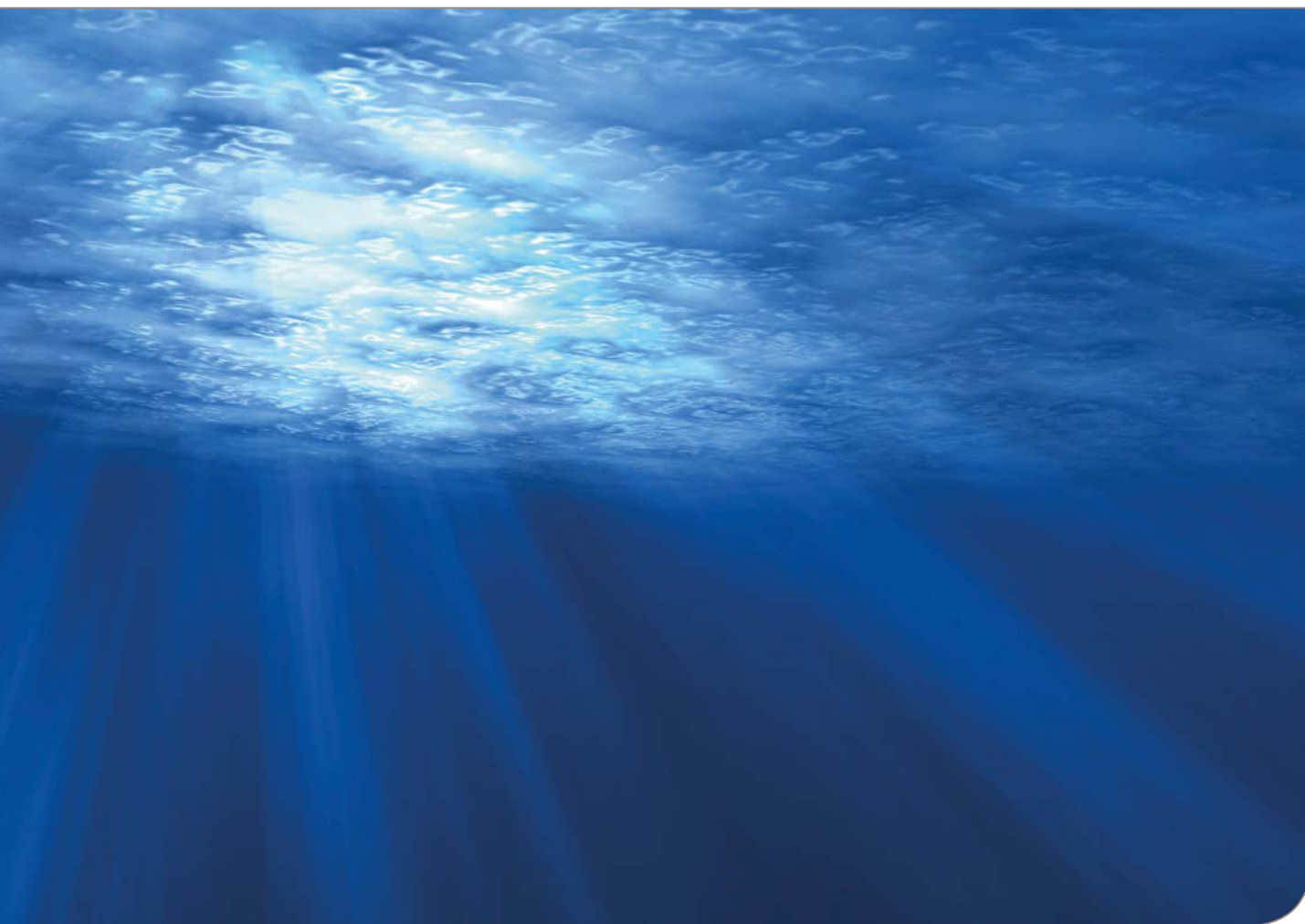




White paper



Bilge water compliance issues

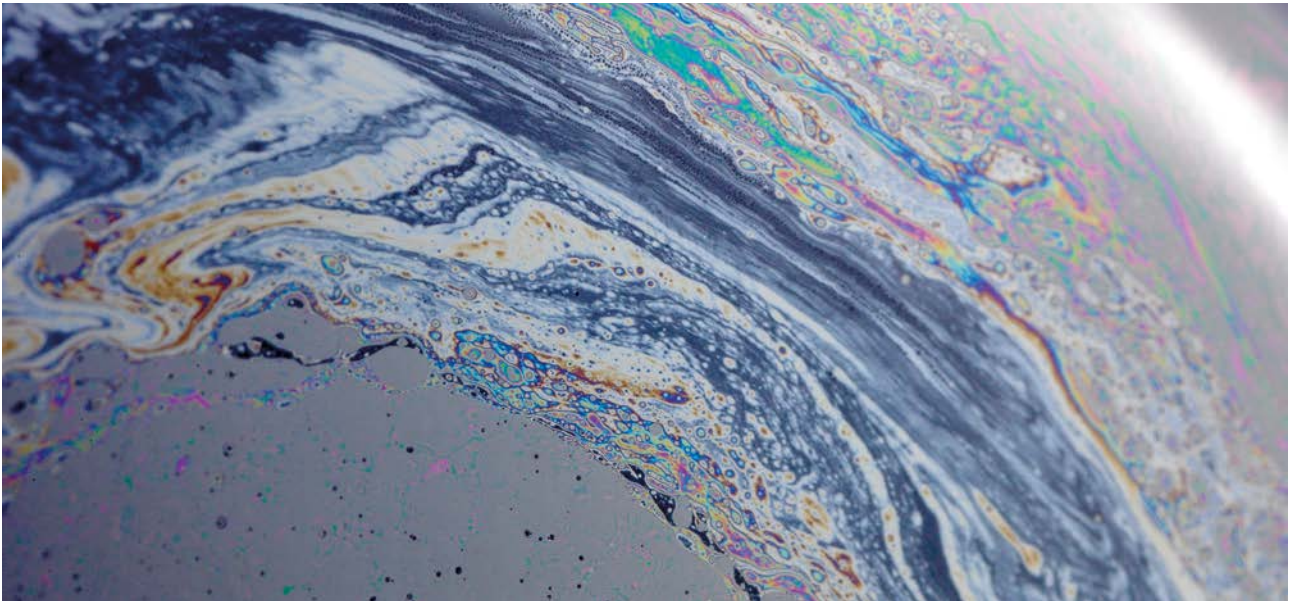
An Alfa Laval white paper on oily water separation

March 2017



Table of contents

1. Summary	3	5. The safe solution	10
2. Introduction	4	6. The Alfa Laval XLrator	10
3. Technologies	5	7. The Alfa Laval PureBilge BlueBox	12
3.1. Static or gravity-based separation	5	8. Conclusion	13
3.2. Membrane filtration	6	9. Contact details	14
3.3. Dynamic or high-speed centrifugal separation	6		
4. The problem	7		
4.1. Filtration and chemicals	7		
4.2. Test protocols	7		
4.3. Oil content monitoring	9		
4.4. Whistleblowing and lack of training	9		



1. Summary

The shipping industry worldwide is acting in good faith to comply to the International Maritime Organization (IMO) Resolution MEPC.107(49) for pollution prevention equipment for machinery spaces of bilges of ships. Regulations mandate that all vessels must operate an onboard type approved bilge water treatment system. This system must be able to treat oily waste water to comply with requirements of oil-in-water content of 15 ppm or less for overboard discharge. Bilge water treatment systems undergo rigorous testing to obtain IMO type approval certificates.

However, despite industry efforts to comply with regulations, both the number and the amount of the fines for violation of IMO Resolution MEPC.107(49) have increased in recent years. Non-compliance raises questions about the adequacy of type approved bilge water treatment technologies as well as of the test protocols, which in some cases do not accurately reflect real-life operating conditions. It also draws attention to the critical need to use OEM filters for systems using static technology.

Ship owners and operators cannot underestimate the value of operating a trustworthy bilge water treatment system on board. With proven centrifugal separation technology at its core, Alfa Laval PureBilge has been tested and validated for compliance under real-life

operating conditions on board, including pitching and rolling on the high seas.

