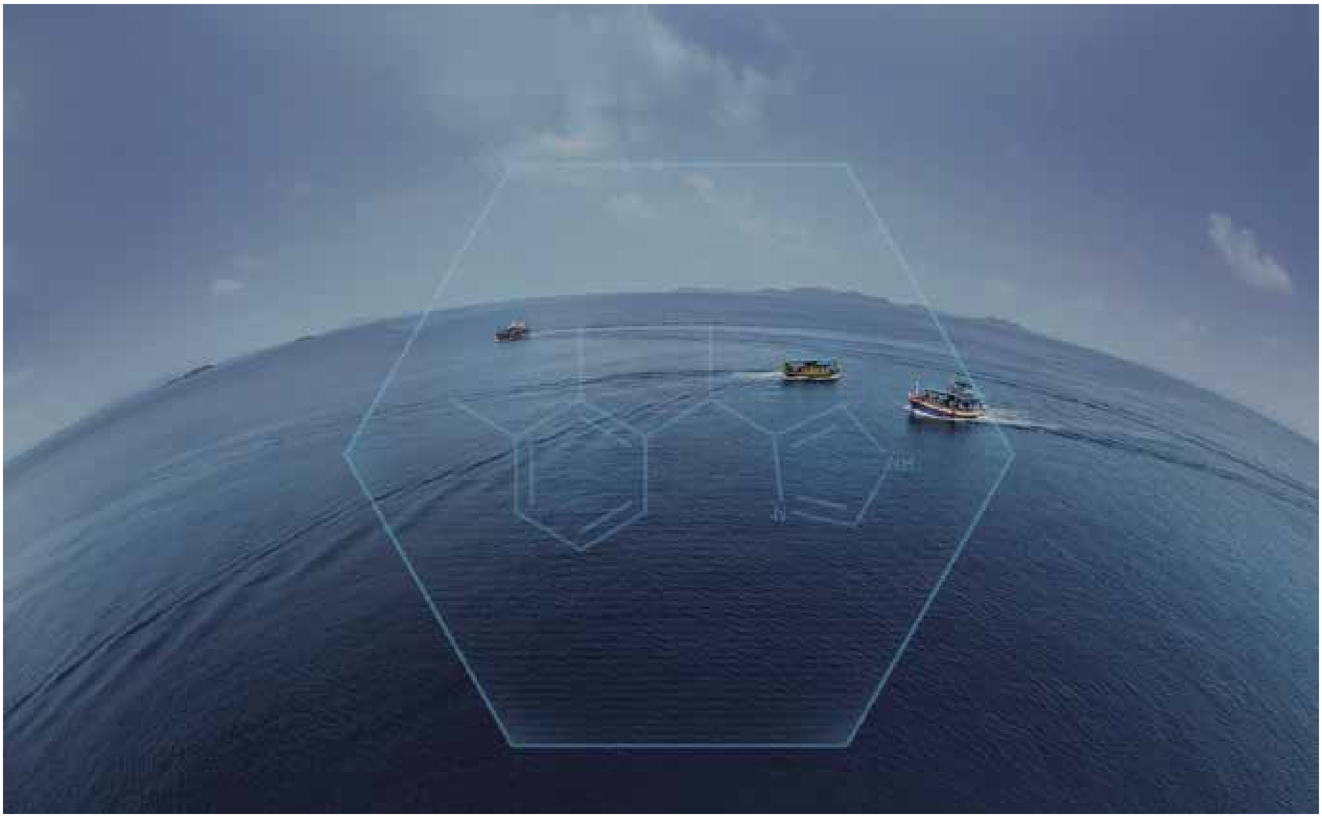

A journey to the marine coatings market - Reaching full approval as a marine biocide

I-Tech

Introduction

Today, despite its central role in sustaining the global economy, shipping's reputation in the public consciousness often rests on its safety and environmental record alone. For many, the sharpest points of contact remain shipping's accidents, its contribution to air emissions, its activities in polar waters and the effect it has on marine organisms.

For some, even good news maritime stories on the environment simply provide one more opportunity to characterise shipping as a closed industry that resists progress, one hiding its colours under flags of convenience that only changes under duress.

This view overlooks the realities of an industry which, in value terms, transports 95% of everything that we use day-in day-out. It also dismisses out of hand the original, painstaking and protracted research required of engineers, chemists and biologists to meet the sometimes conflicting demands of environmental responsibility and a consumerist society.

This is the Story of Selektope®, a new ingredient used in marine coatings to prevent the growth of barnacles on ships' hulls, thereby ensuring that vessels move through the water efficiently and smoothly. It is a story involving chemists, marine biologists and engineers, a 'Eureka' moment, 15 years of trials, and exhaustive regulation.

