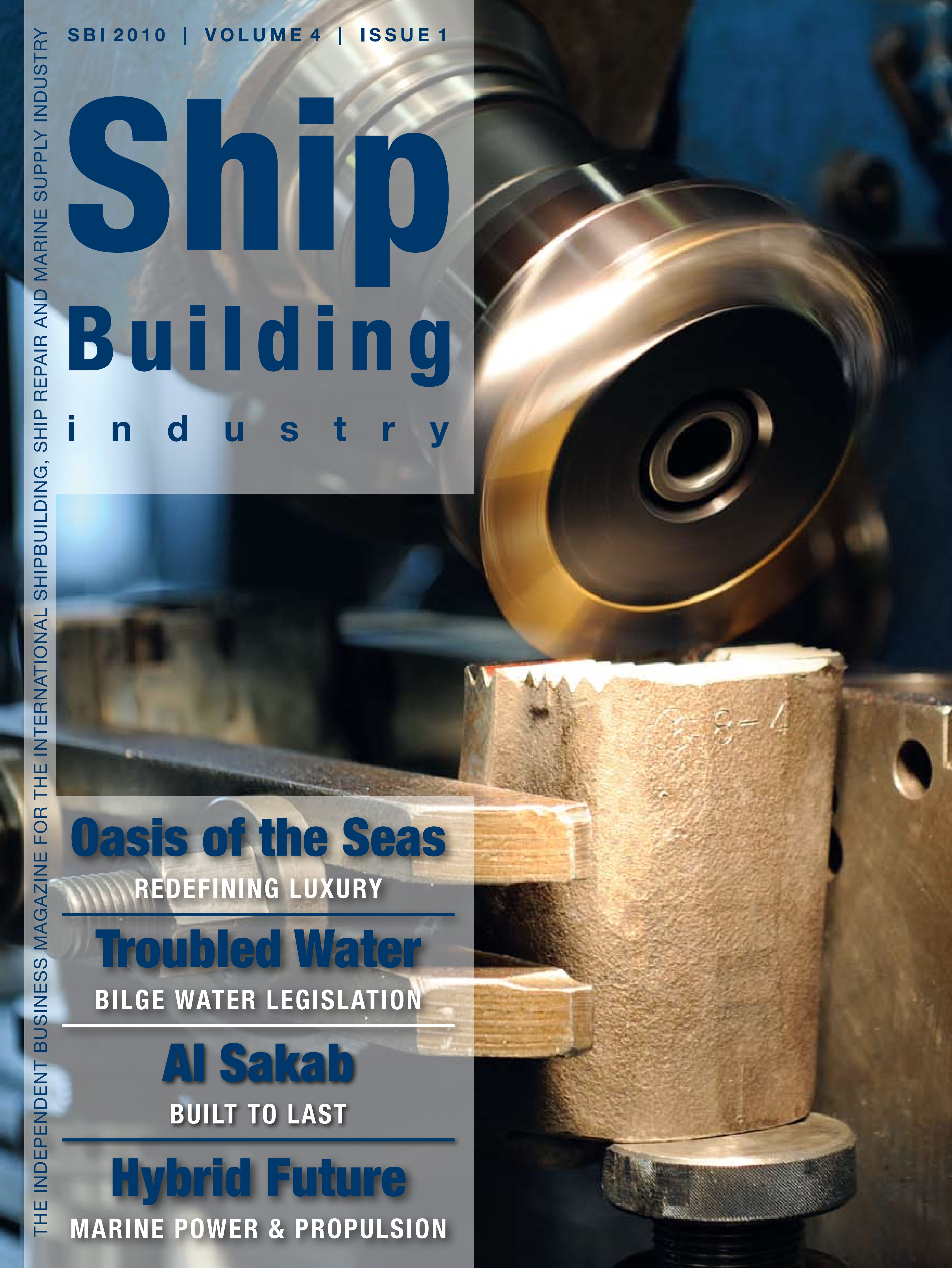
SBI 2010 | VOLUME 4 | ISSUE 1

Ship Building industry

THE INDEPENDENT BUSINESS MAGAZINE FOR THE INTERNATIONAL SHIPBUILDING, SHIP REPAIR AND MARINE SUPPLY INDUSTRY



Oasis of the Seas
REDEFINING LUXURY

Troubled Water
BILGE WATER LEGISLATION

Al Sakab
BUILT TO LAST

Hybrid Future
MARINE POWER & PROPULSION

Where There Are Engines...

