



Congresso Internacional de
Corrosão, Integridade,
Pintura e Revestimentos
Anticorrosivos



What is marine fouling and how can coatings prevent fouling on offshore structures?

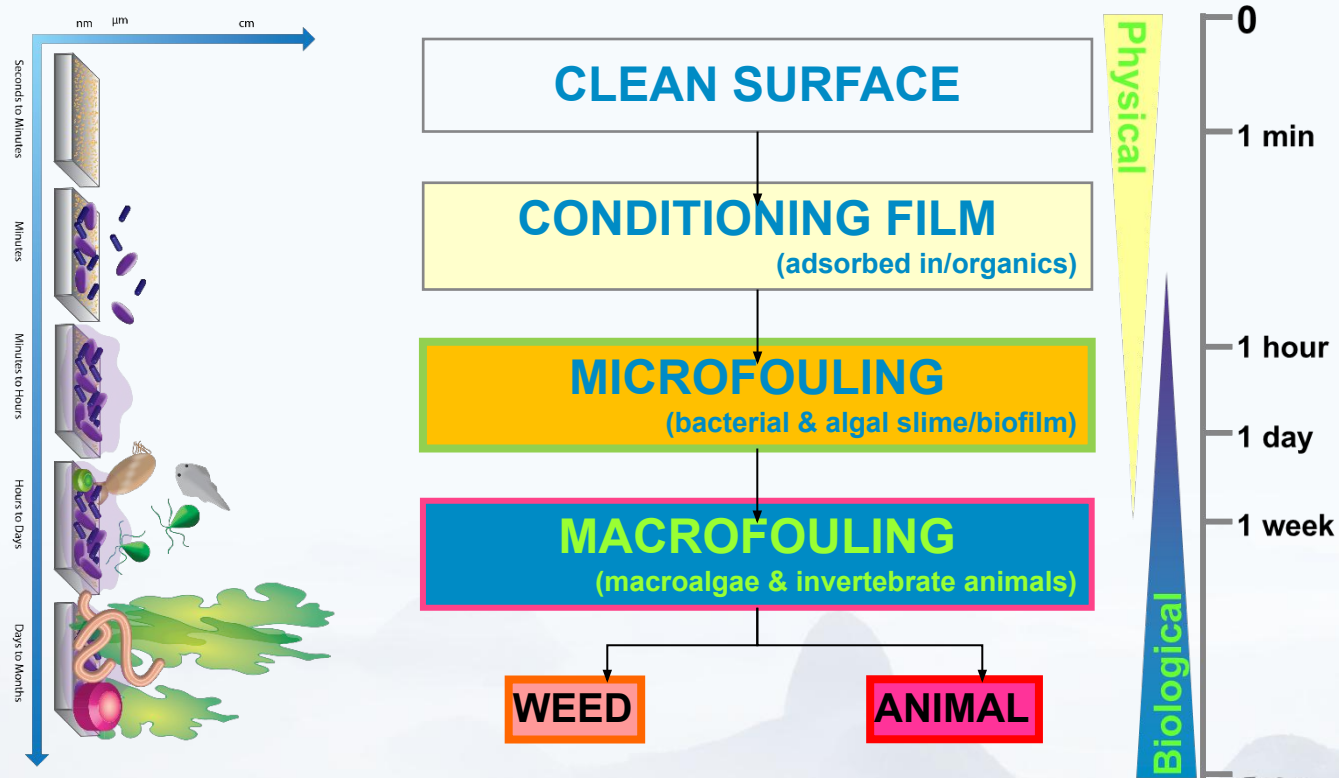
John Willsher International Paint



Agenda

- Different types of fouling & factors affecting growth
- Fouling control technologies
- Case study on Brazilian FPSO
- Future Developments