Fouling is the phenomenon routinely degrading hull hydrodynamics; if not controlled, ship fuel consumption may rise by up to 80%, and direct consequences for air pollution.

In an academic world fully aware of the antifouling problem but lacking a new and viable solution, this is a story of original thinking and how a biological discovery became the first step in a 15-year journey to market. Today, Selektope is available to shipping to cut fuel bills and air emissions, and is fully approved by regulators.

The Selektope® Story TIMELINE

2000	– The science of Selektope: an antifouling breakthrough
2002	– Marine coatings at the crossroads
2006	– Selektope endorsed through peer review
2009	– Shipping at the tipping point
2009 to date	– Selektope and the rules of the road revolution

2000 - The science of Selektope®: An antifouling breakthrough

As a new millennium beckoned, pressure mounted on suppliers of marine coatings to find a replacement for organotin (TBTs) as the principal ingredient used in the antifouling products protecting ships' hulls from the attachment of weed, slime and barnacles.

The active compounds included in antifouling coatings were slowly released into the marine environment to kill the marine life attaching itself to ship bottoms. These coatings are 'self-polishing', in that the friction generated by the ship's motion through water causes tiny quantities of the base polymer to leach at a predetermined rate, while the active antifouling maintains its performance evenly through the paint's lifetime.

While effective and widely applied to commercial ships from the early 1970s onwards, over time marine biologists gathered evidence of the damaging impact of TBT on marine life. The effects included the poisoning of oyster beds and imposex among dog whelks and were particularly discernible in coastal areas near the dry docks flushing coatings.

TBT toxicity began to reach unacceptable levels in the marine ecosystem, resulting in an early ban on its use for leisure craft. By the late 1990s, pressure had mounted on commercial shipping, bringing first national, then international regulatory action. The end-game was the International Maritime Organization Convention on the Control of Harmful Anti-fouling Systems on Ships (2001), enforcing TBT phase-out from 2002.

Some two years earlier, in February 2000, biologists at the University of Gothenburg published a research paper on biofouling in Swedish waters. Researchers had been investigating how a range of substances could be used that would prevent the settlement of hard fouling when dissolved in seawater.

The research focused on the barnacle Amphibalanus improvisus, and its 'colonization' of man-made surfaces at the larval stage. The organism's characteristics made it an ideal case for study. The researchers set their goal as discovering 'adrenoceptor active compounds' that manipulated the barnacle larvae's behaviour to inhibit invertebrate larvae from settling.

The paper's lengthy title (Surface Active Adrenoceptor Compounds Prevent the Settlement of Cyprid Larvae of Balanus improvus) disguised startling results: larval-stage receptors were remarkably responsive to one substance in particular - medetomidine. This bioactive substance, even in tiny quantities, simply prevented organisms attempting to settle.

Medetomidine - widely used as a sedative on animals and humans - was also distinguished by its reversible effects. Larvae that came into contact with the substance metamorphosed into juvenile barnacles with no apparent ill effect.

Moving on to panel-testing stage, a further discovery was made. Remarkably, a polymer containing medetomidine in a concentration equivalent to 0.02% by weight volume rejected 97% of the aggressive Barnacle improvus after two weeks, and 96% after four weeks. No other macro-fouling organisms were present at all. A further distinction pointed towards medetomidine's potential for "large scale synthesis": its "tendency to accumulate at the solid/liquid interface" across the full extent of a surface.

Two years before the International Maritime Organization enforced the phase-out organotin, it had been established that medetomidine offered a new antifouling solution. Over time, the findings would prove to be a turning point for the marine coatings industry. Today, the antifouling action of medetomidine has been registered under the Selektope brand, recognising its selective action.

2002 - Marine coatings at the crossroads

As the University of Gothenburg researchers confirmed the astonishing antifouling properties of the ingredient that would become Selektope, shipping's need to respond to the global ban on TBT as an active biocide was laid out by R.L. Townsin in 'The Ship Hull Fouling Penalty' (2002).

Respected authority Townsin credited Holzapfel as making the first mention of the 'leaching' effect that dominates merchant shipping antifouling solutions today as long ago as 1904. However, it was not until 1971 that ship hulls were able to take advantage of copolymers loaded with Tributyl tin as a workable biocide. Subsequently, new products emerged capable of a constant biocide leaching rate to perform over an extended lifespan (up to five years).

That these coatings came to dominate merchant shipping for the next 30 years demonstrated their effectiveness. By 1981, The Ship Performance Group at Newcastle University was using the term self-polishing copolymers (SPCs) to describe their action.