There is enormous business potential for bilge water treatment systems that require low capital expenditure. However, Alfa Laval believes that the benefits of investing in centrifugal separation technology with a solid track record of compliance far outweigh the risks of developing systems that, under real-life conditions, often fail to meet the prescribed oil-in-water requirements. The costs of non-compliance on the marine environment are too high.

While this paper does not in any way purport to be an academic study, it intends to address the current regulatory playing field, the type approval processes, and the various technologies that are now available. It proposes that static gravity-type systems are inefficient and, despite of their so-called low capital costs, end up costing ship owners and seafarers dearly.

The aim of this Alfa Laval white paper is to share insights into why compliance with bilge water regulations proves difficult and what maritime authorities, ship owners and operators, and bilge water treatment system suppliers can do to promote compliance.

Test regimes and protocols for type approval of these systems are inadequate and fail to reflect real-life conditions on board vessels. Therefore review and revision of these regimes and protocols are required.

This white paper recommends the following actions by the IMO:

- Conduct an assessment of current test protocols.
- Conduct an assessment of bilge water treatment technologies.
- Make these assessments available to the public.
- Make the necessary amendments to test protocols and type approval processes to ensure the use of compliant bilge water technology.
- Continue to support Coast Guard, State and industry efforts to improve bilge water/pollution prevention practices.

It also recommends the following actions by ship owners and operators:

- Evaluate bilge water treatment systems now on board to ensure effective treatment.
- Follow OEM recommendations for operation of static systems and use OEM filter elements and chemical additives as required.
- Improve seafarer training in handling oily waste water.

This paper also proposes that an efficient, cost-effective bilge water treatment solution is available to safeguard the world's oceans from oily waste pollution

and ship owners and operators from MEPC.107(49) violations and reputational damage. Proven compliant, that solution is Alfa Laval PureBilge.