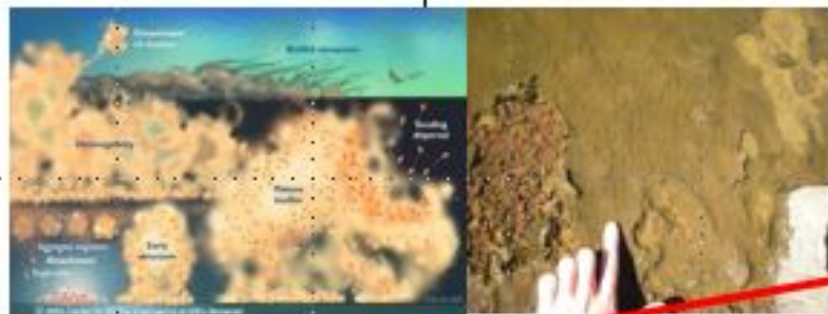
So what is biofouling?



Kirschner, C. M. and Brennan, A. B., *Bio-Inspired Antifouling Strategies*. Ann. Rev. Materials Research. 42(1), 211-229 (2012).

MICROFOULING

(bacterial & algal slime/biofilm)

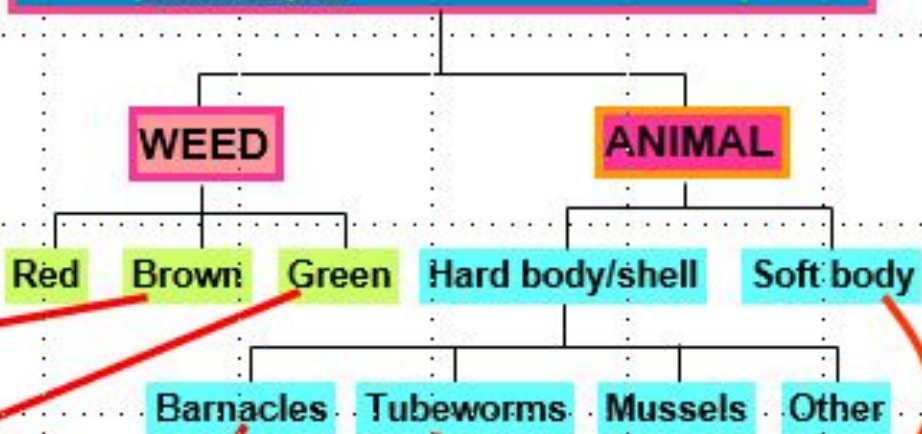


"Weed"



MACROFOULING

(macroalgae & invertebrate animals)



Barnacles



Tubeworms



Hydroids

The Fouling Problem

'The unwanted colonisation of marine/aquatic organisms on immersed substrates'