The mandatory phase-out of TBTs worldwide from 2002 presented shipping with a major challenge if it wanted to overcome what Townsin described as 'the ship resistance penalties of slime, shell and weed'. Neither scheduling penalties, nor increased fuel costs were acceptable to a globalised industry reliant on just in time delivery.

In 2002, Townsin summed up "The marine coatings industry, at the present time, does not wish to lose the benefit of an ablative matrix containing a biocide. The chemistry is being reconstructed to accommodate different biocides, copper returns as the major present candidate, supplemented with booster biocides."

Barnacle built up on test patch after seven months in static condition on west coast of Sweden using antifouling without Selektope®

Biocides were shortly to run into a new regulatory minefield, in the shape of the EU Directive on Biocidal Products (98/8/EC) but, in the aftermath of the TBT ban, the urgent challenge appeared to be a quick remedy to match the day-to-day effectiveness of the banned substance. For Townsin, in 2002 the non-stick (foul-release) coatings first developed in the 1980s offered a distinctive and promising alternative, but these "fish-slippery" coatings were also 'premium'-priced; furthermore they were less effective at slower speeds.

The detailed analytical work in Townsin's 2002 paper focused on slime and weed as the greatest fouling issues facing shipping. Hard fouling or "shell infestation", he suggested, was "less common than it was in the 1930s and is supplanted today by weed fouling".

Shipping's intervening years tell a different story. The subsequent decade saw record oil prices triggering slow steaming, trade flows steering more ships through the tropical waters where hard fouling flourishes, and massive overcapacity driving ships into lay-up. Slower, or even stationary, hulls are also more vulnerable to hard fouling.

What Townsin did foresee was that it would be "the marine paint chemists and the marine biologists who pave the route ahead".

In 2002, the avid readers of Townsin's "The Ship Fouling Penalty" included the marine biologists and chemists at the University of Gothenburg who had already established a new antifouling agent which promised to match the performance of TBTs.

As subsequent events would prove, however, the "route ahead" to market would be long.

2006 - Selektope endorsed through peer review

By 2003, research into the mechanism that made medetomidine so effective as an antifouling substance had attracted funding from The Swedish Foundation for Strategic Environment Research (MISTRA) Programme for Marine Paint. After years of accumulated study, researchers at the University of Gothenburg were ready to publish their findings for peer review.

However, medetomidine did not affect the secretion of the cement that allowed the barnacle larvae to settle as first anticipated. The precise mechanism of medetomidine's mode of action remained something of an enigma.

The resulting vindication played a pivotal role in persuading Volvo to offer seed money to develop the substance, now registered as Selektope®, towards a commercial antifouling offering for the marine coatings industry.

In the paper "An in vivo study of exocytosis of cement proteins from barnacle Balanus improvisus (D.) cyprid larva" Lena Lindblad also emerged as the common thread between the original research and the formation of I-TECH.

With co-authors Kristin Ödling, Christian Albertsson and James T. Russell, Lindblad pointed out that 2,500-3,000 sessile marine invertebrates, such as barnacles, mussels and tube worms 'glue' themselves to hard surfaces in coastal waters. The authors added "Our approach is to understand the biology of barnacle cement secretion in detail so that new techniques could be developed to control their settling on to man-made marine surfaces".

The researchers at the University of Gothenburg took a new approach to the secretion of cement, and started to study the larval behaviour. In collaboration with two Finnish universities, it was discovered that medetomidine could bind to a specific group of receptors, the octopamine receptors. The receptors were cloned and the causality between the receptor and medetomidine was established. Further study led the

Chugoku Marine Paint hull bottom test patch of antifouling coating using Selektope® after one year trials on low activity coastal vessel in Tokyo Bay (high fouling area)

Chugoku Marine Paint test patch of antifouling coating using Selektope® on Japanese coastal vessel after two years

researchers to link the binding to octopamine receptors to changes in the larval behaviour at a surface. This explained the high efficacy in preventing and deterring barnacle larvae in an antifouling paint without its being toxic to the barnacles.

In a counter-intuitive discovery, given its sedative effect on vertebrates, Selektope was found to induce "hyperactivity in the barnacle larvae to disrupt the settling process;" researchers likened the effects to a small dose of adrenaline in humans. The "kicking response" identified in the cyprid larvae was also temporary, the research showed.

"Our results open up the possibility for developing novel efficacious and environmentally sustainable antifouling substances".

In 2006, buoyed by the further confirmation of earlier research, I-TECH entered a new stage of its development, by initiating the registration of the marine antifouling agent Selektope® for regulatory approvals.

2009 – Shipping at the tipping point

The growing public appetite for a new solution for its antifouling challenge, and for the scientific evidence supporting Selektope® as an industry breakthrough was tested in 2009, with the publication of an exclusive article in the Shipgaz Maritime Technology Yearbook.

