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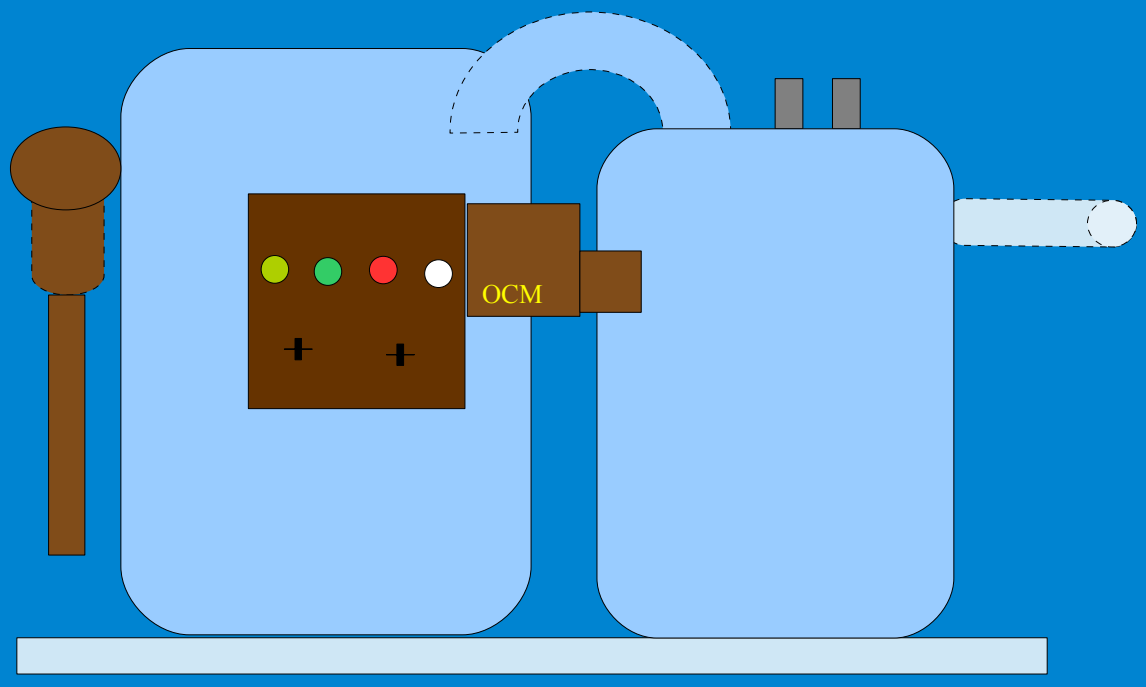
A Guide to Operating Oily Water Separator on Ships



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A Guide to Operating Oily Water Separator on Ships

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Introduction

Considering the introduction of various stringent regulations related to marine pollution, efficient operation and maintenance of oily water separators on board ships is a must.

This guide explains a normal Two-Stage Oily Water Separator (OWS) as it's the most widely used one on ships. It is to note that except the constructional and design factors, OWS of different types have almost the same functional and operational characteristics.

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Content

Chapter 1

Oily Water Separator: Construction and Working

To minimize the oily content in the bilge water, MARPOL has a regulation under "ANNEX I" which limits the oil content in the bilge water that vessels can legitimately discharge into the sea. It is now a compulsory requirement for all vessels to have an oil discharge monitoring and control system along with an Oily Water Separator.

There are numerous varieties of OWS in the market and each has its own peculiarities and problems. The popular type of bilge separator which are available in the market are:

- **Single stage OWS** (old type)
- Two Stage OWS (Cargo ships)
- Three stage 1 ppm separator (Cruise ships, ferries)
- Light weight 5ppm separators (Military Patrol Vessels)
- Centrifugal Oily Water Separators

Understanding the Regulation

Any discharge into the sea of oil or oily mixtures from ships of 400 gross tonnage and above shall be prohibited except when all the following conditions are satisfied:

- The ship is proceeding *en route*
- The oily mixture is processed through an oil filtering equipment
- The oil content of the effluent without dilution does not exceed 1 5 parts per million
- The oily mixture does not originate from cargo pump-room bilges on oil tankers
- The oily mixture, in case of oil tankers, is not mixed with oil cargo residues

In Antarctic and other environmentally sensitive areas, any discharge into the sea of oil or oily mixtures from any ship shall be prohibited.