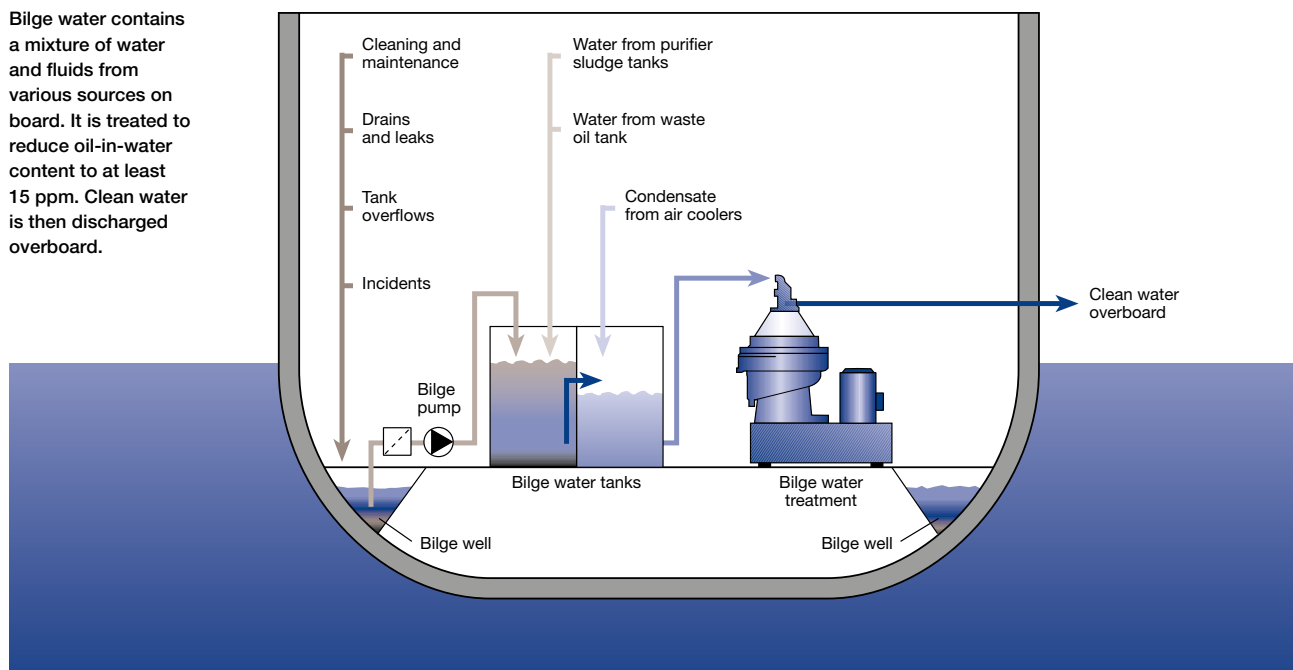
2. Introduction

Running a ship's engine and auxiliary machinery produces oily waste. These highly noxious oily chemical by-products collect in a vessel's bilge and amount to millions of litres of oily waste streams each year. Bilge discharge is considered to be one of the major factors contributing to the pollution of the oceans, and vessels are coming under increasing scrutiny by port state control authorities worldwide.

Oily bilge water is a mixture of water, oily fluids, lubricants and greases, cleaning fluids, detergents and other chemical wastes. The main sources of oily waste on board are ship engines, generators and other parts of the propulsion system, such as pipes, pumps and mechanical and operational components installed in ship machinery spaces.

As an operational practice, bilge wells are periodically pumped out. The accumulated bilge water is transferred to a holding tank for discharge to a port reception facility or for treatment by way of an onboard

Bilge water contains a mixture of water and fluids from various sources on board. It is treated to reduce oil-in-water content to at least 15 ppm. Clean water is then discharged overboard.



system designed to remove the oil from the waste stream prior to discharge of clean water overboard.

Discharge of bilge water is restricted for commercial vessels under Annex I of the International Convention for the Prevention of Pollution from Ships. Under MARPOL, all vessels of 400 gross tonnage and above are required to install and operate equipment on board that ensures the discharge of 'clean' bilge water does not exceed 15 parts per million (ppm) or less of oil. Some flag states and administrations stipulate a discharge limit of 5 ppm.

Vessels are also required to document all oil operations in an oil record book and to install and operate an oil content monitor or bilge alarm, which indicates the performance of the bilge separator, whether static or dynamic.

There are numerous considerations that ship owners must take into account when specifying an oily water treatment system. For instance, is a single-stage or multi-stage treatment process required? Does the technology require pre- and/or post-treatment systems?

Is the technology operator friendly? What are the requirements for maintenance and for consumables? What amount and types of waste are generated? And above all, how does the system perform?

Oily water treatment systems tend to fall into two categories: those that work on board ships and those that do not.