For offshore structures fouling can cause issues for hull surveys

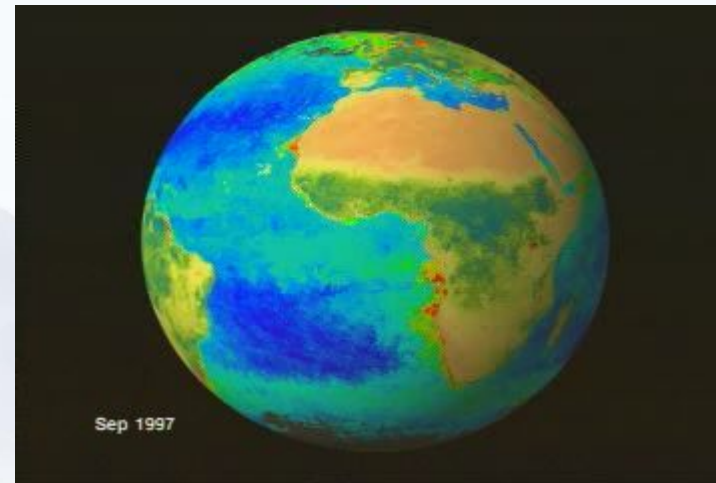
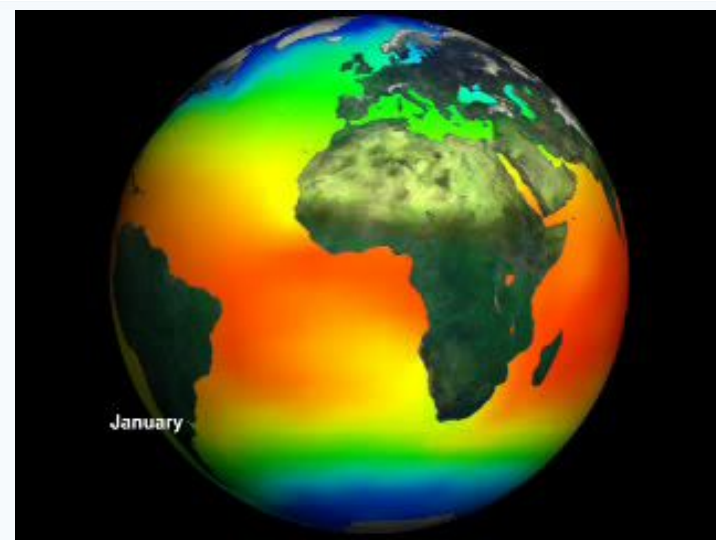
- High levels of fouling can be difficult to remove
- Expensive and time consuming underwater cleaning on station
- High costs for removal and disposal when the vessel enters dry-dock



FPSO Terra Nova entering dry-dock after 7 years off Canada (no fouling control system)

The fouling challenge

- The 'fouling challenge' depends on many environmental factors, including water quality, temperature, illumination, location and time of year
- Year-round severe fouling challenge in many tropical locations (including Brazil), especially in-shore/coastal waters with high nutrient levels
- Severe seasonal fouling even at low or high latitudes
- Fouling challenge generally highest for static objects and located in high fouling coastal environments

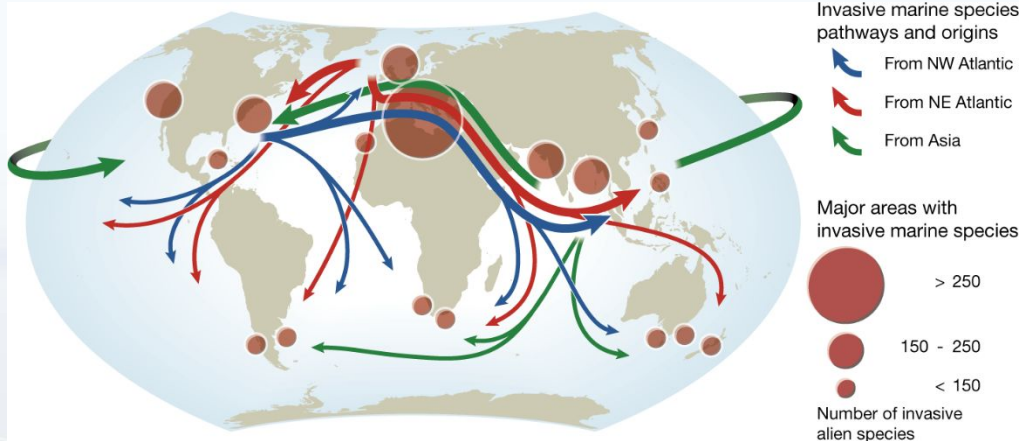


Surface chlorophyll a (Credit: NASA)

