Ultra Low-Friction
Underwater Coating System

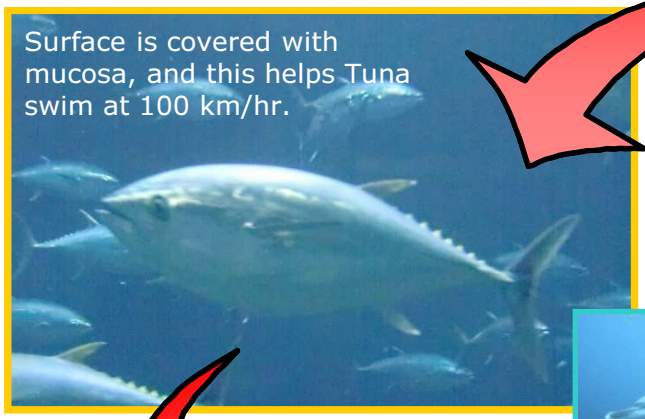
A-LF-Sea

April 2014

Basic & New NIPPON PAINT MARINE

Biomimetics

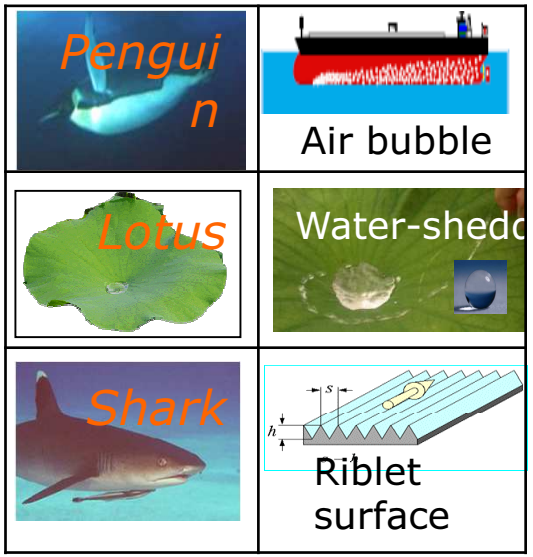
Tuna



Wisdom of Evolution

Smooth & flexible surface help Dolphin swim fast.

