泡の力で省エネ 空気潤滑法の実船適用例
Energy saving by air bubbles Air Lubrication technology applied to M.V. SOYO

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株式会社大島造船所
OSHIMA SHIPBUILDING CO., LTD.

1. 「双洋」について About M.V. SOYO

● 主要目 Principal Particulars

船種	Type of ship	:	Bulk Carrier
全長	Length overall	:	235 m
幅	Breadth	:	43 m
満載喫水	Draught	:	13 m
載荷重量	Deadweight	:	91,000 MT

オーストラリアから
東日本へ石炭を運送
Transporting coals to power stations in East Japan from Australia, etc.

● 省エネ効果 How ECO-friendly?

CO_2 削減効果
Reduction **5%**

実航海での最大値
max. value in service

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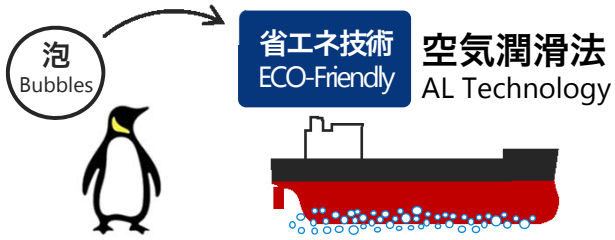
「双洋」エコの秘密とは？
The Secret of ECO on M.V. SOYO

2. 空気潤滑法の適用 Air Lubrication Technology applied

● 空気潤滑法とは AL Technology

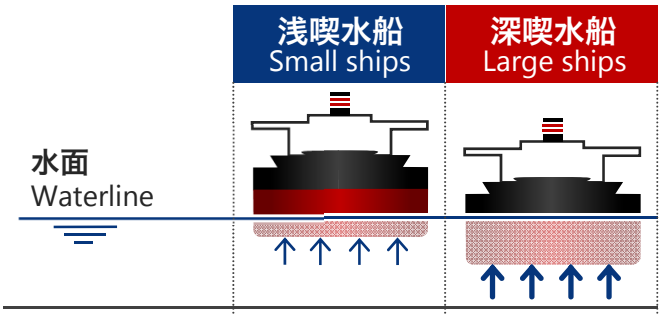
船底の気泡流により船体と海水間の摩擦抵抗を減らす省エネ技術。
Reducing frictional resistance on ship hull by creating layer of air bubble flow between seawater and ship bottom.



しかし、大型船舶への適用には、「喫水の壁」がある。
The theory is simple, but it is hard to get benefits on large ships like SOYO due to the Barrier of Draught.

● 従来方式 Conventional System

電力を使って船底まで空気を送り出す。
Electric air blowers or compressors are used to pump air to ship bottom.



	浅喫水船 Small ships	深喫水船 Large ships
船底の水圧 Hydraulic pressure on ship bottom	小 Low	大 High
必要電力 Required electric power	小 Small	大 Big
必要電力 Benefits of energy saving	プラス Positive	マイナス※ Negative

※ 双洋での試算 / Estimated for SOYO

従来方式では、「双洋」のような深喫水船では、省エネ効果がマイナスに…
Conventional systemis simple but not suitable for large ships like SOYO.

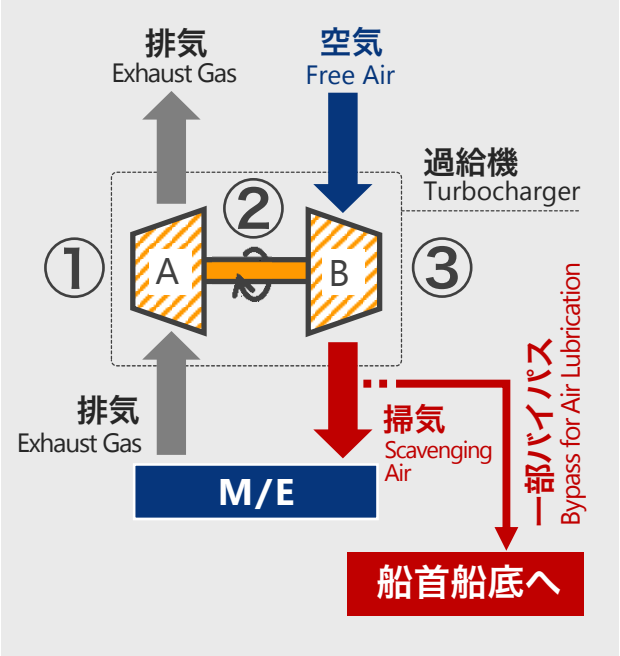
「喫水の壁」打破に新技術投入
New Thechnology introduced

● 世界初方式 World's First

主機掃気バイパス方式
Main Engine Scavenging Air Bypass system

掃気とは？ Scavenging Air

主機の燃焼用圧縮空気のこと
Compressed air produced by turbocharger, supplied to main engine for combustion utilization



① 主機の排気でタービンAを回転
Turbine wheel(A) driven by main engine exhaust gas

② その回転力でコンプレッサホイールBを駆動
Coaxial compressor wheel(B) rotating together with turbine wheel(A)

③ コンプレッサホイールBが空気を圧縮
Suction air compressed by compressor wheel(B)

↓

この圧縮空気が「掃気」といい、船底への空気投入に電力は不要 !!