The milestone publication presented shipping's hard fouling issue in hard-hitting terms, outlining the increasingly urgent need to find a viable alternative to the bioactive chemicals in common industry use. These were described as "acting by being toxic and lethal", in an article which went on to observe that "killing is not necessary when preventing settlement".

By 2009, original researcher Lena Mårtensson Lindblad had become Associate Professor Zoophysiology at the University of Gothenburg, and I-TECH R&D Manager, now working alongside I-TECH Regulatory Affairs Specialist Cecilia Ohlauson and R&D Chemist Dan Isaksson.

Fouling organism biology itself now provided an answer, the article said. "That can be done by taking advantage of the natural behaviour of the fouling organisms." To achieve these ends, I-TECH was now stating in public that "a molecule should be potent to maximize the antifouling efficacy while minimizing the release to the environment or it needs to be highly degradable to minimize pollution".

What was also now being newly emphasised was the compatibility between Selektope and the paint matrix in the marine coatings industry, and specifically the slow and steady release that secured the antifouling effect over time.

Minimizing the friction between hull and water had also become more pressing for shipowners by 2009, as fuel oil prices soared. Keeping fuel consumption down offered an environmentally-responsible air emissions/greenhouse gasses benefit, but the real imperative of saving fuel costs was being demonstrated by the widespread adoption of slow steaming regimes.

With remarkable foresight, however, the regulatory barriers for a new antifouling molecule to reach the market remained "vast and challenging", according to Shipgaz. "Throughout the years as we have worked with medetomidine, our perspective has always been that we have to know the biological effects both on target organisms as well as non-target species, including humans, control the release - thereby reducing risks," Selektope developers emphasised.

Almost a decade after the action of medetomidine on barnacles was first recorded, its proponents could not know that a further 5-6 years of regulatory scrutiny lay ahead, as the long gestation of the EU Biocide Product Directive (98/8/EC) – in particular - brought uncertainty to an entire coatings industry.

Nevertheless, what emerged is a regulatory structure for marine biocides that will provide a predictability that the marine biocides sector has been lacking.

2009 to date – Selektope and the rules of the road revolution

In 2014, I-TECH signed a supply agreement with Chugoku Marine Paints. As an environmentally responsible ingredient, Selektope® is not only ready for next generation antifouling coatings, it is in service today.

Today, Selektope is fully approved for use as a marine biocide under EU Biocide Product Regulation (EU528/2012). It has also been approved by relevant authorities in the world's leading shipbuilding nations - China, South Korea and China.

However, the journey towards regulatory approval was by no means plain sailing. When the marine coatings industry withdrew organotin as an antifouling substance in 2002 after International Maritime Organization (IMO) action, established paint suppliers concentrated on optimising the performance of marine antifouling coatings allowed by law.

By 2003-2004, the EU Biocidal Products Directive may have been taking shape, but its final form remained unclear. After seeking guidance from established coatings suppliers, by 2006 it had become clear to I-TECH that securing regulatory approval for Selektope would lie in its own hands.

Few can doubt the dedication required to submit a new substance to the BPR's evaluation process; the dossier BPR (EU528/2012) consists of more than 20.000 pages 528 files and refers to 90 investigations regarding human and environmental safety. By 2008, I-TECH had nonetheless attracted a notable convert, and investment from Volvo Group Venture Capital to support a cooperation with Volvo Penta and Selektope's industrialisation for global shipping.

The agreement led on to a production arrangement with global life science company Cambrex Corporation and further field tests whose results would later be invaluable when the product came to the attention of CMP. However, though featuring neither metals nor any harmful metabolites or other questionable compounds, it would be a further seven years before Selektope gained EU approval to confirm that it poses no risk to the environment when used as an antifouling biocide.

Over that time, Selektope has come a long way. It has answered the biological, chemical and regulatory questions. Now, all ship owners need to know is whether Selektope is cost-competitive (it is), whether its action will last up to three years (it will) and how it performs in compared to conventional biocides (it's better).

In short, this is a story which ends with the true answer to the challenge regulators set commercial shipping when they banned TBTs – the antifouling ingredient Selektope®, which is available and fully approved for use in marine coatings for the entire shipping market.

About company

I-Tech is a Gothenburg based company with global reach, holding all IP and regulatory rights to its all new antifouling agent Selektope® (generic name, Medetomidine). Relying on academic research in Gothenburg, I-Tech has since 2006 successfully transformed the scientific invention into a commercially ready and available antifouling agent. I-Tech has had several listings as top start-up company and is now an entirely commercially driven company with continuous revenue streams.