Other directions



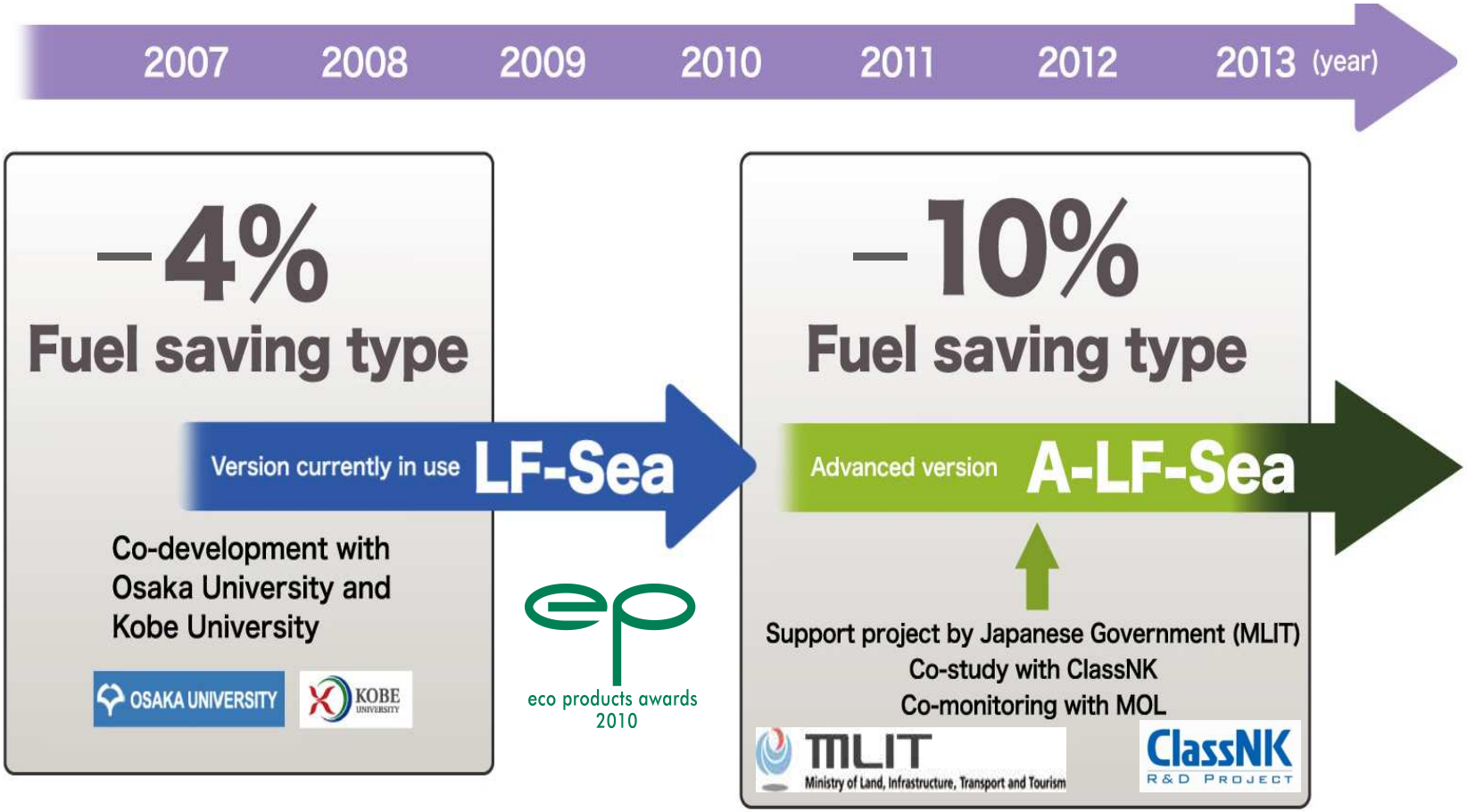
Pseudo-hydration surface

Friction between solid and liquid surface

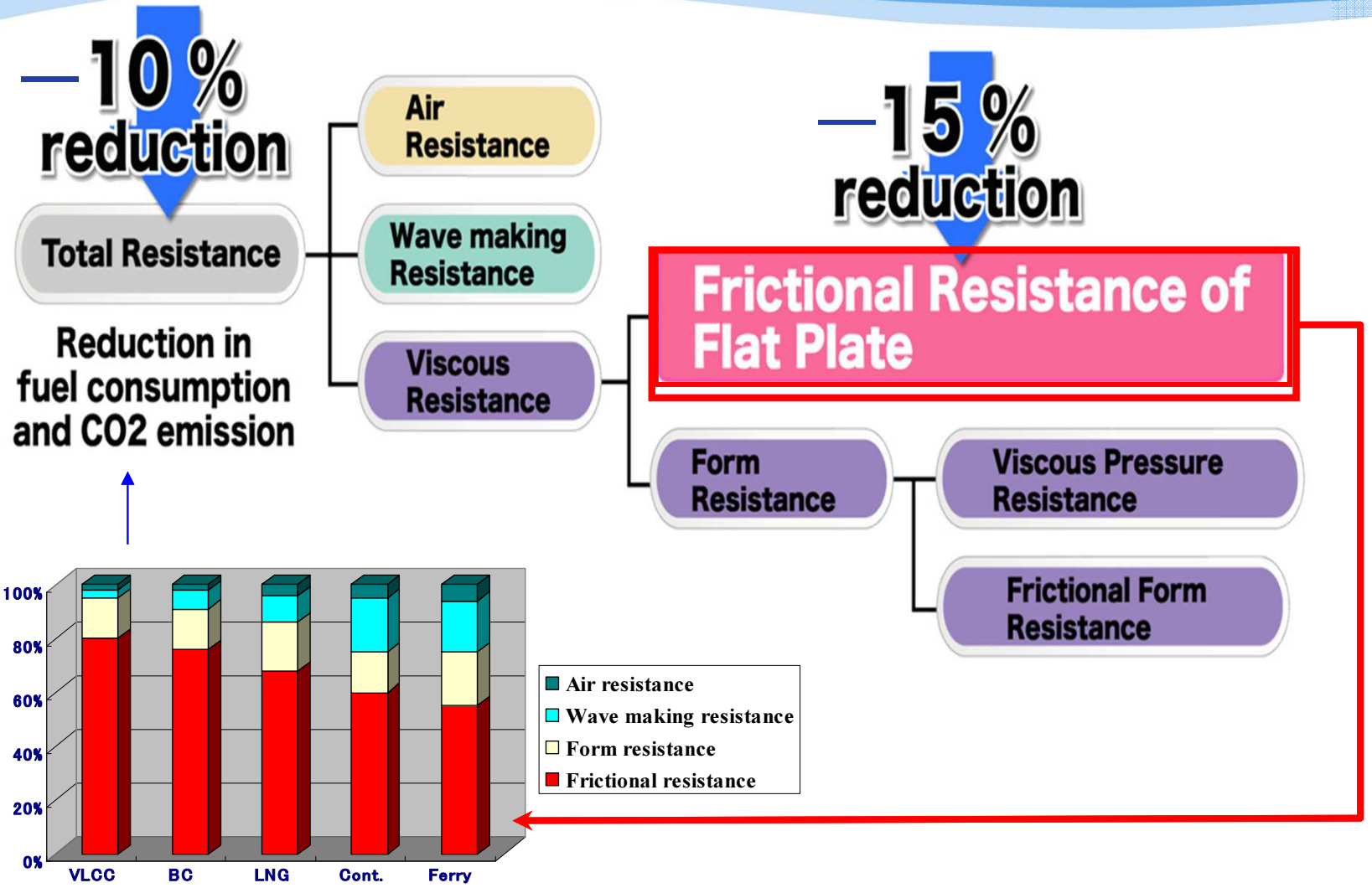
Hydro-gel Technology

Friction between pseudo-liquid and liquid surface

History


2007
2008
2009
2010
2011
2012
2013 (year)
−4%
Fuel saving type
Version currently in use LF-Sea
Co-development with
Osaka University and
Kobe University
OSAKA UNIVERSITY
KOBE UNIVERSITY
eco products awards
2010
−10%
Fuel saving type
Advanced version A-LF-Sea
Support project by Japanese Government (MLIT)
Co-study with ClassNK
Co-monitoring with MOL
MLIT
Ministry of Land, Infrastructure, Transport and Tourism
ClassNK
R&D PROJECT

Residence


−10 % reduction
Total Resistance
Reduction in fuel consumption and CO2 emission
Air Resistance
Wave making Resistance
Viscous Resistance
−15 % reduction
Frictional Resistance of Flat Plate
Form Resistance
Viscous Pressure Resistance
Frictional Form Resistance
100%
80%
60%
40%
20%
0%
VLCC
BC
LNG
Cont.
Ferry
Air resistance
Wave making resistance
Form resistance
Frictional resistance

2008 –

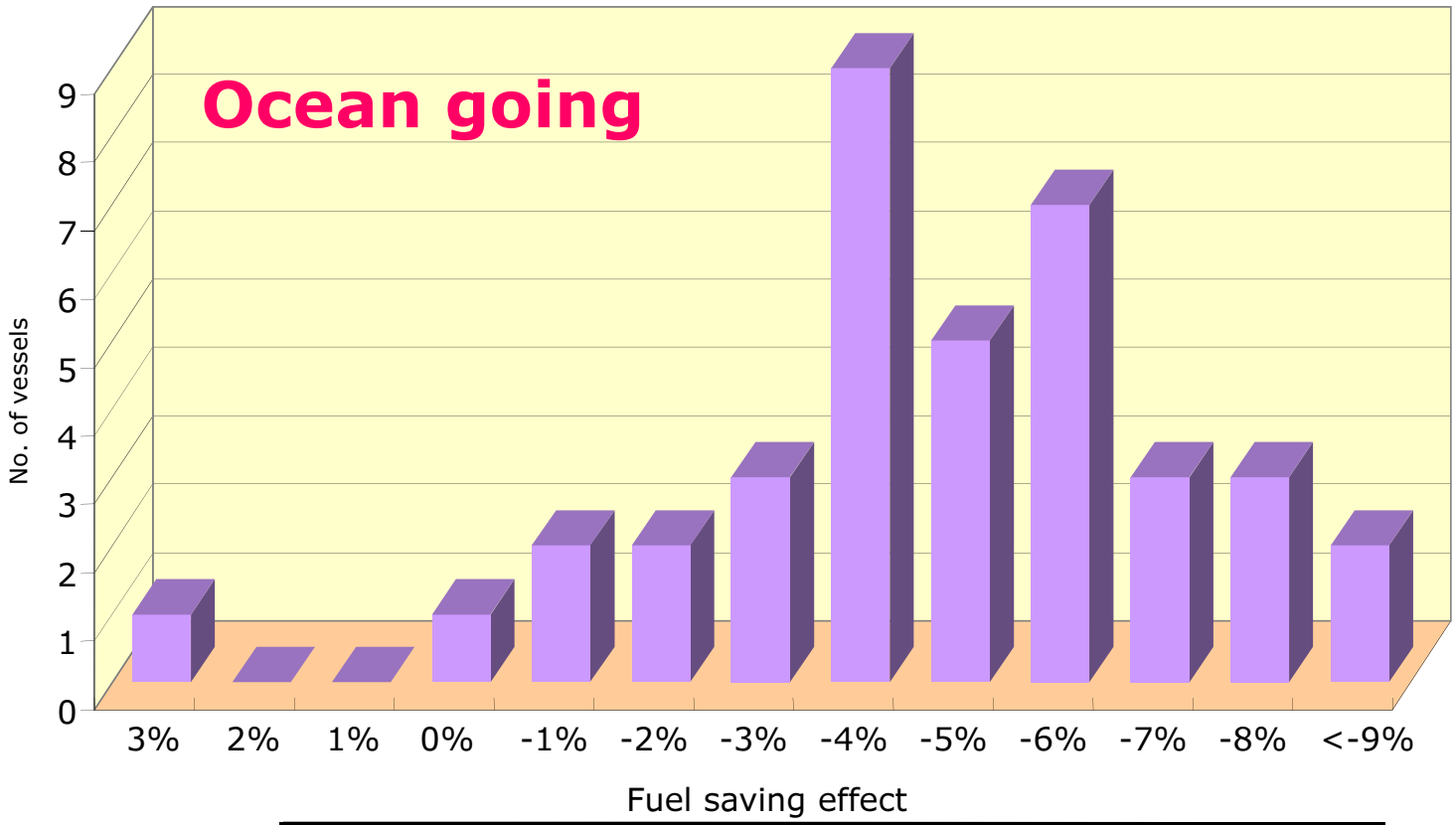
LF-Sea (launched in 2008)