3. Technologies

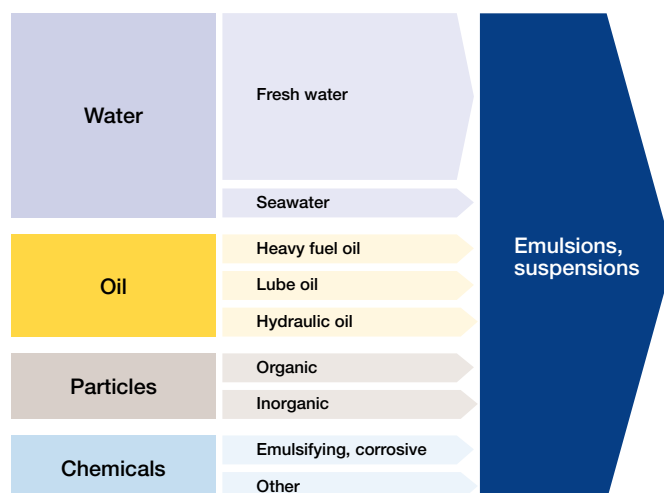
An oily water treatment system typically combines a gravity- or centrifugal-type separator with an additional process to reduce the concentration of emulsions. This process may include absorption and adsorption, biological treatment, coagulation and flocculation, flotation, and ultrafiltration.

3.1. Static or gravity-based separation

Gravity-based or static separation systems are the most common bilge water treatment systems found on board ships today. These were once considered effective when ships were running on lighter fuels and bilge water contained minimal emulsions. However, gravity-based separation systems are now considered ineffective; they fail to treat the complex cocktail of heavy fuel oil (HFO) mixed with other types of oil and chemicals found in the bilge of modern tankers and other large commercial vessels today.

Static coalescer-type separators only operate at 1 G, a force that is insufficient for breaking down emulsions to meet the mandatory 15 ppm requirement. In a pitching and rolling environment, complex and emulsified bilge water compositions can seldom be separated through gravity alone. This means that bilge water must be stored in large tanks until conditions are right for treatment, and that chemicals and carbon adsorption filters must be used to handle what does not separate naturally.

Bilge water composition.



When the IMO rules were updated, emulsions were added to bilge water test protocols. However, many systems were found to be ineffective in breaking down emulsions without the use of chemical additives.

What's more, oil particles of 20 micron or less in size are not separated from the emulsion mixture, and the chemical concoction found in oily waste streams can limit separation efficiency in the presence of dense and highly viscous oils.

In 2004, tests carried out on a static coalescer-type system on board a U.S. naval vessel found that treated bilge water not only exceeded the 15 ppm limit, but was recorded at 42 ppm after completion of post-treatment.

3.2. Membrane filtration

This technology uses oil-eating bacteria to treat oily waste water. The presence of oxygen, nutrients and hydrocarbons and other contaminants in a carefully managed environment is required to promote growth of these microorganisms. Bioremediation is typically used as the first stage in a multi-stage purification process along with a plate separator; however, membrane clogging may result and require costly and frequent membrane replacement.

Alfa Laval
PureBilge



While these systems remain a good prospect for smaller craft, such as luxury yachts, where there is a less potent chemical mixture in the bilge, membrane filtration does not present a viable solution for large commercial vessels.

3.3. Dynamic or high-speed centrifugal separation

Unlike static systems, high-speed or dynamic centrifugal separators operate with a gravitational force of 6000 G, enabling them to cope with the constant motion of a vessel as well as the complexities of modern bilge water. With a long track record of effective performance on board ships, this type of oily waste water treatment system is not sensitive to high solids or oil loads. No additional chemicals are required, and maintenance is minimal. Clean water can be pumped directly overboard thereby negating the need for large bilge water holding tanks.

Not only is such technology readily available, centrifugal separation succeeds where static technologies fail. Whereas static systems operate in batches and require frequent filter changes and/or chemical dosing to do the job, a high-speed centrifugal bilge water separator can operate continuously without requiring much attention. Varying bilge water feed, oil shocks and even the toughest emulsions pose no difficulty when using centrifugal separation.

4. The problem

4.1. Filtration and chemicals

Static systems often require the use of filters and chemicals to achieve compliance. In a bilge water study conducted in 2011 by the U.S. EPA, Canadian operator Seaway Marine Transport stated that low-cost bilge separators, especially separator/filter combinations, may work but are more sensitive to changing bilge water composition and require large quantities of consumables and higher maintenance.

Static coalescer-type separators are commonplace, largely due to the low capital costs used to promote this equipment. However, the use of these separators is resulting in an increased number of fines and prison sentences as seafarers unknowingly discharge oily waste water in the false belief that these systems clean bilge water according to the regulatory limits. They do not.

Static coalescer-type separators have proven ineffective in rough seas due to poor settling thereby leaving a large amount of the oily waste in treated water. As a result, adsorption filters and chemicals are required, which increases operation, maintenance and tank cleaning costs.

Typically, a static system requires two main consumables: a coalescing filter element and an advanced granular media, the efficacy of which is wholly dependent on the bilge water content.