Invasive Species

Transferred via fouled hulls
and ballast tanks

Can have devastating
effects on native
population



Sun Coral - Brazil

Tubastraea coccinea

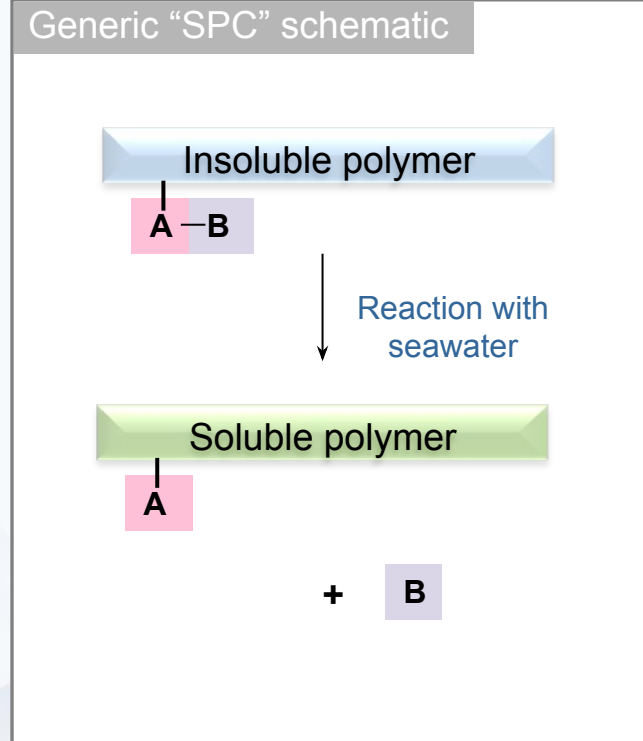
Tubastraea tagusensis



Antifouling Technology

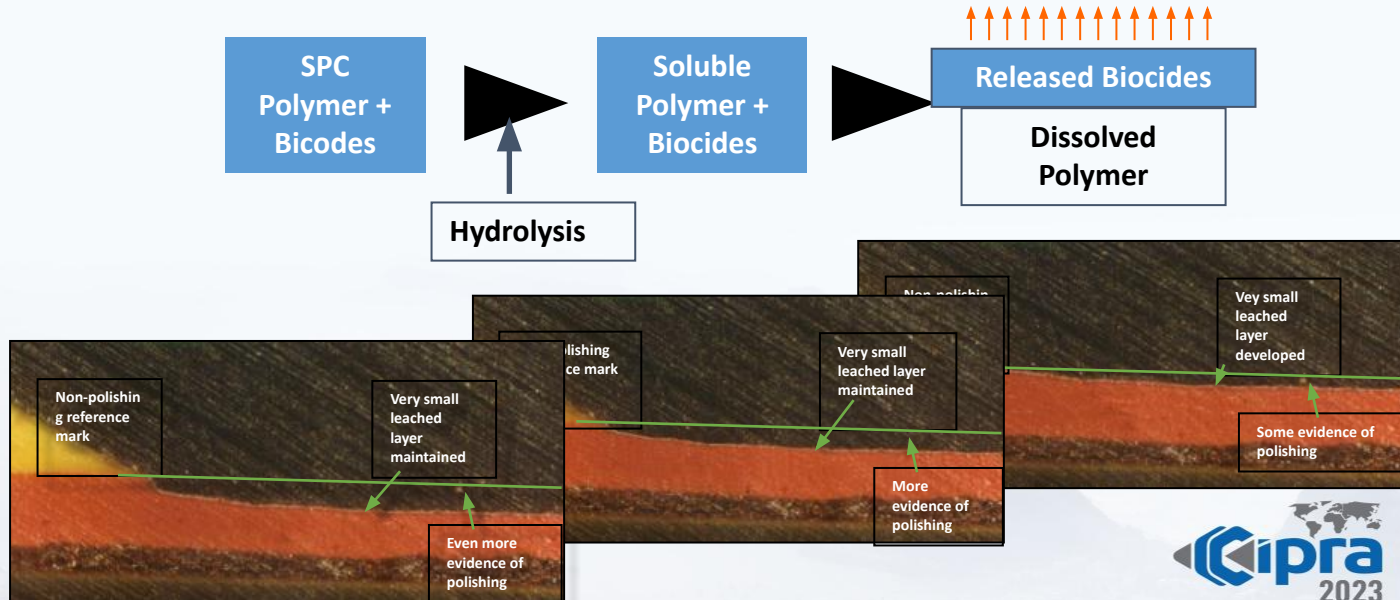
1) Self-Polishing Copolymer (SPC)

