NON-TOXIC, COST AND LABOR FRIENDLY ANTIFOULING
INTRODUCING THORN-D
1. Introducing Micanti – Thorn-D
2. Working principle
3. Antifouling effectiveness
4. Drag performance
5. Sustainability Evaluation
6. Summary
MICANTI’S PRODUCT: THORN-D®

- The first truly environmental friendly antifouling
- Patented worldwide
- Developed in cooperation with leading institutes and companies
Thorn-D® is a self-adhesive film with specific microfibers. The fibers create a physical barrier through forming a textured surface.
USE OF FOILS
COMMON TO INDUSTRIES

Planes  Short Sea Shipping  Powerboats  Sailboats

Trucks  Offshore  Ferries
APPLICATION PROCESS

Self adhesive foil directly applied on the primer

Zinc anodes are applied on top of foil

Foil is applied over cooling tubes
• 6 years effectivity proven on full scale in Mediterranean (aquaculture)
• 6 years effectivity proven in North Sea (panel tests Oosterschelde)
• Product expected lifetime: at least 5 years
• Application carried out on various ships
  – (pleasure craft, 200ft² with difficult shapes
  – professional craft up to 4000ft² with need for high speed application
• No effect on drag observed for major market segments
**Why do we believe we will succeed in shipping industry?**

- Thorn-D® is the first product in the world that prevented fouling on **static objects** for more than **5 years**
- Preventing fouling on static objects is **far more challenging** than on moving objects.
- Thorn-D® has been tested at **various locations** such as Norway, Chile, Scotland, Canada, Turkey, France etc.

- Cooperating with well established companies diminishes most of the technological obstacles and facilitates fast market penetration.
WORKING PRINCIPLE

1. Sorts of species
2. Drawings of mechanism
Settlement of species takes place in three different mechanisms:

- Spore settlement (algae, seaweeds, kelp)
- Larvae settlement (bivalves, barnacles, tubeworms, ascidians, hydroids)
- Single cell attachment (bacteria, microalgae, diatoms)

Though for each climate, different species arise, these broad categories are found anywhere.
WORKING PRINCIPLE

Settlement of barnacle larvae

Flocked surface → Plain surface

Secreted adhesive

Flocked surface → Plain surface

Flocked surface → Plain surface

Flocked surface → Plain surface
WORKING PRINCIPLE

Settlement of algae spores
WORKING PRINCIPLE

Settlement of microalgae
ANTIFOULING EFFECTIVENESS

1. Results Aquaculture (Mediterranean)
2. Panel tests Oosterschelde (NL)
3. Results Pilot Boat (NL)
4. Performance on Regal motorboat (Mediterranean)
5. Performance Electric Boat (FL)
6. Performance 32’ Grand Banks (CA)
# **THORN-D® in Practice**

## Regular copper antifouling in Turkey

<table>
<thead>
<tr>
<th>Time</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 months</td>
<td><img src="image1.png" alt="Image" /></td>
</tr>
<tr>
<td>12 months</td>
<td>meshes are blocked</td>
</tr>
</tbody>
</table>

## Thorn-D® in Turkey

<table>
<thead>
<tr>
<th>Time</th>
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<tbody>
<tr>
<td>6 months</td>
<td><img src="image2.png" alt="Image" /></td>
</tr>
<tr>
<td>12 months</td>
<td><img src="image3.png" alt="Image" /></td>
</tr>
<tr>
<td>Time</td>
<td>Regular Copper Antifouling</td>
</tr>
<tr>
<td>--------</td>
<td>----------------------------</td>
</tr>
<tr>
<td>1.5 year</td>
<td>X</td>
</tr>
<tr>
<td>2 years</td>
<td>X</td>
</tr>
<tr>
<td>2.5 years</td>
<td>X</td>
</tr>
</tbody>
</table>
Long term performance

In the Oosterschelde (NL), antifouling tests are continuing since 2006.
Test Pilot boat, after 6 months in the water in The Netherlands. Pilot boat runs 25 knots, 24/7.

**Picture 1:** left hand Thorn-D®, right hand unprotected by Thorn-D®

**Picture 2:** unprotected area

**Picture 3:** a competitive product for commercial shipping failed to protect against barnacle growth, even when vessels run 25 knots in cold water
In July 2010, a Regal motorboat was coated partially with Thorn-D, partially with Interspeed.