Construction and Working of OWS

OWS consists of mainly three segments:

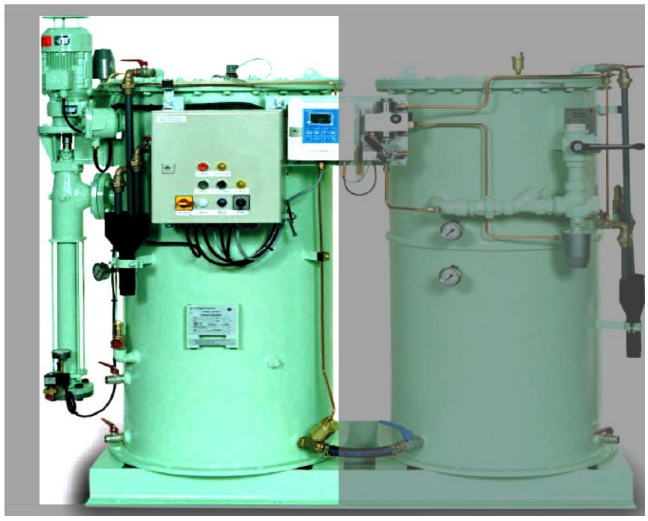
1 .....Separator Unit

This unit consists of catch plates inside a coarse separating compartment and an oil collecting chamber.

The oil having a density lower than that of the water, rises into the oil collecting compartment. The rest of the non-flowing oil mixture settles down into fine settling compartment after passing between the catch plates.

After a period of time, oil will separate and collect in the oil collecting chamber.

The oil content of water which passes through this unit is around 100 parts per million of oil.



Stage 1

A control valve (pneumatic or electronic) releases the separated oil in to the designated OWS sludge tank. Heater may be incorporated in this unit for smooth flow and separation of oil and water. First stage of OWS helps in removing some physical impurities to achieve fine filtration in the later stage.

2 .....The Filter Unit

This is a separate unit with its input coming from the discharge of the first unit.

This unit consists of three stages – filter stage, coalescer stage and collecting chamber. The impurities and particles are separated by the filter and they settle at the bottom for removal.

Stage 2 (image Credit- Nauticaexpo

In the second stage, the coalescer induces coalescence process in which oil droplets are joined to increase the size by breaking down the surface tension between oil droplets in the mixture.

These large oil molecules rise above the mixture in the collecting chamber and are removed when required.

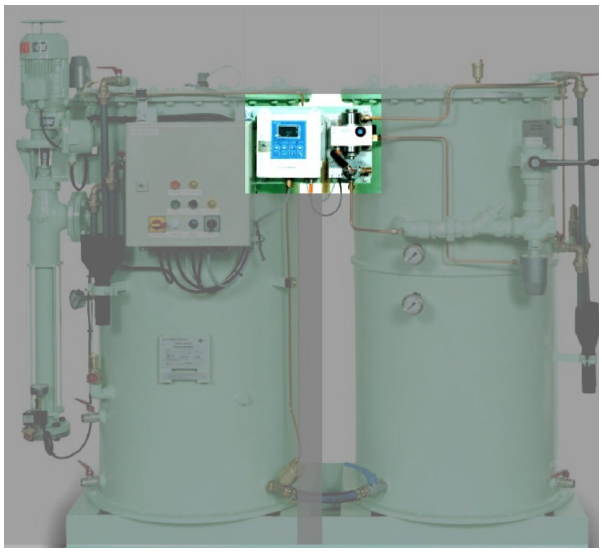
The output from this unit should be less than 15 ppm to fulfill the legal discharge criteria.

