Eco-efficiency – a new tool to support better decisions on hull coating investments

As fuel costs continue to rise and ship owners and operators examine new strategies aimed at improving vessel operating efficiency, the options relating to investments in effective hull coatings are increasingly complex. A new decision-making tool, developed by International Paint, has been designed to assist ship operators as they face the challenge of choosing between different fouling control products by comparing both economic and environmental costs and benefits

Eco efficiency analysis allows ship owners to see both the economic and environmental benefits of a product from cradle to grave

Since the first oil crisis nearly 40 years ago, the world's leading marine coatings manufacturers have developed a wide range of hull coatings designed to limit plant and animal growth on the underwater hulls of ocean-going ships and coastal vessels. Untreated, fouling growth creates significant additional hull resistance and, as a result, leads to higher fuel bills and increased emissions. These coatings have been based on various technologies with ongoing research and development on the part of the world's leading coatings companies enabling new and more effective products to be brought to market on a regular basis.

Coatings fall into two broad categories, biocidal antifouling coatings and biocide free foul release coatings, each of which has subsets. Biocidal antifoulings – whether self polishing copolymers or controlled depletion polymers – all function by releasing active ingredients, biocides, into the marine environment, repelling organisms and thereby preventing their adhesion to ships' hulls. Copper forms the basis for the most widely used biocides today.

The second group are biocide-free and are known generically as foul release coatings. Unlike biocidal antifoulings, they do not release any active ingredients into the marine environment but work on a purely physical basis using advanced polymer technologies. Again, there are subsets within the foul release grouping – some coatings are based on silicone technology; others are known as fluoropolymers. It is the development of these coatings on which more research and development is becoming focused. They have less environmental impact and are generally more effective.

The ongoing challenge facing owners and operators is to formulate an effective comparison between the relative costs and benefits of different fouling control products. They must undertake this process against a global backdrop of greater environmental concerns over the effects of man's activity on the welfare of the planet. International shipping has found itself clearly targeted as one of the

largest consumers of fossil fuels and, as a result, a continuing generator of carbon dioxide and other gases which can affect the environment. Effective hull coatings can have a notable impact on ships' fuel consumption, with some of the most sophisticated foul release coatings typically cutting fuel use, and therefore greenhouse gas emissions in the form of carbon dioxide, by up to 9%.

However, any comparison between products is complex. Almost every coating comes with a different set of "user instructions". Paints are applied in different dry film thicknesses, in varying numbers of coats, sometimes involving several different products which together make up the "paint scheme"; some must be blasted off and the hull re-coated regularly at docking intervals; others can be scrubbed clean and touched up; they have different application requirements and drying times; some work better at higher speeds, others are better suited to slower vessels. And so on.

Recognising the complexity of the decision-making process faced by owners and operators, particularly in the light of growing environmental concerns, International Paint executives set about devising a strategy to support this complicated decision-making process. The company's chemists in conjunction with parent company Akzonobel, were already aware of a relatively new concept designed to assist in the economic and environmental comparison of different products. Before long, they had embarked on the first stages of an "Eco-Efficiency Analysis", to be tailored specifically for use in the fouling control sector.

What is Eco-Efficiency Analysis?

The term Eco-Efficiency is defined as maximising efficiency while minimising environmental impact. The concept of Eco-Efficiency Analysis was introduced through work undertaken by BASF in the mid 1990s as the company sought to assess the real financial and environmental impacts of providing a specific customer benefit through different products. Thus Eco-Efficiency Analysis, which is also known as Life Cycle Assessment, compares and contrasts the financial and environmental costs and benefits of different products providing the same customer benefit over their entire lifetime. It is a particularly useful process when comparing new products with competing products in the market, within both an economic and environmental framework.

Undertaking such an Analysis is covered by two ISO standards:
ISO 14040:2006 Environmental management – lifc cycle assessment: Principles and framework; and
ISO 14044:2006 Environmental management – Life cycle assessment: Requirements and guidelines.

In a fouling control context, the customer benefit was identified as optimising vessel efficiency by ensuring a clean underwater hull. The Eco-Efficiency Analysis supports the best decision-making, taking into account a broad range of variables including raw materials and energy consumption, through-life costs relating to maintenance, repair and replacement, the benefits of use through limiting marine fouling thereby reducing fuel consumption, and ultimately the costs of waste disposal and any end-of-life requirements.

Who can benefit?

International shipping finds itself in the environmental spotlight as never before and a growing number of blue-chip shipping companies have undertaken fundamental revisions of their corporate environmental strategies recently. Corporate social responsibility (CSR), still itself a relatively new concept in global shipping, is now a key priority for many progressive shipping companies and their managers. They realise that implementing sound strategies today is likely to help in marketing their ships' tomorrow. Furthermore, shipping company compliance with increasingly robust CSR strategies implemented recently by leading shippers and cargo owners is a key priority.