Thorn-D, slight green thread like algae and hydroid formation

Interspeed covered with microalgae and slime

Strong hard fouling on old Interspeed (Thorn-D torn off due to low quality foil)

Interspeed with initiation of hard fouling (tubeworms)
Duffy Electric boat in Florida. Duffy sails every 2 weeks at a maximum speed of 5 months. The owner, Dennis Delong, normally cleaned the hull every month.

Dennis Delong: "We applied Thorn-D ® about a year and a half ago to my Duffy Classic 21 in S. Florida, amazingly it has kept the bottom un-fouled. Thorn-D is the ideal product"
Some tube corals attach in between fibers (product has been modified to prevent this)

Cleaning can be done with a nylon brush
PERFORMANCE 32’ GRAND BANKS
6 MONTHS SAN DIEGO

Some algae attach

Cleaning is easy and can be annulled by some sailing action
Hard fouling (barnacles and tubeworms) attach on non-protected area’s.
1. Towing tank tests at MARIN
2. Surface friction tests at TNO/TU Delft
3. Various field measurements on ships out
4. Computer modeling at TU Delft
As the fiber structure of Thorn-D modifies the surface properties, drag tests have been carried out to evaluate the performance:

1. Towing tank tests at MARIN
2. Surface friction tests at TNO/TU Delft
3. Various field measurements on ships
4. Computer modeling at TU Delft
TOWING TANK TESTS MARIN
Change in flow pattern:

- Delayed bow wave separation
- Lower ripple
- No wake
Turbulent flow over and in canopies is dominated by large coherent structures, that scale with the canopy height.
HOW DOES THORN-D® WORK (V)?

BENEFICIAL TEXTURE FOR DRAG DECREASE

Passive flow separation control of flocked surfaces

(b) $\alpha = 3^\circ$
PERFORMANCE TESTS REGAL MOTORBOAT
Performance Test
Fast Professional Craft

![Graph showing the speed vs. RPM for different craft types.](image-url)
WHAT ABOUT DRAG? (VI)

PERFORMANCE TESTS PILOT BOAT

![Speed vs. Rpm Graph]

- **Mercury bare hull**
- **Mercury long fibers**
Conclusions test lab and in practice:

1. No drag increase observed for major market segments

2. The change in water flow around the hull changes stern and bow wave
SUSTAINABILITY EVALUATION
## COMPARISON: TOXIC BOTTOM PAINT

<table>
<thead>
<tr>
<th>Current practice: Copper based antifouling</th>
<th>Thorn-D</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Toxins (copper and other organic biocides) leach into the environment</strong></td>
<td>Thorn-D is based on a physical mechanism, no leaching</td>
</tr>
<tr>
<td><strong>Binder material leaches into the environment</strong></td>
<td>Thorn-D foils are stable for many years and are collected after their use for recycling</td>
</tr>
<tr>
<td><strong>Paint based on organic solvents, VOC’s are evaporated during drying and contribute to greenhouse gas effects</strong></td>
<td>VOC’s used in production, they are used for heating production lines (flocking) or recycled (foil production)</td>
</tr>
<tr>
<td><strong>During lifetime, fuel consumption increases gradually, rule of thumb: 6% drag increase after 6 months</strong></td>
<td>No increase in time, stable fuel consumption leading to lower fuel consumption during lifetime compared to toxic coatings</td>
</tr>
</tbody>
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## COMPARISON: FOUL RELEASE COATINGS

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<th>Current practice: Foul release coatings (FRC’s, silicone coatings)</th>
<th>Thorn-D</th>
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<tbody>
<tr>
<td>FRC’s contain high amounts of dibutyltin compounds, higher than allowed according to IMO ban on organotin compounds</td>
<td>Thorn-D is based on a physical principle and does not leach products into the environment</td>
</tr>
<tr>
<td>FRC’s are difficult to apply and to keep them stable, many dangerous (carcinogenic) solvent are used that are evaporated during application</td>
<td>VOC’s are used in production lines, they are used for heating the production lines (flocking) or are recycled (foil production)</td>
</tr>
<tr>
<td>FRC’s claim to have fuel reductions due to slippery surface. In practice this is only true at the highest speeds (24kt or higher) that are not used in operation (common cruising speed: 19kt).</td>
<td>Thorn-D has fuel reductions for all speeds as no growth is occurring and the effect of structure has effect at all speeds</td>
</tr>
</tbody>
</table>
SUMMARY
WHAT DO WE OFFER THE SHIPPING INDUSTRY

- Reduction of fuel consumption
- No more cleaning (pleasure craft US)
- Long lasting protection
- Easy and clean to apply
- Environmentally friendly

APPLYING THE THORN-D® FOIL INSTEAD OF PAINTING
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