If the oil content in water is more than 15 ppm then maintenance work such as filter cleaning or renewal of filters is to be done as required.

3 .....Oil Content Monitor & Control Unit

This unit functions together in two parts – monitoring and controlling. The ppm of oil is continuously monitored by Oil Content Monitor (OCM); if the ppm is higher than the pre-determined unit, it will give an alarm and feed data to the control unit.

The control unit continuously monitors the output signal of OCM and in case of alarm, it will prevent oily water to go overboard by means of operating 3 way solenoid valve.



OCM

There are normally 3 solenoid valves commanded by the control unit. These are located in the first unit oil collecting chamber, second unit oil collecting chamber and one in discharge side of the oily water separator which is a 3 way valve.

The 3 way valve inlet is from the OWS discharge, where one outlet is to overboard and second outlet is to OWS sludge tank. When OCM gives alarm, 3 way valve discharges oily mixture in the sludge tank.

An oily water separator clears the bilge water of oily content to bring it inside the acceptable range to discharge it overboard. An oily water separator is a machinery of such importance that it is handled only by the 2nd or chief engineer. (However, the duty engineer might also be asked to operate under supervision.)

Chapter 2

Oily Water Separator: Operating Procedure

An oily water separator can only be operated when the ship is sailing and en route. According to MARPOL, the oil content of the effluent must be less than 15 ppm and the ship has in operation an oil discharge monitoring and control system and oily-water separating/filtering equipment. In case of failure to follow any of the above mentioned rules, the ship will be fined and stopped, and the chief or 2nd engineer can be imprisoned.

Because of such high risks, operating an oily water separator should be done with utmost precision to minimize the risks of marine pollution. Though a “How to Operate?” guide is always posted near the oily water separator, there are few points to be kept in mind and followed to prevent any mistake.

Operating Procedure

The following points are to be followed while operating OWS.

- OWS overboard manual discharge valve is to be kept locked and keys are to be kept with the chief engineer. Open the lock and overboard valve. Open all the other valves of the system
- Open the desired bilge tank valve from which the oily water mixture is to be discharged from the OWS
- Open air if the control valves are air operated
- Switch on the power supply of the control panel and OCM unit
- Fill the separator and filter unit with fresh or sea water to clean up and prime the system till the water comes out from vent of second stage
- Start the OWS supply pump which is a laminar flow pump and one that will supply the oily water mixture to OWS

- Observe the OCM for ppm value and keep checking sounding of bilge tank from where OWS is taking suction and also of the OWS sludge tank
- A skin valve/sample valve is provided just before overboard valve and after the 3-way valve. Keep a check on the sample for any effluent and clarity
- Keep a watch on the ship side at the overboard discharge valve
- After the operation, Switch off the power and shut and lock the overboard valve
- Keys to be handed over to the chief engineer
- Entry to be made by chief engineer in the Oil Record Book (ORB) with signature of operating officer, chief engineer and the master

Chapter 3

Oily Water Separator: The Design Factors

Oily Water Separators are one of the most important yet neglected equipment on board ships. Revered and feared alike, marine engineers are often afraid to use it, and want to keep it unused and working so that they can show it to the Port State Control Officer (PSCO) and stay on the safer side.

Based on simple working principles and designed to be reliable and less labor intensive, oil water separators are however troublesome and demanding to engineers due to later's lack of knowledge, proper training, operational negligence and sometimes apathy.

However proper care, maintenance, correct troubleshooting and efficient starting/stopping can keep it working properly and making life easier and safer. With stricter control and PSC inspections combined with stringent penalties including criminal action against the operating crew, it's in the interest of marine engineers to keep the OWS working properly.

A lot has been said and written about the inadequacy of some of the market equipment and especially those that have been retrofitted in old ships in seminars and forums.

However, the seagoing marine engineers do not have access to these seminars and their voices are often unheard. In the absence of a sympathetic ear, marine engineers just endeavor to keep the equipment running during their "contract time" and abstain from complaining for the fear of victimizing.