In the container ship sector, particularly, leading lines are in constant dialogue with their shipper clients, reassuring them that they have adopted the very latest moves to raise efficiency and reduce their environmental impact. Leading charterers in the dry and liquid bulk sector are also increasingly conscious of their environmental responsibilities and this is evident throughout their

Consider the life cycle for one raw material: cuprous oxide

Copper ore is mined
Resource consumption
Emissions
Fuel consumption
Human exposure
Waste
Cost

Transported to factory
Fuel consumption
Emissions
Cost

Processed to cuprous oxide
Fuel consumption
Emissions
Land fill
Human exposure
Cost

Transported to paint factory
Fuel consumption
Emissions

owned and controlled fleets, as well as the vessels they take in on charter.

Potentially, everyone can benefit from Eco-Efficiency Analysis. Maximising economic benefits whilst minimising environmental impact is a noble aim for everyone as, after all, almost everyone relies on ocean transport in one way or another. However, in a shipping context, Eco-Efficiency Analysis benefits:

- Liner shipping service companies whose vessels transport containers, ro-ro and reefer cargoes on scheduled services. Since these companies pay for their own fuel, they have a particular need to maximize operating efficiency. Many of their customers are increasingly focused on "green" issues; for them, sound environmental strategies throughout their business operations are a key marketing strategy.
- Independent owners of ship types including tankers and bulk carriers whose businesses depend on the support of the world's leading industrial corporations, including oil companies, mining firms and agricultural entities. They provide long-term ocean transport and are, effectively, in the service business. It is incumbent on them to meet or exceed their customers' environmental requirements.
- Cargo owners who seek to hedge an element of their marine transport risk by owning and/or controlling ships of their own. A key objective for them is to be seen to be as progressive as possible in all matters relating to the environment.

The International Paint Eco-Efficiency Analysis

Three products were identified for consideration in the International Paint study which, company executives agreed, would require external management, full compliance with the ISO standards and sign-off by an independent third-party auditor.

The products consisted of:

- A standard copper containing biocidal antifouling;
- A foul-release coating based on silicone technology (Intersleek 700);
- A foul-release coating based on fluoropolymer technology (Intersleek 900);

However, each of these three products is a component within a paint scheme and therefore an analysis of each of the products involved in each scheme was required. Six separate coatings were assessed therefore, comprising the three finish coatings above, an anti corrosive epoxy coating, and an epoxy tie-coat and silicone tie-coat to ensure good adhesion between the foul release coating and the anticorrosive.

A sustainability consultant, Tobias Boren, who works at Akzo Nobel's central Sustainable Development division in Gothenburg was asked to oversee the Eco-Efficiency Analysis, and the Swedish Environmental Institute was retained to audit the Analysis and verify its conclusions.

The biocidal antifouling works by releasing biocides which repel fouling organisms and prevent them from adhering to the hull. The biocides in such coatings, however, leach out over time, reducing efficacy, and ships' hulls must be re-coated at every docking

Intersleek 700, a silicone-based foul release coating, works through the hydrophobic nature of its surface. This means that marine organisms can only stick to the surface weakly. No biocides are released into the marine environment but mechanical abrasion reduces coating efficacy over time, and the finish coat of this scheme needs to be refreshed every five years.

Intersleek 900, a fluoropolymer foul release coating, works through the very smooth and amphiphilic nature of its surface. Most organisms are repelled whilst those that do stick to the surface, do so only weakly. Once again, there is no release of biocides, mechanical abrasion reduces coating efficacy over time and the finish coat needs to be refreshed every five years.

In order to undertake the analysis, every conceivable piece of life-cycle inventory data was collated and analysed for each of the six products in the International Paint Analysis. These included raw material consumption, processing energy, waste creation and disposal, environment toxicity effects, human toxicity effects and all emissions – to air, land and water.