In response to the revisions adopted in MEPC.107(49) governing emulsion removal, all manufacturers of coalescer-type systems introduced an active filtration stage to the treatment process. This worked well in land-based testing environments but proved incapable of handling the various emulsions found in bilge water under actual operating conditions. The addition of chemical additives was therefore required.

Another issue is that these systems require the use of original equipment manufacturers components, such as certified OEM filter elements, to ensure proper function. However, due to the increasing costs of filtration technologies, there has been a proliferation of cheaper, non-OEM active filters, which are not certified for use and do not

provide the same filtering efficiency and protection as OEM filters.

The oleophilic plates and carbon filters in these systems are also subject to fouling and therefore require frequent replacement, further increasing operating costs. What's more, ship owners must also factor in the costs for increased maintenance and cleaning, which is more time consuming than comparable technologies and increases total cost of ownership.

4.2. Test protocols

The treatment of chemical emulsions is a major problem. Although emulsion tests are part of the new IMO test protocols, the test fluids do not represent the complex emulsion mixtures that form in ship bilge wells.

A 2011 study on the efficacy of different oily waste water treatment technologies conducted by the U.S. EPA substantiates this claim. The study concluded that some technologies "appear to perform better than others at sea" and reported shortcomings in laboratory certification tests for oily waste water treatment systems.

The report stated: "Certain treatment technologies require excessive operator attention and/or maintenance to function properly, or generate excessive quantities of oily residuals requiring handling and disposal."

Yet while Resolution MEPC.107(49) that took effect in 2005 and amended the 1993 Resolution MEPC.60(33) provides guidance on the use of oily water separators and oil content monitoring prior to discharge into the sea, the aforementioned U.S. EPA report also states that the testing and certification processes are "insufficient to replicate actual conditions onboard" and therefore do not reflect real-life conditions on vessels at sea.

The IMO guidelines, which continue to form the basis for type approval, stipulate that "a 15 ppm bilge separator must be able to handle any oily mixtures from the machinery space bilges and be expected to be effective over the complete range of oils which might be carried on board the ship, and deal satisfactorily with oil of very high relative density, or with a mixture presented to it as an

emulsion” as well as cleansing agents, emulsifiers, solvents or surfactants used for cleaning purposes that invariably end up in bilge water. Many systems have successfully passed land-based type approval testing, yet fail to perform effectively at sea.

A 2009 article published in Tanker Operator reported that certification tests were too limited to measure the true effectiveness of bilge separator treatment systems under real-life operating conditions on board vessels. The testing issues under scrutiny included: the short test duration; the static environment in which tests are conducted; and, the rate and composition of the test fluids, which many believe to be uncharacteristic of the operational discharges that comprise bilge water.

According to the rules, tests should be performed using three grades of test fluids:

- Test fluid A, which is a marine residual fuel oil in accordance with ISO 8217, type RMG 35 (density at 15°C not less than 980 kg/m³);
- Test fluid B, which is a marine distillate fuel oil in accordance with ISO 8217, type DMA (density at 15°C not less than 830 kg/m³); and,
- Test fluid C, which is a mixture of an oil-in-fresh water emulsion, in the ratio whereby 1 kg of the mixture consists of:
 - 947.8 g of fresh water
 - 25.0 g of test fluid A
 - 25.0 g of test fluid B
 - 0.5 g of surfactants (sodium dodecylbenzene sulfonic acid in dry form)
 - 1.7 g of iron oxides (black ferrosferric oxides, or Fe₃O₄, with a particle size distribution of

which 90% is less than 10 microns in size and the remainder has a maximum particle size of 100 microns.

Test fluid C is contentious because it contains only one emulsion when in reality there can be 15 or more different types of chemicals in the bilge water mixture. According to the article, the duration of the test also failed to account for system capacity beyond the test period. This highlighted the fact that “tests can be passed using simple filters that, in actual service, would be incapable of maintaining performance over longer time periods”.

Additionally, the test protocols fail to replicate the pitching and rolling motions encountered at sea and therefore do not provide an adequate test regime for gravity-based systems.

“During fluid C testing, the separator treats the specified emulsion fluid for just 2.5 hours, but fluid C is not as complex as those fluids found in a ship’s bilge. What’s more ships do not operate for just a few hours, they’re operating for weeks on end,” says Magnus Lagerfors, Application Manager, Marine & Diesel Equipment, Alfa Laval. “This is the major difference between static coalescers and dynamic high-speed separators. High-speed separators can continue working indefinitely.”

The EPA report and others like it appear to substantiate claims that the failure of certification tests has led and continues to lead to the approval of bilge water treatment systems that are not able to treat ship bilge water to meet mandatory legislative requirements.



4.3. Oil content monitoring

Monitoring oil content is another area that offers opportunities where real improvements can be made. Verification of the performance of an oily waste water treatment system is important; an oil content monitor or bilge alarm is therefore a critical component of any bilge water treatment system.