- Biomimetic technology
- Water-trapping function incorporated into Copper silyl acrylate antifouling coating

- Verified average -4% fuel saving *
- Applied to **over 970 ships**
- Patented
- Easy application at New Build or in Dry-Dock

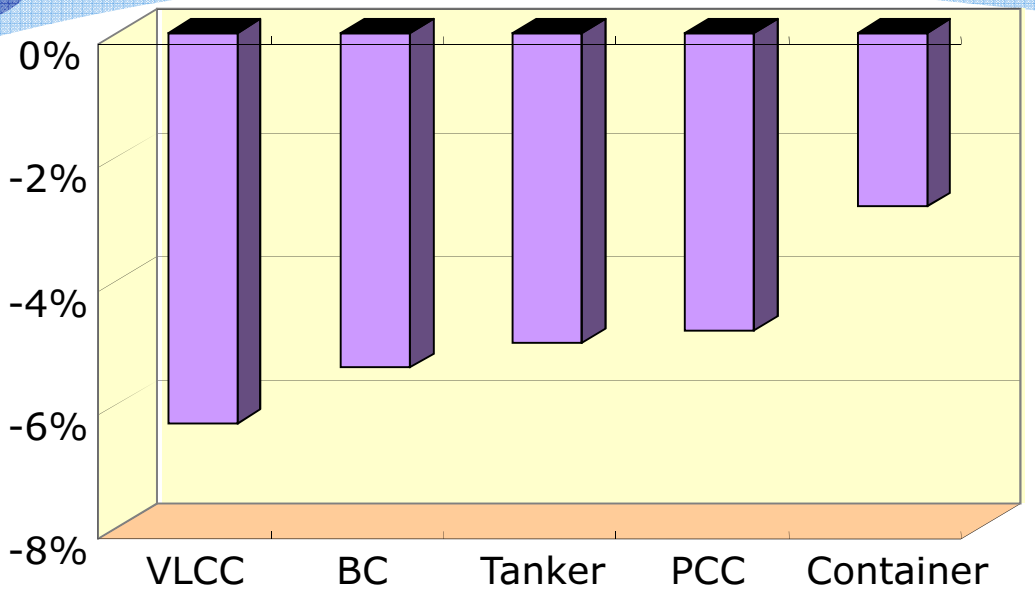
* Percentages quoted compare the power saving benefit of the system to a clean SPC AF in good condition at the same point in the vessel's docking cycle

Fuel saving effect of LF-Sea

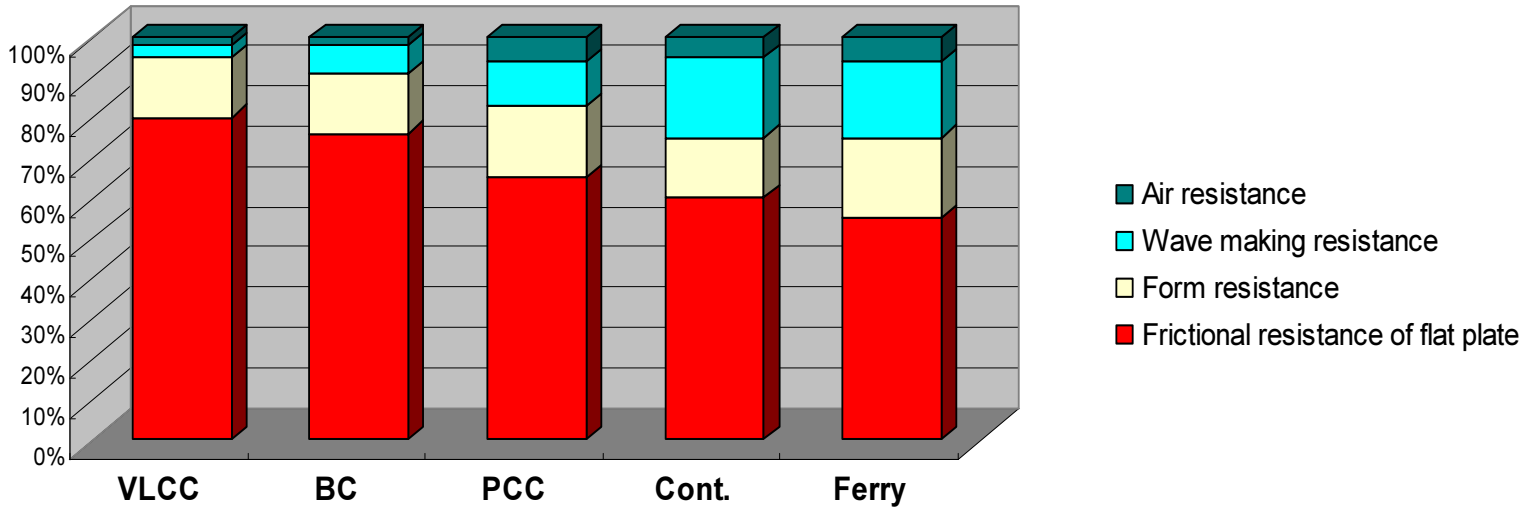


Fuel saving effect	Vessel	Content (%)
Less effect (3 ~ - 1%)	4	10.5%
Proper effect (<-2%)	34	89.5%

Fuel saving effect of LF-Sea



The larger ship,
the greater "Frictional resistance of flat plate"
and the greater fuel saving effect