Bilge Water, IMO & Regulations

Where there are engines, there is always oil, soap, solvents, and the particulate matter that accompanies mechanical operations – from dirt to bacteria. The waste from pumps and compressors above deck also accumulates in the bilge. It has been the goal of the IMO and the desire of all nations to reduce oily pollution in the oceans, a resource which is intimately linked to the survival of every individual on earth. Significant work was done in the eighties by the European Space Agency and NOAA (National Oceanographic and Atmospheric Administration) to characterize and quantify sources of oil pollution through the use of multispectral satellite imaging techniques.

Also known as synthetic aperture radar (SAR), this imaging technique is able to detect oily discharges very sensitively, day or night, from space. It became apparent as a result of this work that even in years when significant oil spills occurred, 80% or more of the oil loading was due to operational discharges. The greatest contributor to the operational component was bilge and ballast water with the greatest loading occurring right before sun up. These results confirmed what everyone familiar with ship operations already knew – that untreated or incompletely treated oily bilge water was routinely and illegally discharged at night.

Dispersed Oil Content

The standard for discharge governed by MEPC 60(33) limited the oil content to fifteen parts per million (ppm) (15 mg/l water) and employed oily water separators (OWS's) for treatment of the bilge water. All 60(33) OWS's operated on the premise that oil floats on water and, in one way or another (centrifuge, plate separators, etc.), exploit the buoyancy difference between water and dispersed oil. In trying to find an explanation for the discharge, it became apparent that only some of the oil in the bilge actually floated. The remainder of the oil is dispersed (or 'emulsified') and exhibits very little or no buoyancy difference with water and therefore could not be adequately treated with 60(33) technology. This consideration was the genesis of the 107(49) standard and technology. Broadly, the 107(49) standard augments the 60(33) standard and tests with a component that measures the ability of the system to treat and detect emulsified oil to the same 15 ppm standard, as required in 60(33) for buoyant oils. Toward this end, the 107(49) part C emulsion test fluid formulation was developed and incorporated as part of the test for 107(49) certification. The 107(49) oil content monitors (OCMs) were developed for the purpose of enhanced ability to detect emulsified oils by coupling turbidity and refractive index measurements while 60(33) meters measured only turbidity.

One of the greatest challenges facing the commercial shipping industry, and boats everywhere, is containing the pollution created by engine power generation. Hal Alper explores the state of bilge pollution regulations today and considers the future of maritime pollution regulation and the real solutions available to ship operators in the present.

What Is Wrong?

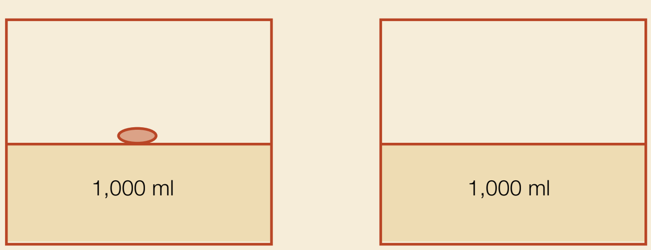
The transition to 107(49) has not gone smoothly or did not have the desired effect. The new equipment was supposed to be more effective and accurate, eliminating the need to discharge bilge water with greater than 15 ppm oil. This has not happened. Since implementation of 107(49) there have been numerous prosecutions for illegal discharges from 107(49)-equipped vessels. Environmental indicators are also not favourable. So what is going wrong? Why are this standard and the associated equipment not able to allow the marine engineer to effectively, reproducibly, and reliably treat the bilge? Why are the OCMs unreliable? In order to understand the answers to these questions, it is essential to understand what 15 ppm means. Both 107(49) and 60(33) require that the bilge discharge contains no more than 15 ppm oil.

