continuously.

Several **non-oxidizing biocides** have proven effective in controlling macrofouling. Quaternary ammonium compounds are widely used since, being undetected by mussels, dosage can be intermittent. Owing to their toxicity for living marine organisms, quaternary ammonium compounds have to be detoxified before being discharged into the sea.

SOLUTION

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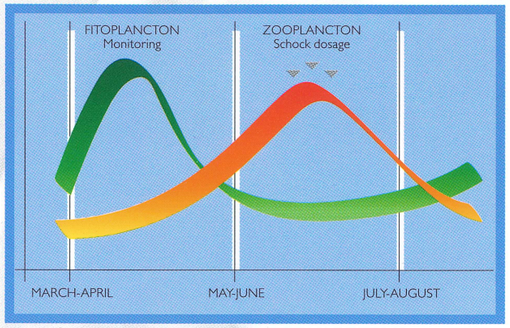


After two years' research, CHIMEC has patented an "environmentally-friendly" technical solution to marine biofouling: the **"NAUTILUS PROGRAM"**.
This complete package for the control of macrofouling in sea-water cooling systems includes:

- **a specific monitoring system for precise evaluation of the mussels' reproduction period and performance of the biocide treatment program**
- **an "environmentally-friendly" range of biocide products**

Advantages of the CHIMEC **"NAUTILUS PROGRAM"** are:

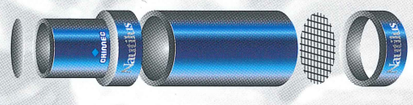
- optimum macrofouling control
- lower treatment cost
- zero or minimal environmental impact
- user-friendly technology

The monitoring system is the heart of the "NAUTILUS PROGRAM" and includes:

- **panels to identify and evaluate organism growth rate**

A NOVEL APPROACH TO MARINE BIOFOULING CONTROL:

- **a *CTD* probe to measure sea-water *Conductivity, Temperature, Depth* and chlorophyll concentration**
- **water filtration for larvae counts**



- **remote control of submerged structures by video**

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BACKGROUND

In seawater environments, cooling water systems and structures provide ideal surfaces for the proliferation and accumulation of biological organisms, forming organic deposits or biofouling. Biofouling is classified as either microfouling (surface colonies of bacteria, fungi and algae which, together with their by-products, form "biofilm"), or **macrofouling** (sedentary colonies of mussels and other invertebrates growing once the biofilm has formed).

Mussels and their larvae filter their food (phytoplankton) from water and their reproduction period is strictly linked to the abundance of this type of food.
The mussel reproduction period can be predicted by measuring the **concentration of phytoplankton** in seawater, which can in turn be evaluated by using chlorophyll concentration as an indicator.

Marine mussels, belonging to the family ***Mytilidae***, are the most commonly reported macrofouling bivalve molluscs.
Mussels living in temperate areas normally show a seasonal trend for reproduction and it normally occurs when the seawater temperature rises above 8-10°C.

SALVATORE SANGIORGIO COMUNICAZIONI VISIVE

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