When mandatory ppm levels are not maintained, the oil content monitor must initiate an automatic stop to prevent the overboard discharge of oily mixtures. Automatic stop is initiated by a valve arrangement installed in the effluent outlet line of the bilge separator. This automatically diverts the effluent mixture back to ship bilge wells or bilge tanks when the oil content of the effluent exceeds 15 ppm (or 5 ppm in some waters).

Given the harsh environment of a ship engine room, a bilge alarm must be robust, corrosion-resistant, suitable for shipboard use, and compatible with the liquids to be monitored. As such, bilge level switches and bilge alarms must be able to withstand harsh conditions, yet provide immediate and reliable operation and alert the crew upon detection of leakage or flooding.

However, some systems are not as effective as others. Some technologies require continuous maintenance and cleaning to prevent malfunction and spurious readings due to interferences with turbidity. Canada's 5 ppm standards for oil-in-water content can also prove challenging for some bilge alarms.

Alfa Laval's Magnus Lagerfors states: "Oil detection equipment not only measures oil droplets but, in some instances, they have been known to measure other microparticles in the bilge water. This means that some chemicals in the bilge are being measured as oil, which skews the readings. It is therefore important to follow guidance such as the IMO Integrated Bilge Water Management plan."

4.4. Whistleblowing and lack of training

Those who report any illegal wrongdoings help hold those who knowingly violate the law accountable for their actions. However, some shipping companies question whether whistleblowers are motivated by a sense of moral obligation or by opportunism due to the financial rewards offered.

In a 2012 article posted on the Center for Public Integrity website, the investigative report and editor Ronnie Greene writes: "Whistleblowers help bring these cases to light, handing to inspectors the scrawled notes or cell phone photos capturing illegal dumping and homemade diversion pipes hidden on board. Yet some defense lawyers for shipping companies have questioned the government's use of whistleblowers, contending that a quest for cash could distort a company's true environmental record. Ultimately, though, the evidence from crews has factored in several cases."

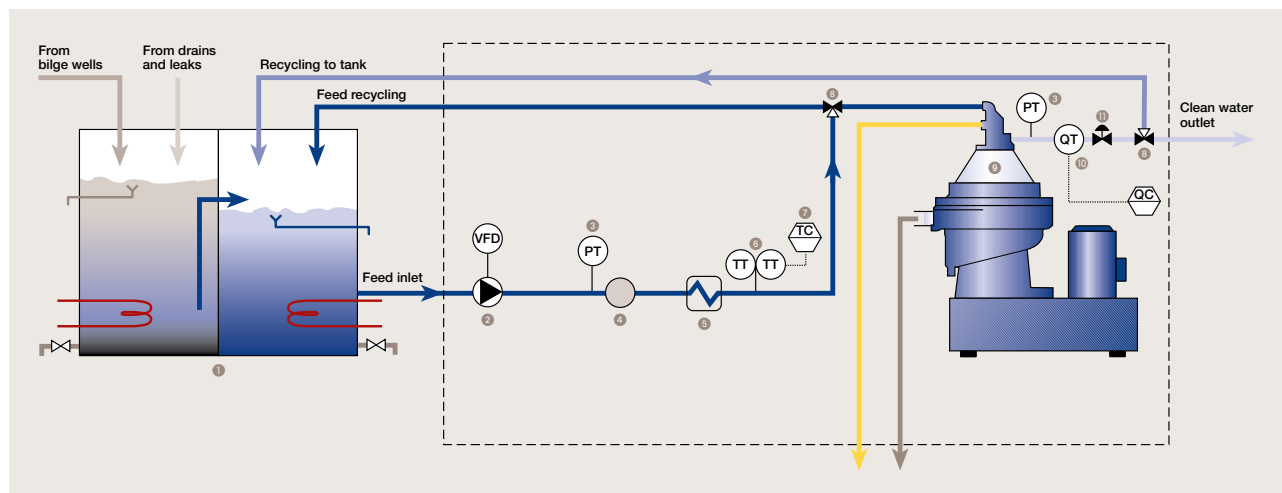
A 2011 article in a shipping magazine reported that the second engineer who provided evidence of deliberate oil pollution to U.S. authorities received 50% of the large fine paid by the owner. Another article reported that crew members found guilty of deliberate pollution on a different vessel each pocketed more than \$400,000 for informing the authorities.

While many question the use of whistleblowers to uncover oil pollution violations, others suggest that the "majority of ship owners want to be compliant and they pay a lot of money to set up these compliance programs and procedures." One ship owner representative is reported to have said, "Some whistleblower who decides he wants to make some money can thwart all those efforts (by the ship owner)... They don't report it to the owner, because they know if they wait until they come to the U.S. and they have pictures of some alleged illegal act, they are going to get a reward."

While such activities are morally questionable, it brings into sharp focus the extent of the problem and the fiscal burden under which ship owners must operate. Certainly no oily water separator will perform perfectly under all circumstances although there are systems and technologies that are more effective than others.

To ensure bilge water treatment systems deliver optimal performance, it is imperative that seafarers responsible for operating and maintaining these systems receive proper training. Many, however, do not fully understand the composition of bilge water, the regulations governing treatment, or indeed how to comply with them.