Factors affecting separation in OWS

The oil water separator (OWS) is designed to work properly under ideal conditions; however the ship is never under ideal condition and there are various sources of contamination in the bilge water. The bilge water is a mixture of various grades of oil in water, along with suspended solids, rust, chemicals, detergents, soot, paint chips and cargo dust etc.

In view of such a complex scenario it is necessary to have the knowledge of various parameters and factors that influence the satisfactory operation of OWS.

Let's take a look as to how the design factors affect the OWS performance. This includes the basic working principle of the OWS and the enhancements made for marine context.

The Oily Water Separator is used to remove oil from the bilge water prior to discharging it overboard. It works on the principle of Stokes law and basically separates the two components utilizing their difference in specific gravities.

The OWS for marine use are optimized to make them smaller in size due to space constraints. Additional components are fitted to help with the separation process but the knowledge of the basic design factors is beneficial.

The rate of rise as per stroke's law is as follows:

The Stoke's Law generally states that the velocity or rise and hence the separation rate is directly proportional to the difference in density of the oil and the continuous fluid, and the size of the droplets of oil.

$$Vt = [(g)(\ \ w - \ \ o)(d2)] / [(18 x \ \ w)]$$

Vt = the rise rate of the oil droplet (cm/s or ft/sec)

g = acceleration due to gravity (cm/s2 or ft/s2)

ρ_w = density of water at the design temperature (g/cm3 or lbm/ft3)

ρ_o = density of oil at the design temperature (g/cm3 or lbm/ft3)

d = oil droplet diameter (cm or ft)

μ_w = absolute viscosity of the water (g/cm-s or lbm/ft-s)

It also states that rate of rise is inversely proportional to the viscosity of the surrounding fluid. We infer the following from the famous law :

1. .....**Density of Oil**: Light oil is having higher rate of rise than heavier oil and therefore it is easier to separate. This information is useful to adjust and lower the flow rate when heavier oil contamination is suspected.

2. .....**Density of Continuous Fluid**: Rate of rise will be higher when continuous fluid is sea water instead of fresh water or condensate. This information is useful and we can discharge the condensate drains into dedicated clean drain tanks instead of bilges.

3. .....**Viscosity of Continuous Fluid**: As rate of rise is inversely proportional to the viscosity of the continuous fluid, the OWS performance is better when continuous fluid is fresh water. As this deduction is contrary to the above one it is a compromise between the two but it does not concern us much as we don't really have much control on what goes to the bilges as per the original design.

4 .....**Size of Oil Droplets:** The larger the diameter of the oil droplets the better is the rate of separation. This information is very helpful and we can assist the OWS by avoiding small drops of oil by mechanical agitation and emulsification.

5 .....**Temperature:** This is another factor which is important as it affects the density and viscosity directly.

- **Low temperature** of the continuous fluid hinders the separation of oil due to additional viscous drag in view of the increased viscosity of continuous fluid in cold temperature. Oil separation is better in warmer temperatures and slightly increasing the temperature of the bilge water would give better separation.

  This information is important as we can increase separation rate by warming the bilge water in the holding tanks or heating incoming fluid by steam coils fitted in some of the OWS.

- **High temperature** result in the formation of emulsion by mechanical agitation which is more than in lower temperature. This information is important as we should not heat the bilge holding tank when the ship is rolling excessively or where we suspect mechanical agitation.

Chapter 4

Oily Water Separator: The Operational Factors

Operational Knowledge and correct operational procedures are generic and not equipment specific. Correct operational knowledge is required for all machinery on ships to run properly and the Oily Water Separator is no exception. Marine engineers work with different types of Oily Water Separators through their sea career and each type has its own unique features.

Equipment specific knowledge is essential for the correct operation of oily water separator and can be learnt from the operational manual on board. However a generic knowledge is also required as the basic working principle is essentially the same.