2013 -

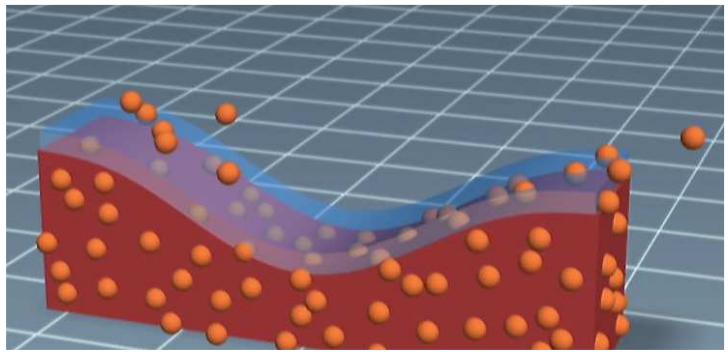
A-LF-Sea (2013-)

- Improved Biomimetic technology

(1) Enhanced water-trapping function incorporated into Copper silyl acrylate antifouling property

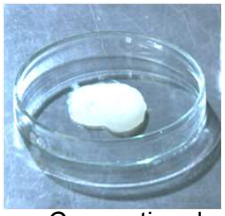
(2) Rheology Control for anti- corrosives (New Feature)

- Expected -10% fuel saving *
- Applied to **over 140 ships**
- Patented
- Easy application at New Build or in Dry-Dock

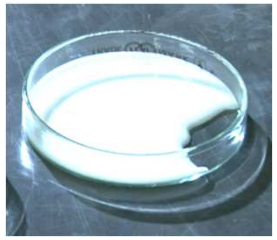


* Percentages quoted compare the power saving benefit of the system to a clean SPC AF in good condition at the same point in the vessel's docking cycle

Advanced Type of Hydro-Gel



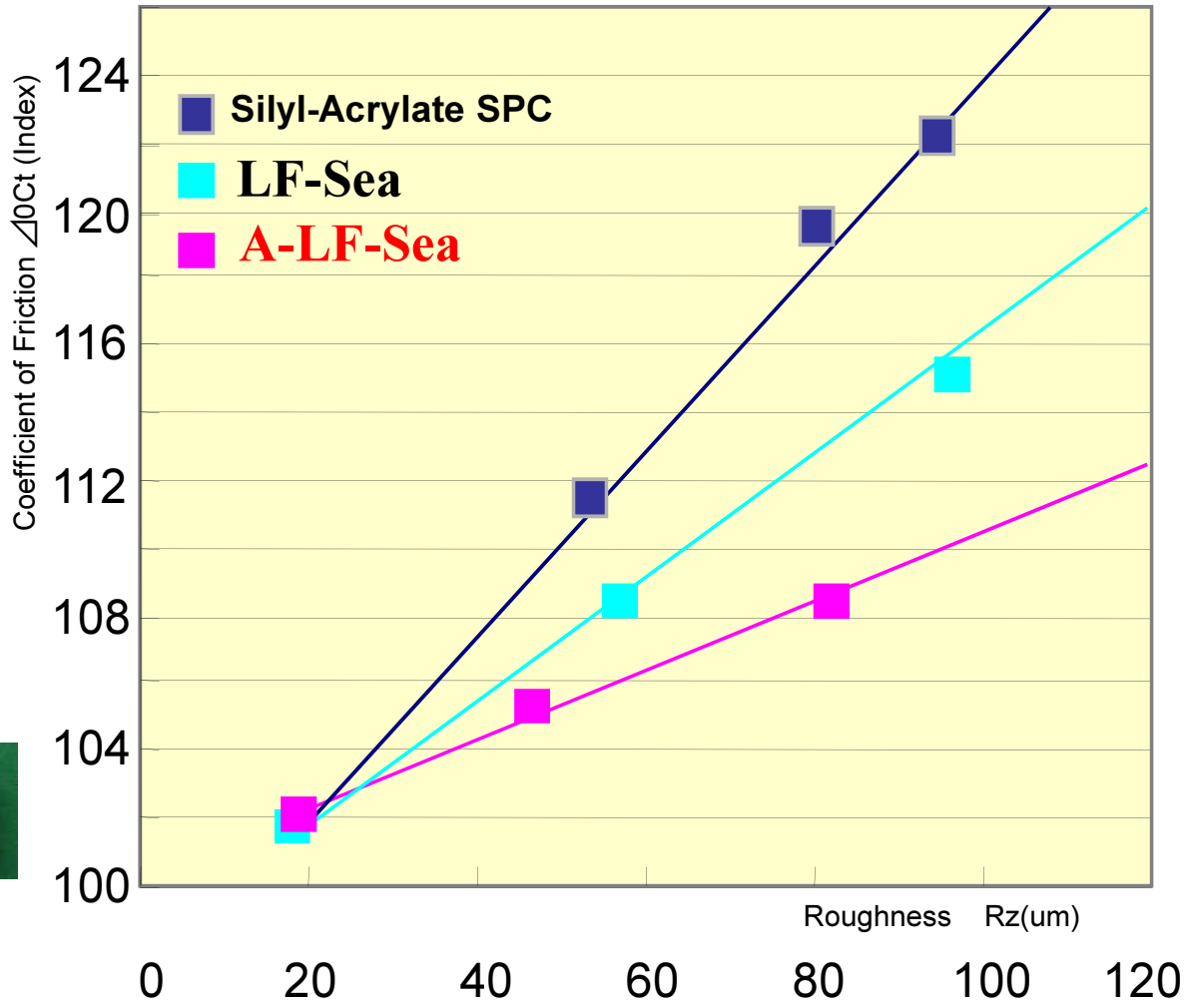
Conventional Hydro-gel



Specially Designed Hydro-gel

Device for Measurement of Frictional Resistance

Std. (Smoothed surface)



Training Ship Test

Year	A/F Paint	n	Test period	AV.Speed (Annual)	FOC between fixed points		FOC reduction
						Speed Corrected	
				Knt	L	L	%
2010	SPC AF	24	2010.2-2011.1	12.41	242.0	242.0	Std.
2011	LF-Sea	19	2011.2-2012.1	12.51	235.2	231.5	-4.4%
2012	A-LF-Sea	19	2012.2-2013.1	12.49	226.7	223.8	**-7.5%**

Reported by Kobe University

・Controllable pitch propeller (CPP) : 305 rpm
・Propeller angle of forward swept wing 18.0˚

Training ship (Fukae-maru)