Over-Simplification

To understand what 15 ppm means, two different states of 15 ppm can be considered. At the first state there is one 15ml

droplet in one ton (1,000 l, 1 m^3) of water. The low density and surface tension / mass ratio of the droplet will cause it to float, spread, and form a film over the surface of the tank (1 m^2). It will behave as a liquid. At the other state – 1 micron droplets – there will be two orders of magnitude increase in surface area. In addition, both the charge-to-mass and the surface area-to-mass ratios will invert causing the oil droplets in this state of 15 ppm to act like solid particles which repel each other. These droplets will not form a film on top of the tank and will stay stably dispersed (emulsified).

The solution will be uniformly turbid and have a higher refractive index than water. The 107(49) OCMs are calibrated for this stable, emulsified state. As was the case previously, relating to the need for the 60(33) to 107(49) conversion, the over-simplification is the cause of operational problems. The assumption of the state of emulsion is at the root of the problem. By definition, an emulsion is a stable dispersion of one immiscible



- Droplet volume 15 ml = 15 cc
- # of droplets = 1
- Diameter of droplet = 3 cm
- Surface Area = 28.6 cm^2
- Mass >> Surface Tension
- Charge << Mass
- Will Disperse

- Diameter of droplet = 1 micron
- Droplet Volume = 5.24×10^{-19} cc
- Number of droplets
  = $15 / (5.24 \times 10^{-19}) \approx 3 \times 10^{19}$ droplets
- Total Surface Area = 9×10^{7} cm^2
- Mass << Surface Tension
- Charge >> Mass
- Will Repel

>

Nature of Bilge Water	
New Ship	*Old Ship*
High Detergent	More Oil & More Slugs
Low Oil	High Particulate
Low Particulate	High Microbial Products
Low Microbrial Products	
Major Problem	**Major Problem**
Emulsified Oil	System Not Able To Adapt To Mixed Properties

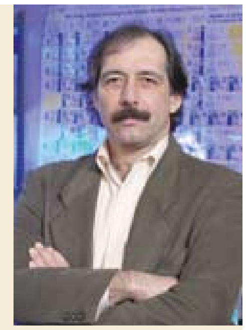
liquid in another. In other words, the system described will remain that way forever with no coalescence to form larger drops and no other processes to form smaller droplets. In reality bilge water dispersions are dynamic pseudo-stable emulsions which exist in a range of size distributions over a particle/liquid continuum.

Incorrect Calibration

Each one of the potentially infinite particle size distribution variations will have different turbidity and refractive indices. Since 107(49) OCMs can only be calibrated to one of these points, they are bound to be wrong almost all of the time. Recent work done by the US Naval Research Facility and presented at ASTM 25 confirmed this by showing that the OCM reading on a 15 ppm effluent can be easily manipulated simply by changing temperature or pump shear rate. Not one of three commercially available OCM's that were tested could accurately read 15 ppm on a 15 ppm challenge.

Perhaps this is why there is no universal standard for calibration of these units shipboard. Strictly speaking, it cannot be said that these units are calibrated at all since they can not

About the Author



Hal Alper is President of MyCelx of Technologies Cooperation and holds seventeen patents, including two patents for bilge and oily water treatment. He is a member of numerous professional societies including NYAS (New York Academy of Science), AAAS (American Association for the Advancement of Science), ASNE (American Society of Naval Engineers), SNAME (Society of Naval Architects and Marine Engineers), AFS(American Filtration and Separation Society), ACS(American Chemical Society) and AICHE(American Institute of Chemical Engineering). Alper sits on the Board of Directors of MyCelx Technologies, the Editorial Advisory Board of International Filtration News, and the technical advisory board of Environmental Protection Magazine. He is co-chair of ASNE/SNAME Technology and Research Environmental Committee on bilge water issues and the lead author of SNAME T&R Bulletin and IMO circular on bilge water trouble shooting.

read accurately over the range of possible turbidity, refractive index, particle size spectrum or be referenced back to NIST (National Institute of Standards and Technology). They are only calibrated to one specific state which may never exist on a given ship. These meters are also not able to detect slugs of pure oil due to the lack of turbidity of pure oil.