An idea borrowed from existing shore technology, the Oily Water Separators for ships are designed to work properly under ideal conditions. However ships do not have ideal conditions, and therefore ship's staff should consider the following operational factors which affect the performance of Oily Water Separator on ships:

1. **Avoid Emulsions**: Emulsions are formed when the inter-facial tension between two liquids is reduced by certain means sufficiently to allow droplets of one liquid to disperse in another. Mechanical agitation, shearing forces, solvents, chemicals, surfactants and the presence of particulate matter can all reduce inter-facial tension and result in formation of emulsion.

2. **Avoid Chemical emulsions:** The chemical emulsion is formed by the addition of some chemicals in the water. These chemicals act as surfactants and they hold the oil drops together in emulsified state. The surfactants may be the detergents used for cleaning, alkaline chemicals used for boiler cleaning and conditioning etc.

3. **Avoid secondary dispersion**: Mechanical emulsions are of primary and secondary types. The primary emulsions are larger drops of oil dispersed in water and generally separated within 24 hours. The secondary emulsions

are fine droplets of oil that are thermodynamically stable and do not separate. The secondary dispersion is caused by turbulent conditions.

4 ..... **Avoid suspended solids**: Suspended solids cause stabilization of emulsion and cause problems in separation of the oil from the bilge water. Suspended solids can be mud, boiler soot and cargo residues sucked from the blowers. The suspended solids get coated with oil and stabilize the emulsion. Neutrally buoyant solids that neither rise nor fall are most troublesome as it is difficult to remove them. They also generate the high ppm alarm.

5 ..... **Avoid Turbulence**: OWS needs laminar flow to operate optimally as per its design. Avoid using OWS in times of heavy rolling and keep all line valves fully open to avoid generating turbulence.

Rolling motion, retrofitting on old pipelines and inadequate opening of the suction line valves can lead to turbulent flow inside the OWS with resulting fall in OWS capacity due to formation of emulsion.

Sometimes due to turbulence some of the oil droplets become less than 8 microns and are affected by the random motion of the water particles. This random motion is called as Brownanian motion and it nullifies the forces of buoyancy and the oil drops fail to rise.

6 ..... **Avoid Particulate Matter**: Fine particulate matter like soot, rust, microbial contamination of bilge water etc. also act as emulsifying agent. Although most of the soot of the boiler washing settles down in the bilge holding tank, fine soot particles (1 µm or less) will give the bilge water a blackish appearance. These particulate matter will not only fool the ppm meter into activating the high ppm alarm but will also physically act as emulsifying agent.

7 ..... **Optimal use of Chemicals:** Sometimes it is required to use special chemicals called emulsion breakers to separate the oil from the water and release free oil. If emulsion breaker chemical is used, care should be taken that it is used as per the instructions given by the manufacturer so that the emulsion does't go worse. Sometimes putting more than the recommended amount can worsen the problem.

8 ..... **Do Proper Filtration:** If there is large amount of solid particles, floating media, jute etc. in the bilge water, it should be properly removed using strainers to avoid fouling of the filter media.

9 ..... **Heat the influent:** Heating the influent reduces the viscosity of the continuous media causing better separation.

10 ..... **Fill up OWS prior use:** Prior to operating the OWS and allowing the bilge water to enter always ensure that it is filled up with clean water and all air pockets have been removed. This is important as air pockets can confuse the capacitive sensors and can make automation go haywire.

11 ..... **Back Flush:** Back flushing of the OWS should be done as per the recommended frequency given by the manufacturer if there is a provision for doing so as it increases the life of the filter media.

12 ..... **Clean Sensors:** Frequent cleaning of the electronic interface sensors would ensure the correct operation, proper oil removal and sharp cutting off ensuring less discharge of water to separated oil tank.

13 ..... **Remove Accumulated Oil:** Apart from the automated oil removal any other accumulated oil should be removed from the OWS chambers regularly.

14 ..... **Proper Operating Procedure:** Make sure that the operating procedure of OWS is followed in a proper step-by-step and systematic procedure.

15 ..... **Proper OWS Maintenance:** Needless to say, proper maintenance of the OWS as per the instructions of the manufacturer would keep it in ship shape condition.