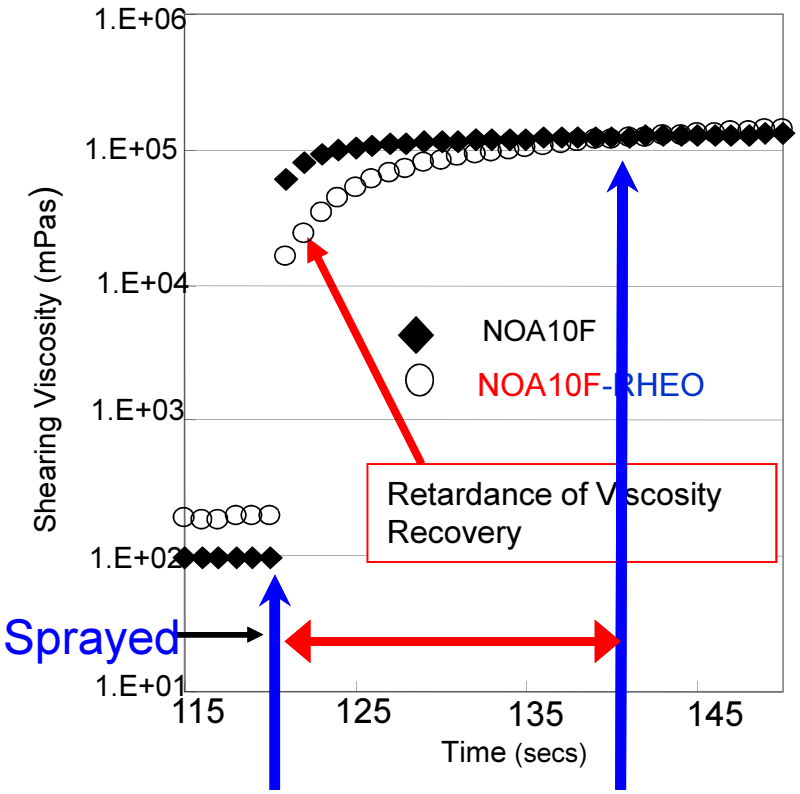
Rheology Control

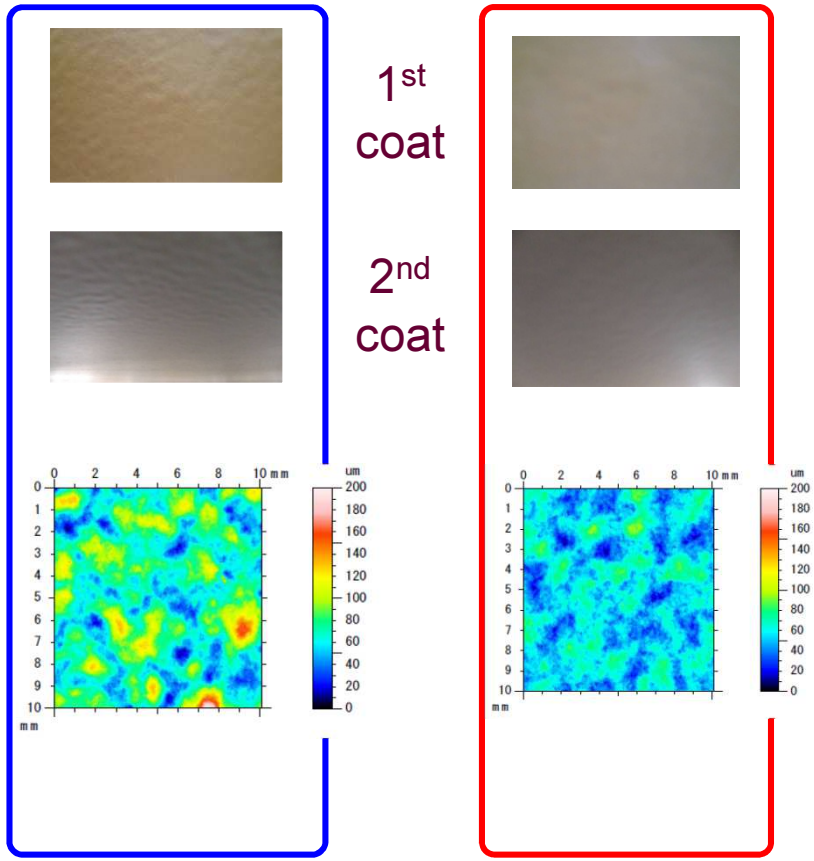
Derived from Know-How in Automotive Coatings

Rheology Control of A/C

By retarding the viscosity recovery of the paint film immediately after application ➔ this will deliver a coating significantly Lower Surface Roughness