We shall now consider the optimum solution.



5. The safe solution

Cleaning bilge water poses distinct fiscal, criminal and environmental challenges. Not only does the composition and flow of bilge water change, making continuous and efficient treatment difficult, but treatment on board also presents operational constraints.

Treatment methods must meet individual ship requirements and demands for safety, reliability, compactness, automation, low maintenance and the ability to withstand rough weather conditions.

These requirements must be met without reducing the performance of the treatment system. Centrifugal separation has been used for decades on board vessels due to the technology's superior efficiency in cleaning fluids. Engine room crews are also familiar with the operation and maintenance of centrifugal separation systems. High-speed centrifugal separation is not only the most efficient way to treat bilge water, but it also provides the lowest possible operating cost of all systems currently on the market.

Alfa Laval PureBilge is by far the most effective system available today and can effectively eliminate problems associated with the use of the magic pipe. There are, of course, comparable high-speed oily water separators with more or less the same price tag as PureBilge. However, these high-speed coalescers are unable to deliver the same performance as PureBilge when operating under real-life conditions.

Unlike other dynamic systems, Alfa Laval PureBilge uses heat to break down emulsions to well below the mandatory requirements. PureBilge was the first type approved system to deliver clean water with verified 0–5 ppm oil-in-water content under real-life conditions and at certified flow rates of up to 5000 l/h – without the use of costly chemicals, adsorption filter or membranes. What's more, PureBilge does not require large bilge water holding tanks thereby increasing payload capacity. In addition, its performance is unaffected by sea heave, oil shocks or the presence of high solids.

How is it possible then for PureBilge to handle emulsions without the use of chemicals, filters or membranes, where so many other systems fail? The patented Alfa Laval XLrator inlet device is the key.

6. The Alfa Laval XLrator

The PureBilge water treatment system comprises four main functions: forwarding/pumping; oily water pre-treatment; centrifugal separation; and, process control and monitoring.

A positive displacement pump with a variable frequency drive transfers oily water from a settling tank to the pre-treatment stage. In the pre-treatment stage, the bilge water is fed through a basket strainer that traps large particles from the fluid. The fluid then passes through a heat exchanger, which raises the fluid temperature to between 60 °C and 70 °C. When all process conditions (feed temperature, pressure

and separator speed) have been satisfied, the oily water enters the separation stage. If conditions are not met, fluid is re-circulated to the bilge water settling tank.

During the separation stage, the fluid enters a high-speed centrifugal separator. Oil and emulsions separated from the bilge water are continuously discharged and directed to a sludge or waste-oil collecting tank.

Solids are discharged intermittently through the self-cleaning mechanism of the centrifuge. Treated water is also continuously discharged. An oil-in-water monitor measures the oil content in the treated bilge water in full compliance with IMO Resolution MEPC.107(49).

When the oil content is below a pre-set value (15 ppm or lower), the treated water can be directed either to a holding tank for discharge overboard at the ship operator's convenience, or pumped directly overboard. If the oil content is above the pre-set value, the water is re-circulated to the bilge water settling tank.

The revolutionary design of PureBilge incorporates the Alfa Laval BWPX 307 high-speed centrifuge and the patented Alfa Laval XLrator inlet device. The XLrator gently accelerates the bilge water into the separator bowl to improve separation efficiency by preventing the splitting of oil drops and the further formation of emulsions.

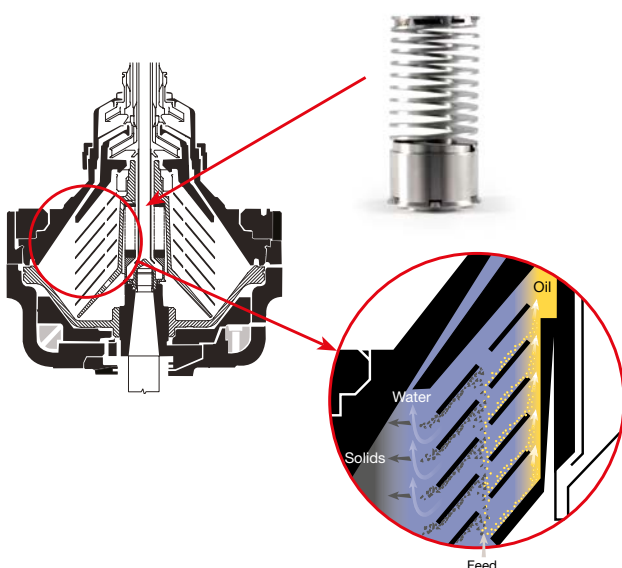


The disc-stack and bowl arrangement provides the maximum surface area and features distribution holes and an optimized caulk configuration to enhance separation efficiency further. The design provides stable, continuous operation to ensure proper handling of oil shocks that generally bring static cleaning systems to a standstill. The high centrifugal force of 6000 G within the PureBilge separator bowl induces coalescence and flocculation, which contribute to the breakdown of emulsions.