Chapter 5

Oily Water Separator: Bilge Management

No matter what equipment is installed onboard ships, if the bilge management is not proper the Oily Water Separator (OWS) is bound to malfunction. Good bilge management practices helps in optimizing the performance of the Oily Water Separator.

In the engine room the bilges and bilge wells are located at the very bottom of the engine room for collecting oil and water from leakages, condensate and wastes so that they can be pumped to the bilge holding tank.

Clean bilges are the first line of defense against marine pollution. All seasoned marine engineers know that if the bilges are clean and dry, almost all the major worries concerning Port State inspections are almost over. Dirty engine room bilges are one of the biggest detainable deficiencies in port state inspections.

Mentioned below are some of the good practices and tips for efficient bilge management:

- ✓ Used or waste oil should not be intentionally put in the bilges or bilge tank.
- ✓ All oil should be collected and put in the separated oil tank or dirty oil tank. Thereafter it can either be burnt in the incinerator or landed ashore.
- ✗ Discarded chemicals should not be disposed off in the Bilge tank as pH of water above 10 and below 4 can cause chemical emulsification of the bilge water and lead to difficulty in separation.
- ✓ Put drip trays where there are leakages and thereafter rectify and stop the leakages.
- ✓ Primary bilge tank is provided in new ships and this should be used properly and not bypassed. Use of the primary bilge tank increases the effectiveness of the Oily Water Separator as most of the oil is removed here. The primary bilge tank helps in separation of the oil from the water and the oil can

be visually seen and put in dirty oil tank and the cleaner bilge water can be put to the bilge tank. Steam coils are provided in the primary bilge tank and they can be used for effective separation.

✓ Use clean drain tank effectively. In tropical climates there is condensation of more than 1-2 cubic meters per day and this water if allowed to go to the bilge tank will increase the load of the oily water separator. As this is mostly clean water, it should not be allowed to go to the bilge tank; instead it should be put to the clean drain tank and thereafter properly disposed. The leakages from the fresh water and sea water pumps should also be put in the clean drain tank.

✗ Vertical pipelines cause the shearing of the upcoming water and should be avoided as much as possible.

✓ Use mechanical seals where possible. Mechanical seals though expensive lead to cleaner engine rooms as there is minimal or no leakages from the glands.

✓ In conventional gland type pumps though the dripping water may appear insignificant, the small leakages can lead to building up of large amount of water.

✓ During new building, repair and retrofitting it must be remembered that, inlet piping should be smooth and without much undue bends to cause turbulence.

✗ Condensate from accommodation AC and ECR AC should not be put in the bilges, but should be put in separate tank or directly overboard.

✓ Inlet piping should have the least amount of valves, bends and other fittings. Where possible straight line valves like gate valves should be used over angle valves and globe valves to avoid turbulence.

- ✓ The inlet piping just before the entry to the Oily Water Separator should be straight for a length equal to ten times the diameter of the piping and should be sufficiently sized to avoid pressure drop.

- ✓ Small diameter inlet pipelines cause shearing of water and make the oil droplets smaller. These droplets are difficult to remove later therefore the inlet pipeline should be of proper diameter.

- ✗ The boiler blow down should not be done in the bilges but to be done overboard as the conditioning chemicals can cause chemical emulsions.

- ✓ Sometimes there is some ingress of air which is generally unnoticed as the positive displacement pumps can handle some amount of air. Any fall in vacuum should be investigated as these air pockets can make the capacitance oil probes give wrong feedback and falsely activate the oil release valves.

- ✓ Bilge cleaning chemicals must be oily water separator compatible. Wrong chemicals will make the oil soluble in water and could never be separated.

- ✗ Dust and cargo residue should not be drained to the bilges. They should be picked up with a broom and scooped and not blown by air into the bilges. These particulate matters can cause stabilization of the emulsions. Soot from the boilers and economizers should be put in a separate tank and disposed off.

- ✗ Mopping water containing detergents as well as hand wash water should not be put in the bilge tanks.