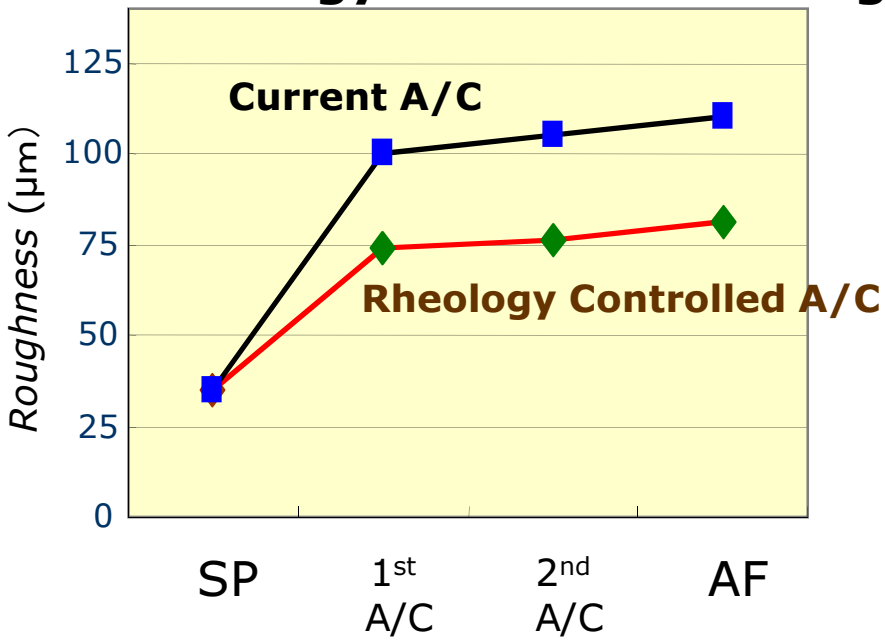
Viscosity of Paint Film





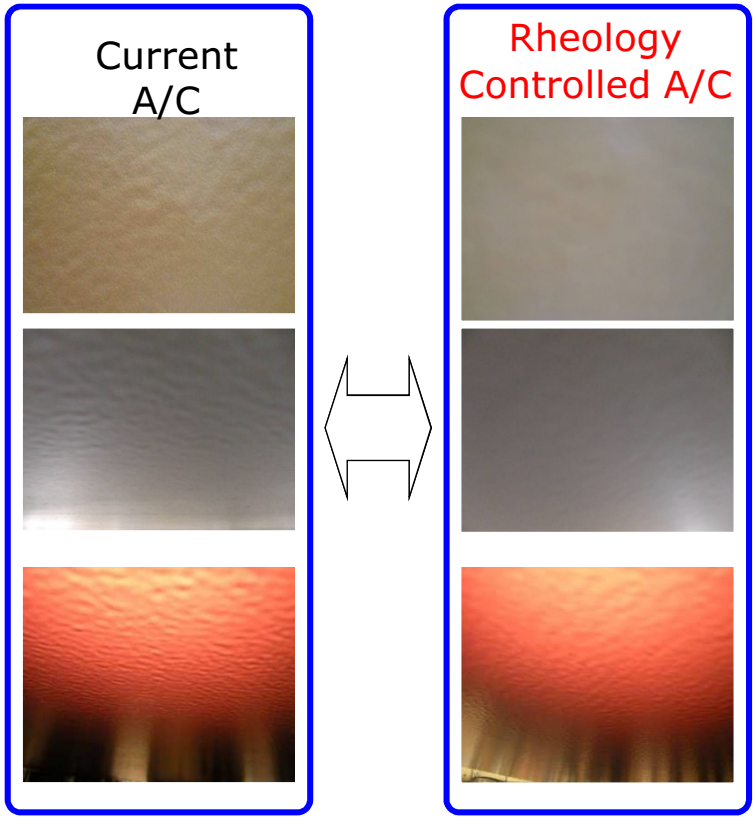
Rheology Control of A/C

Rheology Control Technology

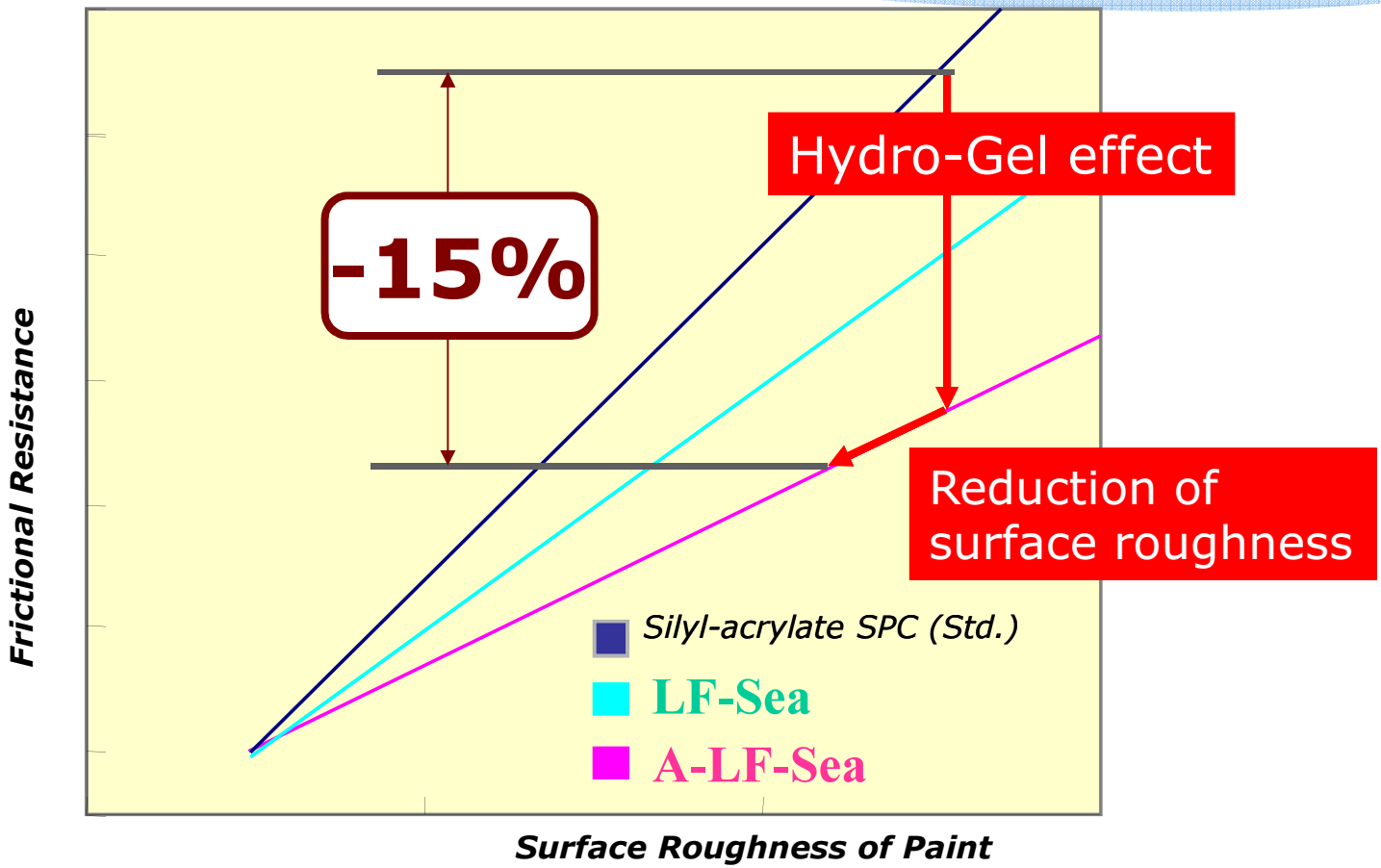


Paint Surface Condition during each phase of the painting process

Block DB9-C for Flat Bottom

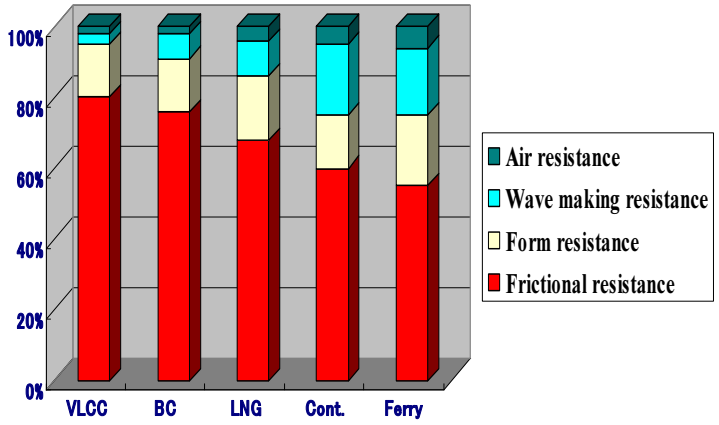


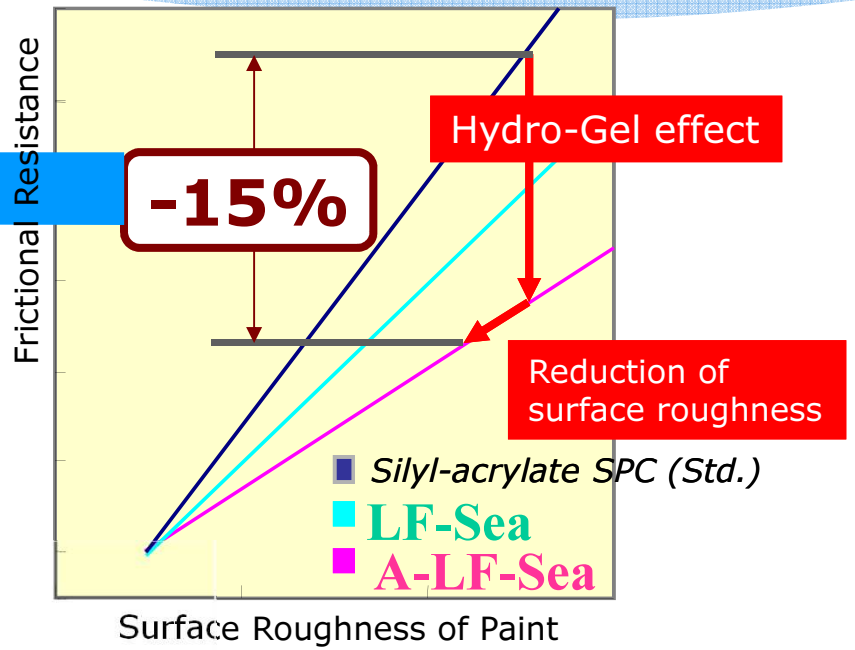
Mechanism to reduce Frictional Resistance

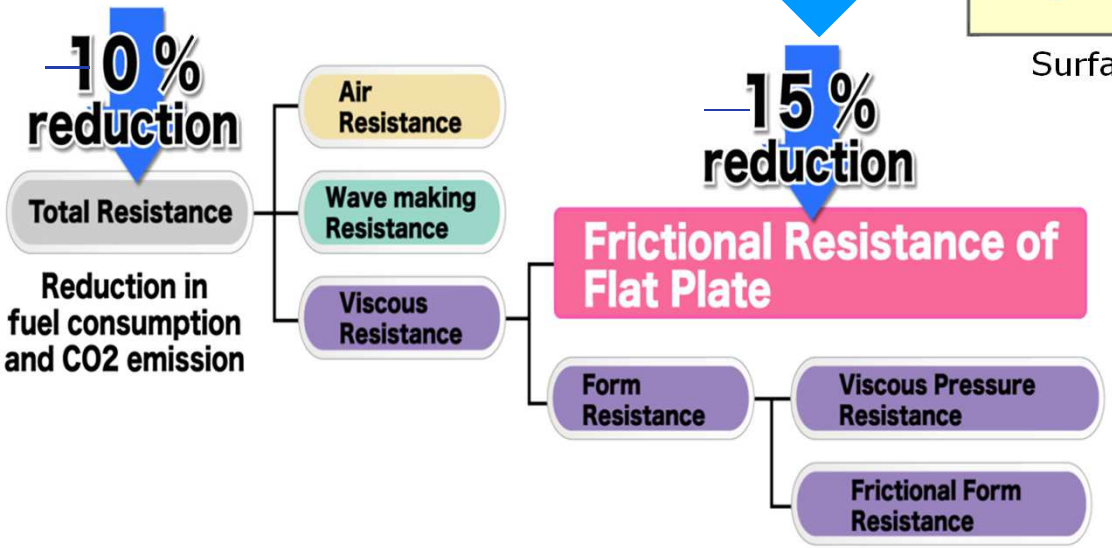


Enhanced Hydro-Gel + Rheology effect ➔ 15% reduction of Frictional Resistance