The IMO standard also does not take into account ship-to-ship differences and changes which occur on a ship over its lifetime. This affects OCM accuracy and the effectiveness of a given bilge water treatment system. A system which is effective for emulsions and buoyant oil may not be able to effectively deal with nanoscale microbial products which often develop as a ship ages, causing fouling of treatment equipment and false positives for oil by the OCM. The 107(49) standard should allow the marine engineer to adapt his treatment train to the variable nature of the bilge water as necessary to meet the discharge standard.

Case-by-Case

Over-simplification is at the root of much of what is plaguing the 107(49) standard. If one looks at the chemical and water processing industries which have had to contend with oily water, there is no such thing as being able to purchase a 'generic OCM'. It does not exist. This is because, unlike many other types of impurities, oil is not a single compound. Instrumental and other analytical methods are usually developed on a case-by-case basis. If there is any doubt, EPA 1664 (hexane extraction) is the primary benchmark of reliability. Similarly, no single treatment scheme exists for treatment of complex oily waters. MEPC 107(49) is a step forward toward responsible marine environmental stewardship; however, it must be refined in order to actually assist the marine engineer. IMO would benefit by examining how other industries approach oily water treatment and analysis.

i. www.mycelx.com

Bilge Water Standards

Bilge pollution is an international problem and it has invited international attention. In 1948, the United Nations adopted a Convention for sea law, creating the International Maritime Organization (IMO). The IMO's mission, in its own words, is 'to develop and maintain a comprehensive regulatory framework for shipping'. In 1973, that framework was effectively extended to the environment when the IMO took up the problem of bilge pollution. To balance the energy needs of a ship with the need to protect the ocean, the IMO denoted a standard of how clean bilge water should be before it may be discharged overboard. The International Convention for the Prevention of Pollution from Ships (modified in 1978). The convention effectively created a technical arm for the IMO, a protocol for interpreting and enforcing maritime pollution, from which it gets its more colloquial name: MARPOL.

MEPC 60(33)

An early IMO resolution on the equipment meant to accomplish water quality was passed in 1992, Marine Environmental Protection Committee (MEPC) 60(33), 'Guidelines and specifications for pollution equipment for machinery space bilges of ships'. Under MEPC 60(33), the primary way of treating bilge water employed oily water separators (OWS's) – gravity based devices designed using the premise that oil floats on water.

However, MARPOL found that OWS's did not accomplish the required water purity – less than 15 parts per million (ppm) of oil in water to be returned to the ocean. MARPOL attributed this problem to the fact that significant oil was emulsified within the bilge, i.e. not merely floating on the bilge surface. As a rule of thumb, newer ships have more emulsified oil (much smaller drops) due to lower amounts of total oil and aggressive use of soaps and detergents in order to keep ships like new, especially before entering port. Older ships have much more loading of particulate, sludgy matter (products of sulphate reducing bacteria, iron, iron-sulphide compounds, and matter from microbial decomposition).

MEPC 107(49)

In 2003, the IMO adopted a new standard, one that encompassed their empirical observations on emulsified oils: MEPC 107(49). The new standard also requires less than 15 ppm in oily bilge water; however the change is in the convenience of sampling small concentrations to demonstrate and prove this water purity.

The current standard involves a two part test: the ability of an OWS to remove separately phase oil as well as its ability to remove emulsified oil. However, flaws in the equipment that monitors bilge water, have made passing these tests problematic. The way rules and regulations play out on ships around the world frustrates shop operators and does not accomplish environmental goals.