Scavenging air produced,
With the high pressure, scavenging air does not require extra electric power for its transportation to ship bottom !!

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世界初方式は、「双洋」のような深喫水船でも省エネ効果がプラスに !!
By this method, positive effects in energy saving can be expected even for large ships like SOYO !!

3. 空気潤滑効果の最大化
Efforts to maximize Air Lubrication efficiencies

● 掃気バイパス最適化
Optimization of Scavenging Air Bypass system

目的 Target

- **掃気バイパス量の最大化**
  Acquisition of maximum amount of scavenging air
- **燃費率悪化の最小化**
  Minimization of deterioration in SFOC of main engine

2年間の主機陸上試験および調整を行い改善。
当初試算2%悪化を最大0.4%に抑え、1/5に。

Prior to the determination of main engine, adjustments of turbocharger and main engine shop tests were repeatedly carried out over two years. Deterioration in SFOC was limited to acceptable level from initially estimated 2% to final 0.4%.

● 船底気泡流最適化
Optimization of air bubble flow under ship bottom

目的 Target

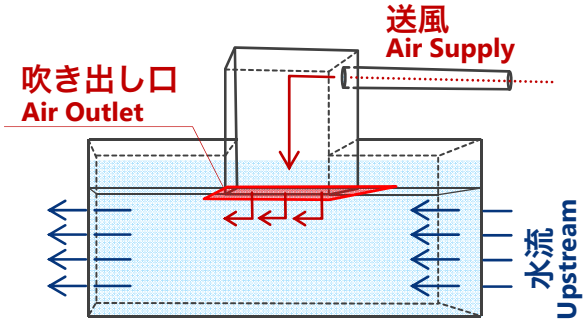
船底を均質な泡で万遍なく覆う
Covering ship bottom as wide as possible by uniform air bubbles

検討・実験・改善を重ねた
Design, tests, optimization were repeated for

- **内部構造**
  Inner structures
- **空気吹き出し位置**
  Configurations of air outlets on ship bottom
- **吹き出し口形状**
  Opening patterns of air outlets

実験例 Example

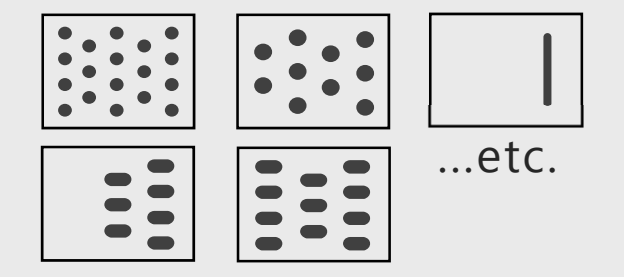
回流水槽実験
Tests in CWC



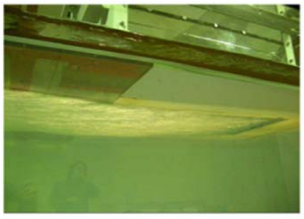
水を循環させる回流水槽で実験を繰り返し、最適な空気吹き出し口形状を選定。

In high speed Circulating Water Channel, an air chamber with full scale was tested repeatedly to determine the best opening pattern of air outlets.

検討した吹き出し口形状の例
Part of tested air outlets

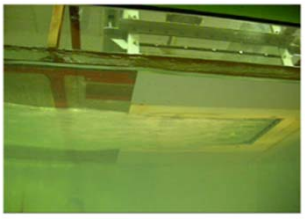


悪い例
Unsuccessful case



流れが不安定で、泡が白く波打っている。
Wavering and unstable air flow

良い例
Successful case



泡が滑らかに流れている。
Smooth and stable air flow

最適な吹き出し口形状を選定
Best opening pattern determined

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- **「喫水の壁」打破**
  Barrier of Draught removed
- **空気潤滑効果の最大化**
  Maximization of AL efficiency achieved

➡ **「双洋」完工**
M.V. SOYO
COMPLETED

4. 海上試運転の結果
Results of sea trial

2012年6月17日、「双洋」は海上試運転へ出発 !!
On 17th June 2012, SOYO departed for sea trial.

● 軸馬力計で一目瞭然
Viewing AL benefits on display of shaft power meter

AL System	OFF	ON
M/E Output	9,097kW →	8,069kW
	abt. 1,000kW down	
M/E rpm	Constant	

泡の効果で、船を前進させるための主機馬力が低下している。
With the assistance of air bubbles, less main engine power is enough to keep ship speed.