Mechanism to reduce Frictional Resistance







Ships in Service

A-LF-Sea – Test on actual vessels

Pure Car Carrier (PCC)

M&R (Dry-dock)

M&R-1 : Nov 2011 applied with **A-LF-Sea**

M&R-2 : April 2012 applied with **A-LF-Sea**

New Builds

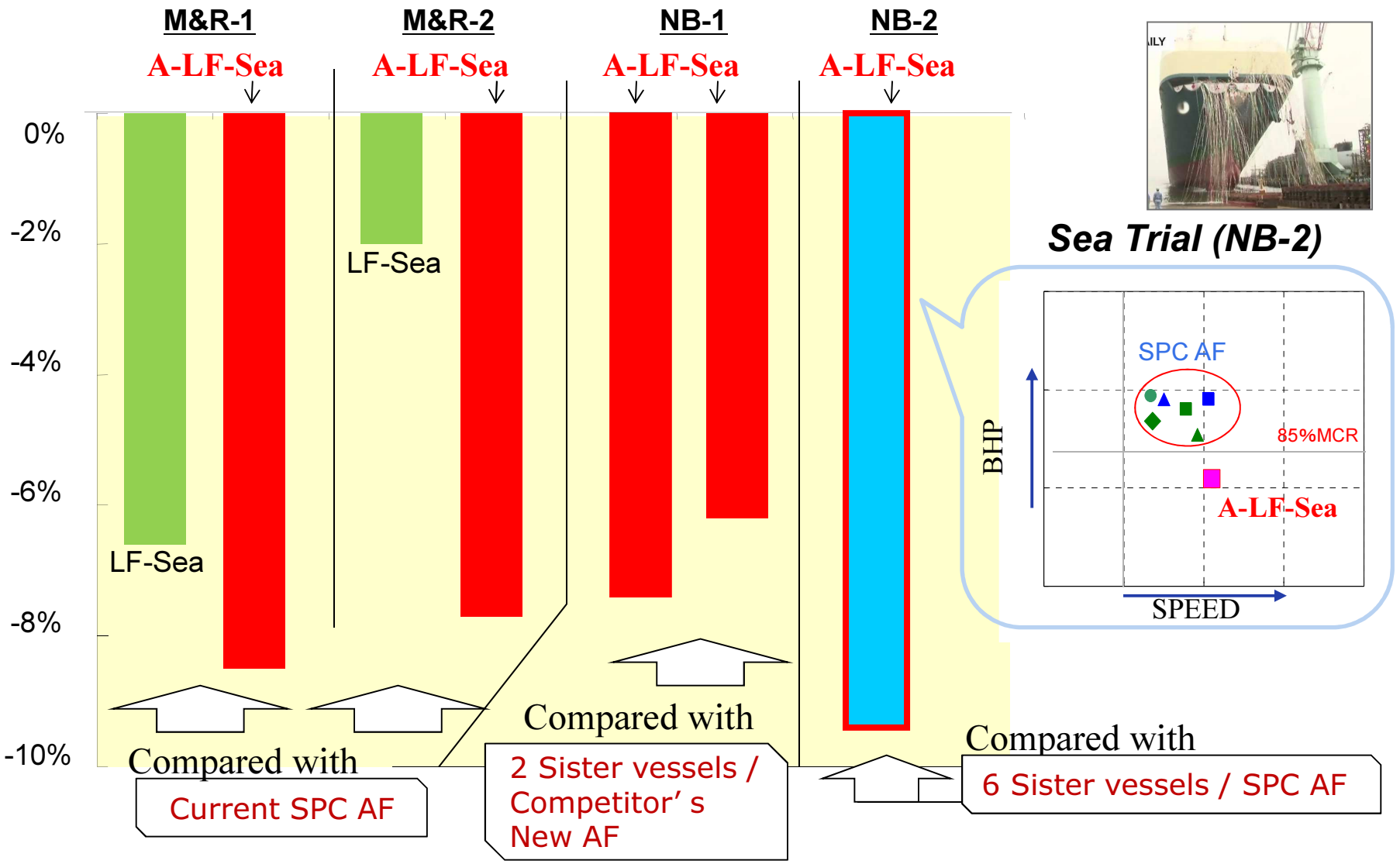
NB -1: applied with **A-LF-Sea** at pre-delivery dock

& delivered in August 2012

NB-2: applied with **A-LF-Sea system**

& delivered in June 2012

Ships in Service / Fuel Saving Effect



Sea Trial (NB-2)

-7 to -8% fuel saving effect is confirmed by above 3 PCCs **without Rheo A/C**.

