# India Develops a Methodology to Reduce Drag of Ships by 43%

**Sudhir Chandrashekhar Sindagi,** *
Tolani Maritime Institute, Pune, Maharashtra- 410507
Email: sindagi@gmail.com

With fuel prices on a rising trend and international authorities putting impending restrictions on emissions for saving the environment; efficiency of any machine (car, bus, truck, ship, etc.) is under scrutiny. On top of that, there is that ever-lingering question which resides in everyone's mind, which was famously conveyed in a television advertisement of Maruti **कितना देती है*? (How much MILEAGE does it give?)*** still remains. To answer this question, researchers have been pondering overdiverse ways to enhance theefficiency of all mechanisms in the machine.In case of ships, the efficiency (mileage) depends upon its shape and size deciding the drag. Drag is a force acting opposite to the motion or movement of the body with respect to the surrounding fluid (liquid or gas). Objective of every researcherin the field of ship design is to reduce the dragof a ship so that with the same available fuel it can cover a larger distance or with the same available power it can move at higher speeds reducing travel time. Experimental work carried out in the Department of Ocean Engineering, Indian Institute of Technology Madras yielded 43% reduction in the drag of ship, in turn reducing emissions by the similar extent. This methodology developed by Indian Scientist will definitely address all concerns confronted by marine transportation business.

Drag of a body or opposing force is divided into two major components: Viscous drag and Pressure drag. Viscous drag is developed due to friction between fluid particles themselves and surface of the body in contact. Here, the viscosity and density of surrounding liquid plays an important role. Higher the value of these properties, higher is the value of viscous drag.  Vehicles

* Mr. Sudhir Sindagi, Ph.D. Scholar from Indian Institute of Technology, Madras, is pursuing his research on "Investigation of Reduction in Frictional Drag of Ship using Injection of Micro Bubbles Below the Hull." His popular science story entitled "India Develops a Methodology to Reduce Drag of Ships by 43%" has been selected for AWSAR Award.

moving in water experiences more viscous drag than vehicles on land or in the air, as the viscosity of water is higher than that of air. Pressure drag, also known as form drag, is associated with the formation of empty space behind the moving body known as low-pressure area or wake, strength of which depends on the shape of the body. Here, bluff bodies like body with rectangular shape will have higher value of pressure drag as compared to a streamlined body like that of a fish. Generally, all surface or underwater vehicles are streamlined to their maximum limit, hence further reduction in the pressure drag is bit difficult. However, still there are opportunities to reduce viscous drag. From the previous research, it has been proved that for slow-moving bodies like ships, viscous drag accounts for as much as 60%-80% of the total drag. This forced researchers worldwide to look for opportunities to reduce the viscous drag.

Micro Bubble Drag Reduction famously known as MBDR, has been conceptualised long ago. However, for last many years it is still in the research phase. Researchers from Japan and United States tried this methodology for ships. However, desirable results have not been achieved. In MBDR, air bubbles are injected below the moving body. When air is injected below the moving body, flow containing both air bubbles and water is formed. This reduces density and viscosity of liquid along with other favorable changes in the flow structure, causing considerable reduction in the viscous drag. If the rate of air injection is increased, bubbles begin to coalesce to form a transitional air layerthat covers the surface in patches. If the injection flow rate is increased further, a continuous layer of air is formed, reducing direct contact of water with the surface of body, famously known as Air Lubrication System (ALS). Formation of continuous air layer is the ultimate thing, reducing density of liquid in contact with the surface from water to air. Different methods have been tested to inject air bubbles below the body, such as injection through porous plate or using array of small sized holes, etc. Each methodology hasits ownadvantages and disadvantages. Based on past experiments carried out worldwide on the flat plate; it is opined that, method of injection through a series of holes yielded favorable results and is able to achieve 80% reduction in viscous drag. As compared to other methodologies used to reduce the viscous drag, MBDR has additional advantages like it is environmentally friendly, is easy to operate, has low initial and maintenance cost and high savings of energy. Since depth of ships is generally quite high, the static pressure of liquid at that depth becomes still higher. Hence, to inject air below the hull at that depth, air needs to be compressed to a higher pressure. Use of air compressor to initially compress the air before it is injected requires considerable energy, reducing efficiency of the methodology. From the past model experiments on different size and shape of ships, reduction in the total drag in the range of 12%-15% was attained. However, with energy requiring to compress the air and reduction in the efficiency of propeller due to presence of bubbles in the water, efficiency of the methodology was reduced to only6%.

Thus, in order to increase the efficiency of the process, a well-planned and executedexperiment on 5-meter-long model of the ship (Bulk carrier) in the towing tank of Department of Ocean Engineering, Indian Institute of Technology Madras was conducted, which yielded a whopping 43% reduction in the total drag of ship at the slower speed of 06 knots and 22% reduction at the cruising speed of 10 knots. For the experimental investigation, a suitable hull was initially

selected withthe wide flat bottom. This caused injected bubbles to stay close to the bottom of the hull due to the action of buoyancy force and, in turn, increased theefficiency of the entire process. For the research, an array of holes was used to inject air. Air compressor was used initially to compress the air, which was then fed into an air injector unit through a valve to control the flow rate of air and then through the flow meter to measure the flow rate. Air injector unit consists of an air chamber which has 225 holes of 1mm diameter each made into its bottom plate. The air chamber is mounted into the wooden model of ship in such way that, the bottom of air chamber is flushed with the bottom of the model. For the visualisation of flow and migration of air bubbles below the hull, the bottom of the model was cut at three longitudinal locations, which was then replaced with 9mm thick acrylic sheet. Special care has been taken to avoid any leakage of water into the model along with proper stiffening of acrylic sheets. The experimental study was carried out for a speed range of 4 knots to 12 knots in the interval of 1 knot. For each speed, effect of six different injection flow rates of 0.5 CFM (Cubic Feet per Minute) to 3.0 CFM in the interval of 0.5 CFM was investigated. In all, 54 experiments were conducted to study the effect of speed and injection flow rate on drag reduction. From the various experiments conducted in the past, it was found that, at certain locations bubbles were escaping in the sidewise direction, reducing efficiency of the entire process. However, as for this experiment, hull was carefully selected,bubbles did not escape till the aft most end of the ship. This was one of the reasons for higher value of reduction in the total drag as compared to previous experiments conductedworldwide.

Due to restrictions from the bottom, inland vessels (ships) operating through rivers usually moves at very slow speeds. Experimental work carried out at IIT Madras opines that, MBDR methodology will be more effective for all types of inland vessels. Inland Waterways Authority of India (IWAI) is the statutory authority in charge of the waterways in India. IWAI has projected that;by the year 2025, 2100 vessels will be operating in National Waterways- 1. If MBDR system is installed on all 2100 vessels as planned by IWAI, one can expect efficiency enhancement, reduction in both fuel consumption and emissions from these vessels. With this system working on all ships, one can make statements like

ये जहाज कम  पिती है ***(This ship consumes less fuel)!***

ये जहाज कम छोडती है ***(This ship emits less pollutants)!***

ये  जहाज सबको पछि छोड आगे भागती है***(This ship leaves everyone behind)!***

YouTube link for the model test: https://www.youtube.com/watch?v=XFKshj5GSkQ