● 速力試験では Results of speed trial

喫水が異なる2つのコンディションで計測
To verify AL benefits in detail, speed trials were conducted at sea trial on two different draughts.

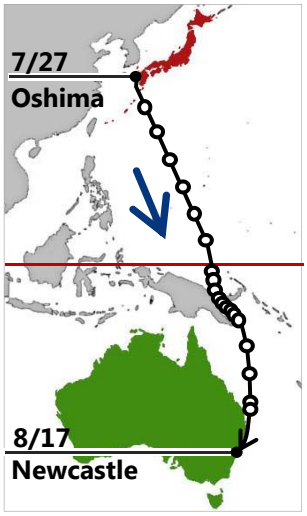
	喫水の浅い Normal Ballast	喫水の深い Heavy Ballast
Draught	6.6 m	8.8 m
CO_2 reduction	8.1%	4.4%

海上試運転において泡の効果が明らかに!
Energy saving by air bubbles confirmed !

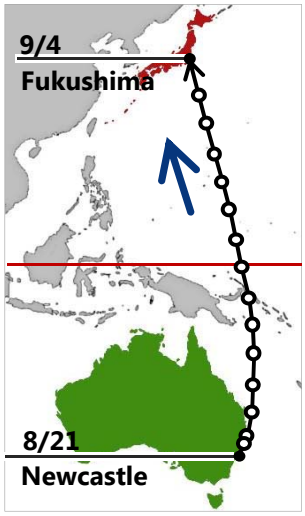
5. 就航後の実船計測
Onboard measurements

「双洋」は就航後、技術者が乗船し実船計測を実施
During her maiden voyage, engineers from shipyard and operator got onboard SOYO, carrying out performance tests at the following conditions.

Ballast Condition
(Draught 8.1m)

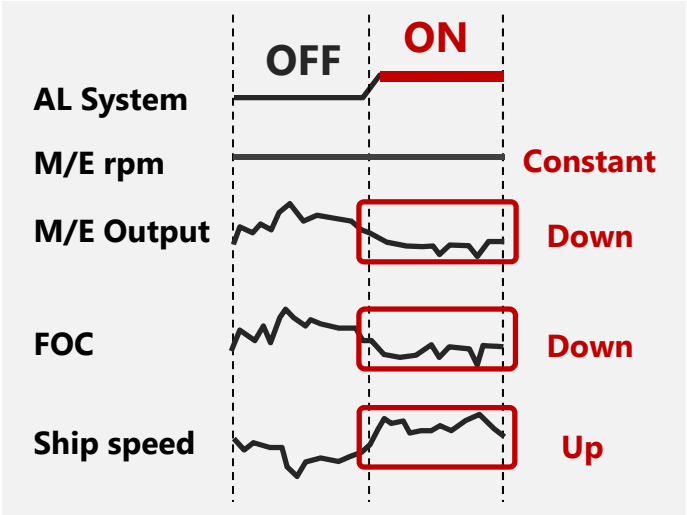


Loaded Condition
(Draught 12.8m)



空気潤滑システムの ON/OFF を1時間毎に繰り返し計測を行い、効果を確認。

Switching ON/OFF Air Lubrication System every one hour, data recording and analysis were carried out over one month.



システムを ON にすると…
When the system switched ON,

- **主機回転数は一定のまま馬力が減少**
  Main engine rpm keeping constant, main engine output going down
- **馬力に応じて燃費も減少**
  FOC also going down following main engine output
- **船速は若干増加**
  Ship speed going up a little

↓

泡の効果が明確に見えた！
Benefits by air bubbles confirmed !

	JPN → AUS Ballast Condition	AUS → JPN Loaded Condition
Draught	8.1 m	12.8 m
CO_2 reduction	5%	3%

6. まとめ Conclusion

空気潤滑技術 Air Lubrication

大型船舶への適用には
「喫水の壁」があった
"Barrier of Draught"
existed for Large Vessels

世界初 主機掃気バイパス
World's First **Scavenging Air Bypass System** applied

双洋

- 「喫水の壁」打破に成功！
  "Barrier of Draught" Removed
- 実航海での効果を実証 !!
  CO_2 reduction verified in service
- 汎用性の高さを示した !!!
  Easy to be widely used

「双洋」への空気潤滑法の適用が高く評価され、シップ・オブ・ザ・イヤー2012を受賞。
NYK/MTI殿と共同実施した本開発事業に対し、ご支援くださいました皆様(国土交通省、日本造船技術センター、日本海事協会、日本財団、海上技術安全研究所)に厚く御礼申し上げます。

Successful application of Air Lubrication technology to M.V. SOYO was highly evaluated.
In July 2013, M.V. SOYO was awarded **SHIP OF THE YEAR 2012** in Japan!
Many thanks to MLIT/SRCJ/ClassNK/Nippon Foundation/NMRI for their great support to this joint project with NYK and MTI.