About **-10%** effect is confirmed by above PCC (NB-2) **with Rheo A/C.**

Comparison : LF-Sea & A-LF-Sea system

		LF-Sea	A-LF-Sea system
Scheme for fuel saving		Only AF	AC + AF
Fuel Saving Effect	(1) NB	-4 % *	-10 % *
	(2) M&R Full Blasting (not including effect of full blasting)	-4 % *	-10 % *
	(3) M&R Spot Repair	-4 % *	-7 ~ -8 % * (Only AF)
Surface Preparation & Application apparatus		Normal (No additional cost)	
Maximum Service Life		60 months (up to 90 months depend on type of ship)	
Product Range		Ocean-going, Coastal vessels	

* Percentages quoted compare the power saving benefit of the system to a clean SPC AF in good condition at the same point in the vessel's docking cycle

Reference / Summary / Award

Research & Development of the Ultimate Fuel Saving AF paint

~ Super Efficient Ship Development Program ~

- Fuel-Saving Target -10% ← Based on evidence of Current LF-Sea **technology** (4%)
- Subsidized by Japanese Government (MLIT)
- Monitoring / Analyzing with MOL
- Supported by Osaka University & Kobe University
- Period for Development : 2009 – March 2013
- Start of Sales : April 2013

ClassNK R&D PROJECT

This technology was developed with the support of ClassNK as part of the ClassNK Joint R&D for Industry Program.

eco products awards 2010

LF-Sea : Eco Product Award 2010

MLIT Ministry of Land, Infrastructure, Transport and Tourism

Seatrade ASIA Awards 2014

Advance Notice

Evolution of Technology

Over 1,100 Track Records

eco products awards 2010

1st Generation

2008 ~

LF-Sea

- Cupper Silyl Acrylate + Cuprous Oxide
- Hydro-gel → Water Trapping function
- **4%** Fuel saving effect

2nd Generation

2013 ~

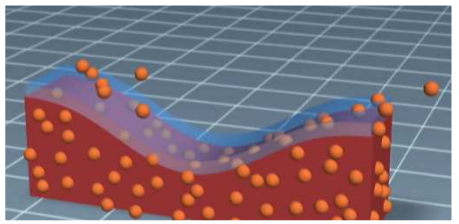
A-LF-Sea

- Cupper Silyl Acrylate + Cuprous Oxide
- Hydro-gel → Enhanced Water Trapping function
- Rheology Controlled A/C
- **10%** Fuel saving effect（for NB, full blasting M&R)
- **7～8%**（for M&R）

3rd Generation

MAXIM

- Under development
- Biocide-Free



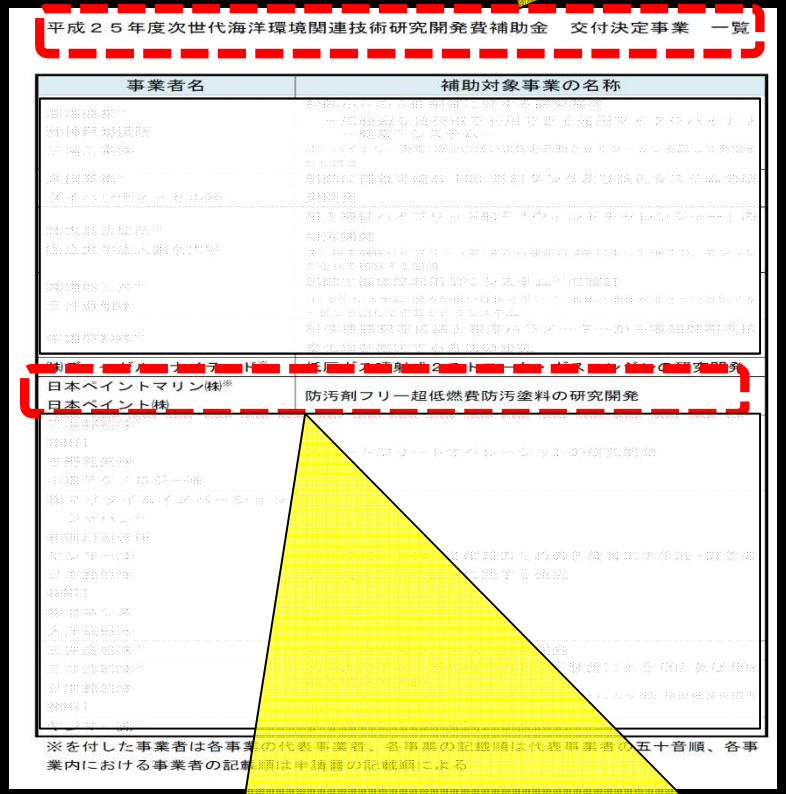
NIPPON PAINT MARINE

Japanese Government

Co-study with ClassNK

平成２５年度次世代海洋環境関連技術研究開発費補助金　交付決定事業　一覧

Quoted from Website of MLIT
the Ministry of Land, Infrastructure and Transport



平成２５年度次世代海洋環境関連技術研究開発費補助金　交付決定事業　一覧

事業者名	補助対象事業の名称
日本ペイントマリン㈱※ 日本ペイント㈱	防汚剤フリー超低燃費防汚塗料の研究開発

※を付した事業者は各事業の代表事業者、各事業の記載順は代表事業者の五十音順、各事業内における事業者の記載順は申請書の記載順による

Supported project List for Next Generation Marine Environment Technical Research & Development (Year 2013)

https://www.mlit.go.jp/common/001019527.pdf

NIPPON PAINT MARINE & NIPPON PAINT
“R & D for Biocide Free Super Fuel Saving AF”

II

日本ペイントマリン㈱※ 日本ペイント㈱	防汚剤フリー超低燃費防汚塗料の研究開発

ClassNK
R&D PROJECT

A-LF-Sea

Advanced Low Friction Coating

NIPPON PAINT MARINE
Basic & New