- 1st generation metal (copper) acrylate and silyl acrylate products introduced 20 years ago
- Quickly became the new dominant technologies following IMO ban on application of TBT A/F from 2003



Biocide Delivery Mechanism – SPC

- Self-Polishing Copolymer (SPC) undergo a reaction (“hydrolysis”) with sea-water, to form a polymer which is then soluble in sea water
- This results in thinner leached layers and therefore much better control of biocide release:



Antifouling Technology

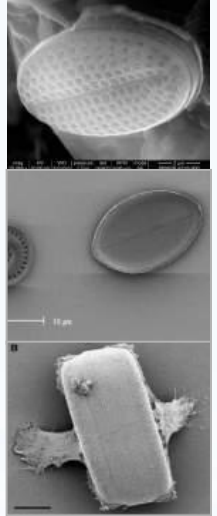
2) Foul Release



What is Foul Release?

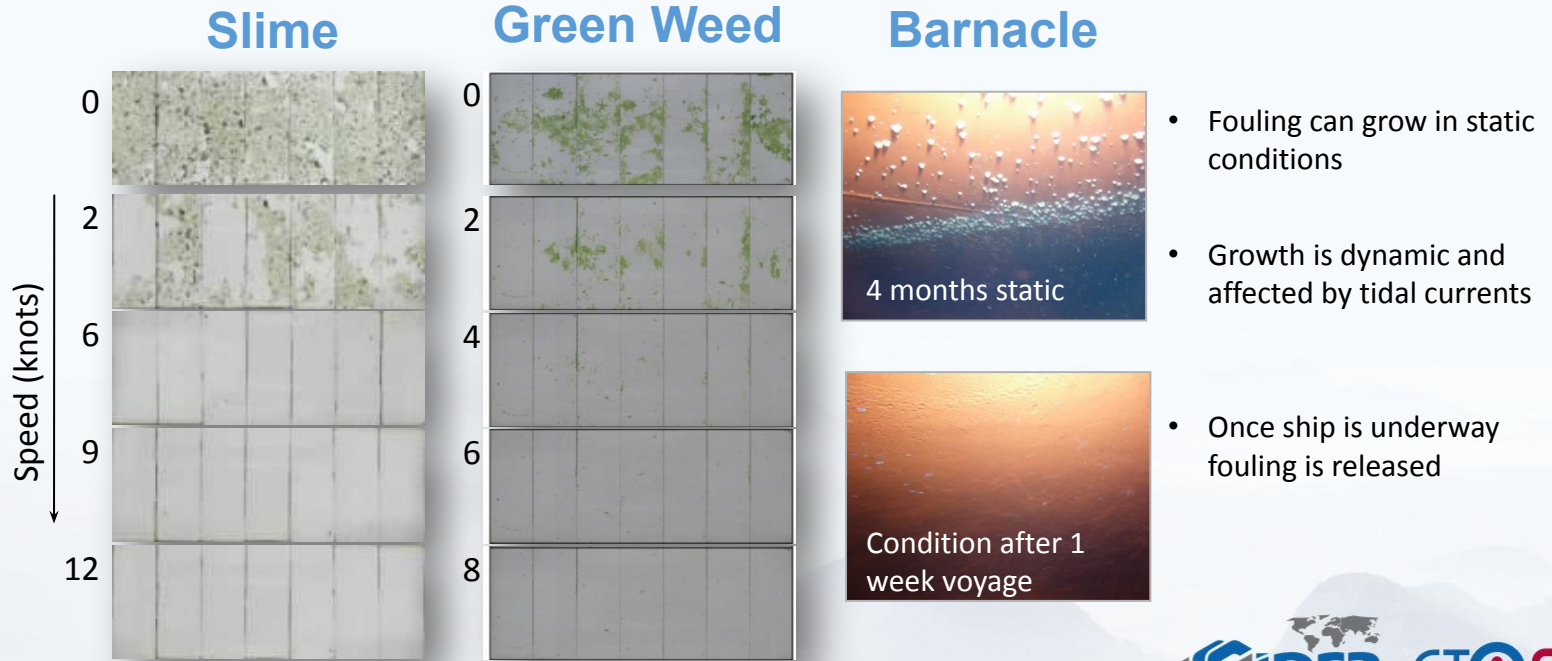
Foul release systems work through influencing the settlement and adhesion of fouling organisms from micro (slime) through to macro shell fouling