- ✓ If care is taken in controlling entry of water and waste in the bilges there will not be any problem in running the Oily Water Separator as the later operates in its designed range.

Chapter 6

Oily Water Separator: Care and Maintenance

The general care and maintenance required to keep the OWS running smoothly is as followed:

- Avoid vibration (self or ship generated) by using steady braces. Excessive vibrations may lead to damage to pipes and OWS structure.

- While maintenance is being performed inside the OWS, do not damage the anti-corrosive surface (normally provided where the liquid is in contact with the body) by doing welding or brushing.

- Keep checking the back pressure for the coalescers and if the pressure exceeds the rated pressure, renew the same.

- Periodic cleaning of OWS to be performed by removing any water scale, sludge, dust, bacteria etc. from the internal surfaces.

- Don't avoid maintenance routines on the bilge pump as increase in the wear of the pump will result in leakage of fine grains which are difficult to be separated by filters and which will later affect the separator's performance.

- Clean the oil level sensor electrode at regular interval.

- A filter is installed on the sample water inlet to prevent fouling by foreign objects which may cause measuring error. If the flow of sample water is insufficient, remove and clean the filter.

- The solenoid valve may malfunction due to fouling,which may occur after a long period of operation. The solenoid valve must be cleaned at regular interval.

- The outlet pipe of the OWS (distance pipe between OWS and overboard discharge valve) should be opened up once a month to check for traces of oil. If found, it can be because

OCM is malfunctioning or misoperation of OWS is being performed.

- The alarm and function of the three way valve and other solenoid valves must be checked every week.
- OWS performance test must be carried out at least once a month.
- Do not forget to record each operation or maintenance performed on OWS in the Oil Record Book (ORB).

Chapter 7

Oily Water Separator: Attitude, Aptitude & Housekeeping

No matter what kind of equipment used on board ships, it needs correct operation and training to run it optimally, along with a crew's positive attitude towards the marine environment.

A responsible crew, which includes good housekeeping for a cleaner engine room, is a must to reduce production of oily water.

Segregation of Wastes: Do not mix sludge and bilges. Even a bit of sludge can contaminate large amount of bilge water. In some ports even discharge of treated sewage is not permitted due to local regulation and therefore in absence of dedicated sewage holding tank, treated sewage is put in bilge holding tank.

This should be avoided as it would be impossible to run the Oily Water Separator thereafter without cleaning the tank.

Restrict Drainage of Chemicals: Lot many chemicals are used in engine room for special purposes such as water conditioning, corrosion inhibition, rust removal, cleaning, degreasing etc.

However care should be taken to collect these chemicals and disposing them properly. Allowing all kind of chemicals to run free into the bilges is not good housekeeping. More over the pH of water above 10 and below 4 can cause chemical emulsification.

Detergent Disposal: Detergents are used for mopping and soap washing of bulkheads and such areas. Generally these are the same detergents we use at home or ashore.

These detergents act as surfactants and cause emulsion of oil in water. Disposing mop water

separately or using quick break detergents would help significantly towards better separation.

- **Avoid prolonged storage**: Prolonged storage of the bilge water causes modification in the nature of free oil. Normally oil water mixture when allowed to stand for sometime (say 24 hours) separates into a layer of oil on top of water called as free oil.

  This free oil is easy to remove but long retention of the bilge water can cause modification in the properties of free oil due to oxidation and microbial action. If this modification occurs then it is difficult to remove the oil.

- **Collect leakages**: Ensure that minimum of oil reaches the bilge wells and if the oil quantity is more in a mixture (of oil and water) put it in separated oil tank.

  Always remember that the Oily Water Separator is not a purifier.

- **Special Precautions**: Drains of Air bottle which contains some amount of oil should not be directed to bilges (as commonly constructed).

  Arrangement can be made to divert or collect this oily water mixture in the sludge tank.

- **Engine Wash room**: Maximum number of ships are provided with a separate wash area in the engine room. Since engine crew job involves grease and oil, the wash basin drain of such area to be connected to the sludge tank rather than bilges.