Before deciding to purchase the PureBilge system, a customer who was well aware of the limitations of current legislation requested sea trials of the system. A diaphragm pump thoroughly mixed a bilge cocktail for four hours to emulsify its contents, thereby compounding the separation problem. The mixture contained:

- 1 m³ of sea water
- 1 litre of compressor oil
- 10 litres of diesel oil
- 10 litres of heavy fuel oil (HFO)
- 1 litre of hydraulic oil
- 1 litre of corrosion inhibitor
- 1 litre of carbon remover
- 1 litre of solvent-based oil cleaner
- 20 litres of mud
- 5 litres of rust
- 50 litres of cooler condensate
- 5 litres of soot

During the trials, PureBilge performance exceeded customer expectations. The average oil-in-water content in treated water was 7 ppm, well below the 15 ppm discharge requirements.





7. The Alfa Laval PureBilge BlueBox

Alfa Laval has developed the PureBilge BlueBox Data Recorder, a fully automatic, oil content monitoring system to provide ship owners and engineering teams with a safe and reliable system to record all oil discharge operations. This records operations to ensure that they have been carried out in accordance with the regulations.

Now integral to the PureBilge concept, the PureBilge BlueBox Data Recorder and EPC 60 Bilge process controller are designed to prevent tampering with the system. The system records oil ppm levels, GPS position, separator operation, full alarm log, discharge valve position and discharge flow data. If the flow meter records a flow rate when the discharge valve is in the recirculation position, for

instance, the PureBilge BlueBox system will set off an alarm and automatically shut down while recording all data.

Clad in a rugged housing, the PureBilge BlueBox is designed to be opened by authorized personnel. It features a coded magnetic limit switch that causes an alarm to sound and the overboard valve to go into recirculation mode should any attempt be made to pry open the BlueBox.

Recorded data includes the start and stop time of each discharge as well as the oil content level of each discharge cycle. All data is logged, encrypted and stored for 18 months, providing documentation that discharge operations have been carried out according to regulations or that attempts to discharge illegally have been made.



PureBilge BlueBox with the EPC 60 Bilge operator panel.



EPC 60 Bilge operator panel.

8. Conclusion

The world's oceans are not the dumping grounds for oily waste water from maritime vessels. Strict legislation and enforcement make it clear that any violation, whether due to gross negligence or willful misconduct, will not be tolerated. Diesel power plant owners and operators must also comply to bilge water regulations.

However, despite hefty fines and, in some cases, imprisonment, ship owners, ship operators and seafarers continue to discharge oily waste water that does not meet IMO pollution prevention regulations.

This is a clear indication that something is not working as it should. Alfa Laval believes that the problem is complex, resulting from a combination of ineffective regulations, test protocols, technologies and seafarer training.

Although MEPC.60(33) has been updated with MEPC.107(49), the problem remains that many systems with active filtration are designed to pass the test protocol in a land-based environment while, in reality, these systems have limited capabilities under real-life operating conditions.

Static systems are common due to low initial capital investment costs, which do not take into account higher installation, operation and maintenance costs. Their continued use is significantly increasing the number and amount of fines as well as lengthening prison sentences for those who violate the law. This points to the inadequacy of the test protocols, which do not reflect real-life conditions.

Until such time that more effective regulatory mechanisms are in place – something that Alfa Laval will continue to lobby for – ship owners can mitigate the financial and environmental risks associated with oily waste water management through the purchase and installation of high-speed centrifugal separators. High-speed centrifugal separators may be more expensive at the outset compared to static, gravity-based technologies. However, they have been proven to exceed the mandatory requirements for bilge water treatment at sea and to be more cost effective to operate over the long term due to lower operating costs. What's more, many high-speed systems are designed to prevent tampering, thereby eliminating the possibility to bypass the system.

Together with its industry colleagues and technological partners, Alfa Laval is advocating changes to the IMO testing and type approval processes for bilge water treatment systems to better reflect operational realities. "We want to make sure that owners remain compliant and keep our marine environments clean. The lower the environmental impact, the better it is for everybody," says Niclas Dahl, Vice President, Marine Separation & Heat Transfer Business Unit, Alfa Laval. "However, current regulations are not helping to ensure that the shipping industry does not contribute ocean pollution, and neither are some of the technologies in use today."

Alfa Laval PureBilge with its integrated oil content monitor has been proven to clean effectively and to exceed regulatory requirements. It is operating successfully on board some 40–50% of the world's tanker fleet. This is due, in part, to value assigned to the environmental and sustainability credentials of tanker owners and charterers. Although other technologies cost marginally less, Alfa Laval PureBilge with its reputation for unparalleled performance is gaining popularity among ship owners. To date the number of vessels operating with PureBilge is close to 1,000.

"Centrifugation has been a hallmark of our company for over a century. Alfa Laval PureBilge uses centrifugal force to counteract vessel pitch and roll, thereby overcoming the issues associated with static bilge water treatment systems," Dahl continues. "PureBilge is truly the difference between noncompliance and compliance."





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