Technology to reduce ship's drag and a key to reduction of CO2 emission

R & D Engineering Inc and Prof Yuichi Murai of Hokkaido University, Post Graduate Institute of Technology are making progress toward practical application of the WAIP technology. This technology is to generate micro-bubble on the surface of ship's hull to reduce frictional resistance between hull and sea water. See Fig 1 below. A cargo ship equipped with this technology completed in June, 2008 and few other ships are scheduled to fit this technology in 2009.Practical application of this technology is in progress.

Today, a public attention is drawn to the measures to stop earth warming trend, particularly to the technology to reduce CO2 emission of automobiles. On the other hand, such technology to effectively reduce CO2 emission of ships has not been available. WAIP technology jointly developed by Prof Murai and R & D Engineering Inc was applied to a car ferry and the tests throughout a year proved 10% reduction of fuel consumption. It is expected this technology will draw public attention as a key technology to reduce CO2 emission of ships.

Practical application depends on how micro-bubble can be generated on the hull surface under water at low cost

There are two types of resistance generated by water when a ship sails, i.e. wave making resistance and frictional resistance(so called drag). Wave making resistance is an energy loss caused by the wave when he ship's bow pushes through water. Such energy loss, however, was substantially reduced by the bow structure called bulbous bow. The bulbous bow is the bow structure under water generating waves before the ship pushes through the water. Waves generated by the bulbous bow will have a phase opposite to the phase of the waves generated by ship's shoulder, thus two waves offset the phase each other and the wave becomes smaller. Effect of the bulbous bow successfully reduced the total resistance of the ship by 30%. History of this technology goes back to the construction of the battle ship Yamato built with bulbous bow during World War II. On the other hand, development of a technology to reduce frictional resistance had been limited to only a few exception such as a hydrofoil but a practical technology applicable to commercial ships such as tankers was not available.

The technology Prof Murai and R & D Engineering Inc jointly developed is called WAIP (Winged Air Induction Pipe). (Fig 2) WAIP generates micro-bubbles on the surface of hull under water with high efficiency utilizing negative pressure on the inboard surface of the wing and it reduces frictional resistance. Its principle is described as follows. When the wing moves forward horizontally under water, a dent is generated downstream. When certain attack angle is given to the wing, such dent increases in size until the angle reaches the limit. Fig 3 shows an air pipe supplying

air to the hull surface under water. Air from atmosphere can reach down to certain depth under water. Such air flow is forced downstream through the Kelvin-Helmholtz Instability causing generation of micro-bubble, which covers the hull surface under water and reduces frictional resistance. However, it is difficult for a ship with deep draft to generate the Kelvin-Helmholtz Instability with the ship's speed alone. For a ship with deep draft, it is necessary to provide an air compressor to assist pushing air/water boundary down to the level of upper side of the wing.

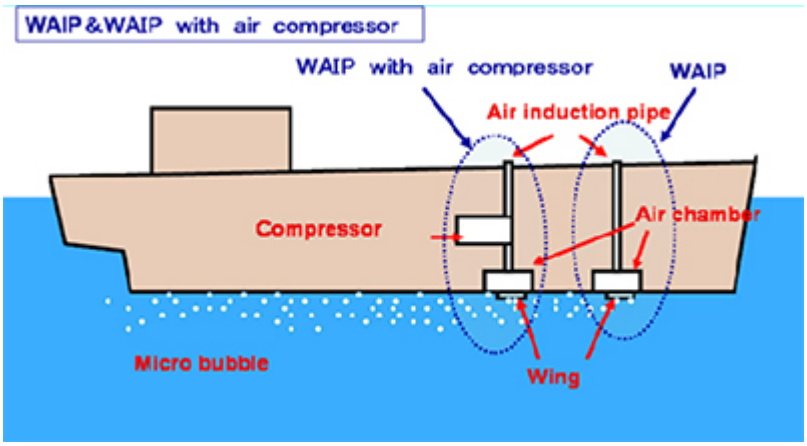
Numerous attempts have been made by researchers in the past trying to reduce frictional resistance of ships. Such attempts, however, have never been used as a practical solution for an obvious reason that energy needed to generate air bubble was either equal to, or, larger than the amount of energy generated by reduction of frictional resistance. WAIP technology made it possible with small amount of energy to generate micro-bubble on the surface of hull under water by means of Bernoulli's Law and Kelvin-Helmholtz Instability. It is now possible for every ship to use this technology as a practical solution to reduce frictional resistance.

R & D Engineering Inc advises there are three features to describe WAIP technology. Firstly, Kelvin-Helmholtz Instability, a physical phenomenon, made it possible to generate ultra fine micro-bubble at low cost. Secondary, the micro-bubble thus generated clings to the hull surface by the function of wing and covers the entire hull surface under water. Thirdly, they developed a calculation method to enable specifying number of WAIP units required for a ship and the effective location of WAIP units on the
Ship.

Ten years of experiments to reach a practical solution

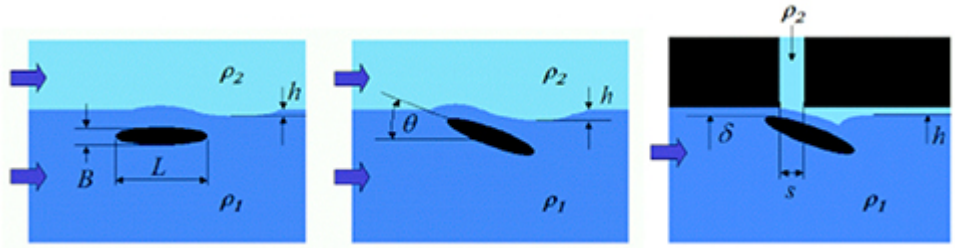
History of WAIP development is long (Fig 4). First experiment started in 1999. A friction generating device like a prism was installed on the bottom of a 11.2 meter ship, "Kiku-maru" and confirmed generation of negative pressure at the aft side of the device.
In 2001 and 2002,series of tank tests were carried out at West Japan Fluid Engineering Laboratory utilizing high speed circulation tank to find out configuration of the most effective WAIP unit with a wing. In December, 2002,two WAIP units were installed on "Adventure 2" and confirmed improved propulsion efficiency in excess of 4%. Configuration of WAIP unit was further modified after the test.
In February, 2005,WAIP units were installed on "Santander Ferry 1" operating in Cebu, Philippines and measured 15% reduction of fuel consumption. In September, 2005,series of experiments completed when WAIP with air compressor assist was installed on "New Ferry Misaki".
In June, 2008,commericial application of WAIP system started when the system was installed on a cargo ship, the "MV Filia Ariea".

(Fig 1)　Concept of the technology to reduce frictional resistance between ship's hull and sea water by generating micro-bubble on the ship's bottom utilizing negative pressure on the wing.




(Fig 2)　WAIP unit

(Fig 3)　Concept of technology to reduce frictional resistance utilizing negative pressure on the wing




(Fig 4)　Ships contributed to WAIP experiments