- By changing the surface energy of the coating marine organism adhesion is reduced
- Slime prefers hydrophobic or water-hating surfaces.
- Barnacles and other higher organisms prefer more hydrophilic (water-liking) surfaces
- Latest foul release systems have a balanced surface of hydrophobic and hydrophilic domains which influence settlement and adhesion of the widest variety of fouling organisms
- Longest track record is for biocide-free technology in offshore industry, however biocide containing foul release systems recently developed



How foul release works?

- The name “foul release” describes exactly how these products work



Hydrodynamic Flume Showing Foul Release

High-speed video of Slime Release capabilities

- Slime film grown for 6 weeks under near static conditions

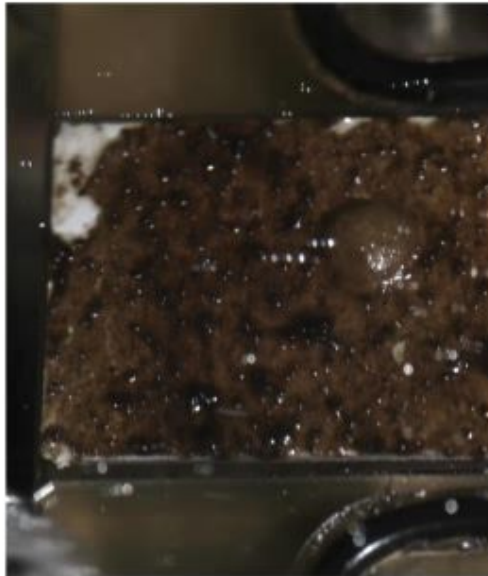
Silicone

1st Generation

2nd Generation

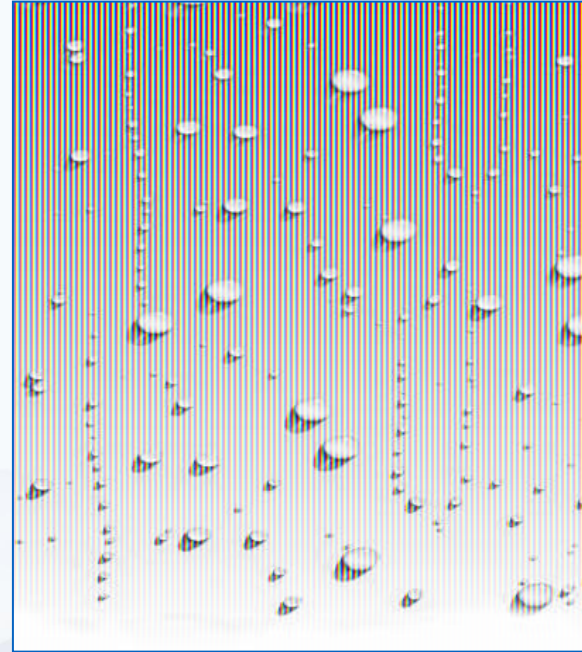
Fluoropolymer

Fluoropolymer



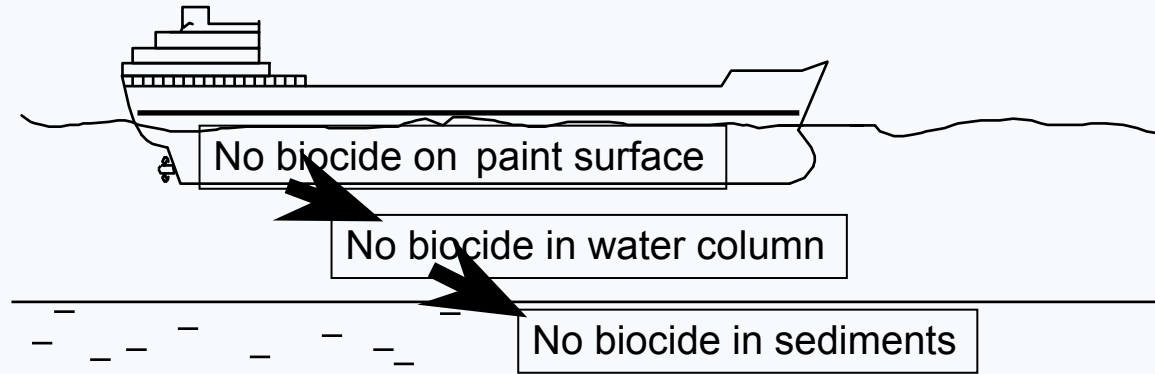
Foul Release Properties

- Patented fluoropolymer foul release technology
- Environmentally friendly
- Excellent foul release properties
- Long term static performance



Environmentally friendly

- Non-toxic, non-biocidal



No environmental issues !

Shell Prelude (2012 to 2015)

The world's biggest floating offshore structure



- Owner: Shell
- Engineering: Technip (Paris)
- Hull & Topsides: Korea
- Hook-up and commissioning: Australia



- 488 metres long
- 600,000 DWT
- First steel cut in 2012
- Installation in 2017

Shell Prelude – Hull & Topsides

- Fabrication: Samsung Heavy Industry, Korea
- Biocide-free foul release on UW Hull
