Theoretical background of WAIP

120530　RDE:　Yoshiaki　Takahashi

1. Preface

WAIP（Winged Air Induction Pipe） is the sole technology ever invented up to now （as of May 2012）in the world which can reduce drag on vertical walls of ships' hull.

This document deals with theoretical background of WAIP hereunder.

2. Contents

(1) Why so small amount of energy for Microbubble generation? :
(2) Why no need to do sea trial after installation of WAIP system? :
(3) Why WAIP can reduce drag on vertical walls of ships hull? :
(4) Why no detrimental effect at all in WAIP application? :
(5) Why maintenance free after installation of WAIP system? :
(6) Why no control at all needed for rough sea conditions? ：

2.Contents

(1) Why so small amount of energy for Microbubble generation? :

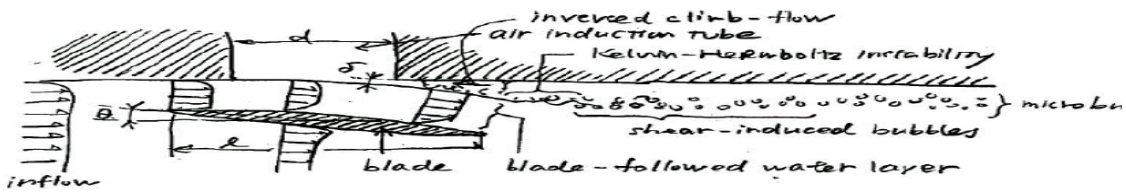
Because, KHI condition only required.

KHI means:

Kelvin Helmholtz Instability which means Microbubble(Peak diameter of Microbubble is about 1.0mm dia.) generation by light fluid(in this case air) over heavy fluid(in this case water) when speed difference between these fluids occur.

Energy required is only for this KHI condition make, that is to say, draft dependent pressurization only and no necessity for generation of Microbubble.

KHI condition to generate Microbubble



(2) Why no need to do sea trial after installation of WAIP system? :

WAIP theory is originated from RDE CEO's theory(you can see attached paper submitted to RINA " Microbubble Drag Reduction ")which shows as follows;

A. Elongation of experimental data to whatever long 500mm wide plate by RDE CEO's theory.

By this theory, RDE can obtain calculated Drag Reduction amount based on original FEL experiments for any length of a ship.

Then Drag Reduction is always as calculated and needs not any sea trial as is usual for wave relevant phenomena.

B. By this theory, RDE can expand its original experimental data for whatever speed the ship advances.

RDE accumulated its speed different actual sea trials and verified its expansion law.

Then RDE can now calculate any kind of ship Drag Reduction always at hand.

C. This theory can be compared with Froude's law for scale effectiveness in case of wave making resistance domaining phenomena as is often the case with the relation between normal model basin test and actual sea trial test.

(3) Why WAIP can reduce drag on vertical walls of ships hull? :

KHI condition shows air phase and water phase on wing of every WAIP at the same time.

Whenever the ship advances, mixing up of both phases occur and transfers into KHI phase and finally generates Microbubble.

This phenomenon has not been affected by WAIP allocation and attitudes at all.

Generated Microbubble has force on it to tighten the hull by effect of aerofoil, therefore Microbubble is considered to flow under the boundary layer of the ship.

In the long run, the ship with WAIP system installed goes through generated hull tightening Microbubble cloud all around the hull by WAIPs around about the bow like necklace and reduces Drag.

(4) Why no detrimental effect at all in WAIP application? :

KHI requires very small amount of air and needs not anything more.

This small amount of air requirement means only about 1% of the amount of slip of propeller may occur.

For example, at 20.2knots 65Liter/Min. and at 14.4knots 46liter/min.

(5) Why maintenance free after installation of WAIP system? :

When WAIP system installed, each air pressure regulating valve at each draft dependent groups is set at first and need no modification at all for any draft differences except on/off for lighter draft cases.

(6) Why no control at all needed for rough sea conditions? :

WAIP is the prime mover of WAIP system.

This means WAIP in water generates negative pressure on wing surface and induce draft dependent pressurized air, while WAIP above water no water inlet to WAIP wing, no negative pressure on the wing and no Microbubble generation at all.

Very simple, without any control at all for rough sea conditions.

3. Conclusion

Ship owners can reduce drag by WAIP for whatever kind of ships they may be.

Although it depends on ships speed and number of WAIPs installed, you can save fuel oil by 10 to 30% with the same speed and with the same loading conditions as before installation.

You can ask for RDE with primary ships data such as:

(1)LppxBmld x Dmldxd(least draft for operations)

(2)Normal output/Normal speed:

For designing WAIP allocation and F.O. saving amount

(3)Actual output/Actual speed:

For actual F.O. saving amount

Concluded