The active ingredient used in the standard biocidal antifouling, is cuprous oxide. The process for considering the life-cycle inventory for this product includes:

- the mining of copper ore – resources consumed, emissions, fuel used, human exposure, waste and cost

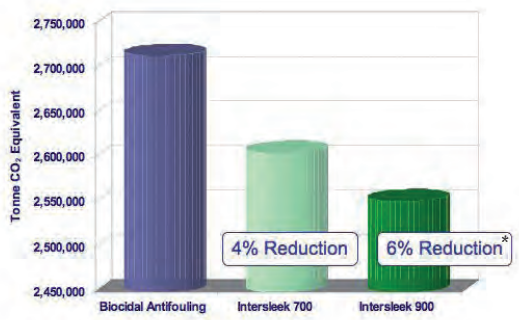
Converted into paint
Energy consumption
Emissions
Waste
Human exposure

Paint transported to drydock
Fuel consumption
Emissions

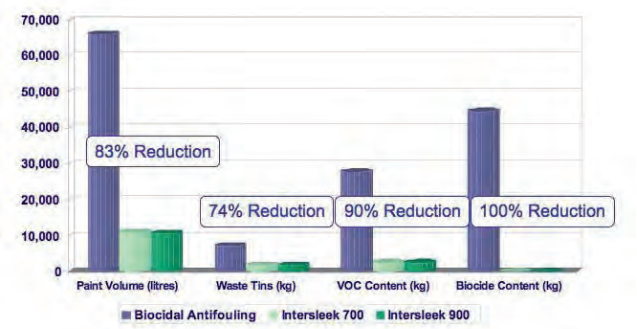
Paint applied to ship
Emissions
Energy consumption
Human exposure
Waste
Environmental toxicity

Ship enters service
Energy consumption
Emissions
Waste
Environmental toxicity

Copper dissolves into ocean
Environmental toxicity
End life



Off-shore global warming potential CO_2 equivalent release from vessel activity



Fundamental reductions provided by Intersleek®900 (versus other fouling control products)

- transportation to factory – fuel used, emissions, cost
- processed into Cuprous Oxide – fuel used, emissions, land fill, human exposure, cost
- transported to paint factory – fuel used, emissions
- converted into paint – energy use, emissions, waste, human exposure
- product transported to drydock – fuel used, emissions
- paint applied to ship – environmental/human toxicity, fuel used, emissions, waste creation and disposal
- ship enters service – fuel savings, emissions savings, higher speeds, cuprous oxide dissolves into ocean
- ship drydocked - environmental/human toxicity, fuel used, emissions, waste creation and disposal
- ship re-enters service – fuel savings, emissions savings, higher speeds, cuprous oxide dissolves into ocean

and the data gathering continues over the pre-determined period of analysis or until ultimate disposal.

The subject vessel

For the purposes of the Eco-Efficiency Analysis, a specific vessel was chosen – a 300,000 dwt Very Large Crude Carrier (VLCC) assumed to have a trading speed of 15 knots, an activity level of 80% and fuel consumption of around 100 tonnes of heavy fuel a day, leading to greenhouse gas emissions of 320 tonnes of CO_2, six tonnes of SOx and 0.5 tonnes of NOx.

A coating life-cycle of 15 years was adopted during which time the VLCC would be coated three times – once when it was built, and twice more at subsequent drydockings. It was assumed that at the end of the 15 years, the ship's hull would have to be fully blasted and all coatings renewed.

All of the data inputs relating to this tanker's 15-year operation were then collated. These included, but were not limited to total environmental burden including energy consumption, acidification potential, photochemical ozone potential; global warming potential, specifically carbon dioxide emissions; through-life costs of paint, application, drydockings; operating costs, notably fuel consumption; and paint volumes.

The results provided the basis for a chart, the Overall Eco-Efficiency Assessment, mapping environmental impact on the x-axis and financial impact on the y-axis. The key result was as follows:

- Intersleek 900 was most effective, both financially and environmentally, principally because of the largest fuel savings and a corresponding reduction in emissions, and substantially reduced paint volumes

The Eco-Efficiency Calculator – an interactive model

The findings on the subject vessel, the VLCC above, are relevant for the owners of such vessels. But one of the aims of this initiative was to provide a means of comparing different antifouling products, potentially on the hulls of a broad range of ships. Therefore, International Paint has devised an interactive model which can produce a tailored Eco-Efficiency Analysis based on information supplied by a customer for a specific ship.

The Eco-Efficiency Calculator is an Excel program which uses "Macros" to process data.

Entering variables relating to specific ships, including vessel particulars, fuel price, drydocking frequency and costs, surface preparation and costs, and coating costs over the stipulated period the model then calculates results including:

- Likely ship operating costs assuming the use of each coating over the period;
- Greenhouse gas, namely carbon dioxide, released in each scenario, affecting onshore global warming rates;
- Greenhouse gas released from vessel activity;
- Other relative data outputs, including paint volumes, waste tins, volatile organic compound (VOC) content, and biocide content.

The result is a chart in which relative operating costs and savings can be easily compared. The figures obviously vary directly with assumed fuel price but the model enables sensitivity analyses by adjusting other variables. This, in turn, enables identification of factors in hull coating equations that have the most bearing on ship operation over time.

** At the time of analysis. Now up to 9%.*