- Post delivery located off Barrow Island West Australia (marine conversation area)
- Biocide-free technology requirement of local regulation



Summary of Benefits

Excellent Static Performance

- Minimises fouling build-up helping to
- maintain the operating efficiency of seachests

Environmentally friendly

- Biocide free – exempt from regulations governing where offshore structures can be located and reduces the disposal costs associated with washings during any dry-dockings

Reduced Lifetime Cost

- Maintains operating efficiency of FLNG and FPSOs and drillships by
- Easy clean surface
- Reduces diving costs to remove any accumulated fouling allowing underwater inspections to be readily carried out

Performance of Biocide-free Foul Release on FPSO Capixaba

Years in-service



Vessel Type	FPSO
Vessel Size	273,000 DWT
Owner/Operator	SBM Offshore / Petrobras
Date of build	2005
Location of build	Keppel Tuas Shipyard, Singapore
Areas with biocide-free foul release (FR)	Sea Chests, Tank Markings, Bilge Keels and Girth Belts
Coating Scheme	Intershield 300 / Intersleek 757
Service Location	Brazil
Year of inspection (Years in service)	2009 (4 years)

Coating Application Singapore 2005



Biocide-free FR application (light grey) on the shipside girth belt. Other areas coated with epoxy anticorrosive



Biocide-free (FR) application on the bilge keel.

FPSO Capixaba sails to Brazil

- Vessel sails to Brazil in Nov 2005.
- Vessel in operation with no docking or repairs carried out.
- Nov 2009 sails back to Singapore to have more modules added and was dry docked in early Dec 2009.
- Underwater hull was cleaned, turret under water area was inspected and cleaned.