- **Keep Yourself Updated** : It is very important for seafarers to keep themselves updated with all the latest information related to MARPOL Regulations and developments in technology of equipment such as OWS.

MARPOL Pledge : Most of the companies have introduced a MARPOL pledge form which has to be signed by the crew members.

The pledge states that the the crew will not violate any maritime regulations under any circumstances. In case the crew is held responsible for the same, strict actions will be taken against them. It's therefore very important for the crew to respect and follow the pledge throughout the entire period of their employment.

Conclusion

As described in this guide, a variety of factors need to be taken into consideration for smooth and efficient operation of oily water separators on ships.

Maritime professionals working on ships must take special care and responsibility while handling this important engine room machinery.

If you have any questions regarding OWS, feel free to contact us at info@marineinsight.com

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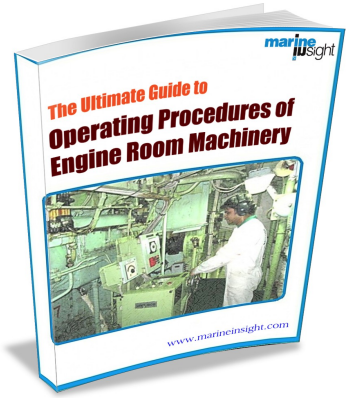

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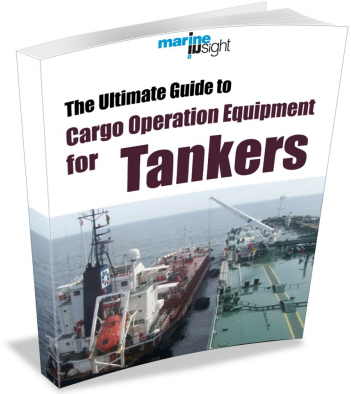

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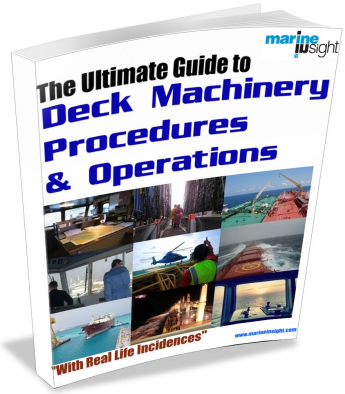

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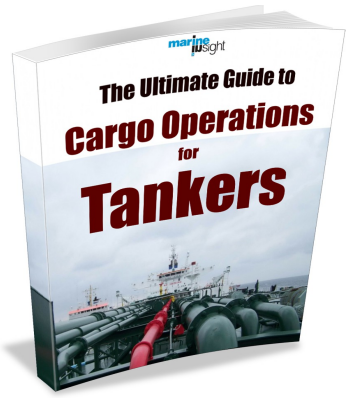

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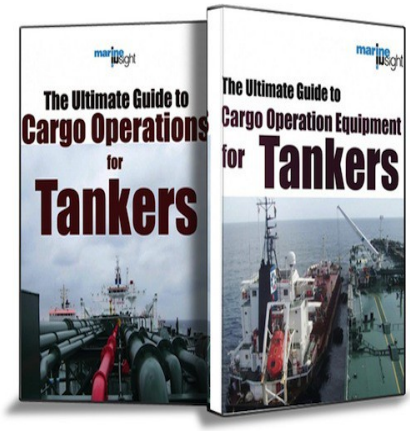

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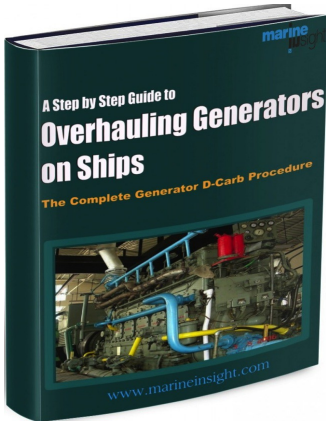

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