FPSO Capixaba (drydock 2009)

Vessel in-docking condition



Heavy barnacle growth in epoxy areas

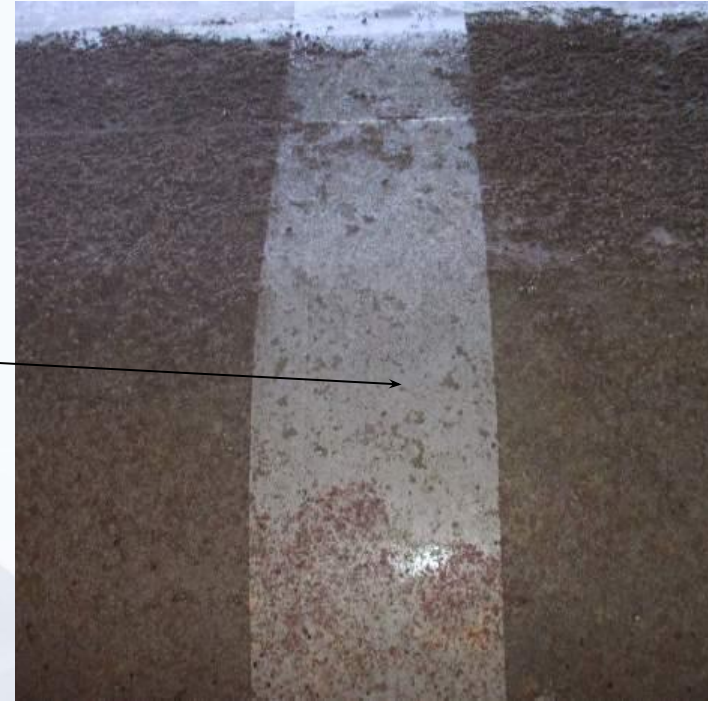


FPSO Capixaba

Heavy barnacle growth has very strong adhesion to the hull and needs to be scraped off

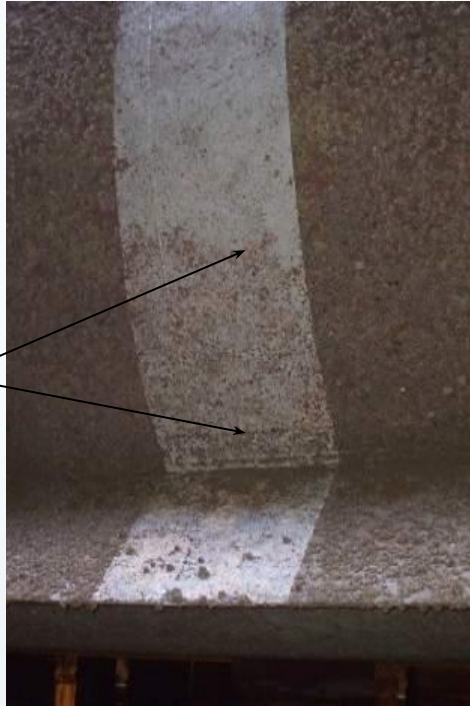


Biocide-free FR on girth belt shows low fouling growth compared to adjacent areas.



FPSO Capixaba

Girth belt and bilge keel areas coated with Biocide-free FR showing low barnacle growth compared to adjacent areas



Barnacles easily removed from Biocide-free (FR) area on flat bottom by low pressure water washing



Future Developments

A technology step change: UV light

Ultra violet (UV) light is widely used to sterilise water and surfaces:

- Healthcare, Aquariums and Swimming pools
- Industrial water treatment installations

But, can it be used to control and prevent the fouling of a ship hull?

- Low voltage, low power UV-C LEDs embedded in a UV transparent silicone tile
- The tiles form a UV emitting 'skin' with a sterilisation zone of a few millimetres



Resistance against high levels of fouling

UV-C LEDs are effective against biofouling...

After 8 months in Dutch waters (Zeeland) on a recreational vessel show that the areas protected with UV are free from all fouling.

Microbially sterile – No bacteria, diatoms, weed spores or animal larvae.

