The management and their innovative utilization of ship generated waste onboard ships – a peculiar reduction in pollution.

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1. ABSTRACT---Humans have always had a close relationship with the aquatic environment, including the early use of the sea for food harvesting and communication .Today, the sea is an important component of the transportation system with large amount of cargo and passengers. But due to increasing scale of transportation through seas, there is sudden rise in level of pollution by generation of different types of solid and liquid wastes. Therefore, this study constitutes an empirical overview of the management drivers, technologies and quantities of different categories of ship generated waste.

For almost every type of ship generated waste, there is a variety of waste flows and onboard treatment methods. Therefore, I considered three major operators of waste generated by ships: - i) Oil Bilge Water ii) Oily Residues (Sludge) iii) Incinerator Ashes. Operational discharges from ocean going vessels that includes discharges of Bilge water which releases oil into Marine Ecosystems that can potentially damage marine life, terrestrial life, human health and the environment. It is a mixture of oily fluids and other pollutants from a variety of sources onboard a vessel. If it cannot be retained onboard, it must be treated by an oily water separator before discharge for larger ocean going vessels. Similarly, oil residues (sludge) are the waste from the purification of fuel or lubricating oil or separated waste oil from oil water separators. It can be treated by an incinerator. Prior to incineration, a heating system (Evaporator) can be used to evaporate the water fraction of sludge. Also ships can be equipped with incinerators to burn sludge, domestic operational waste and other types of wastes. The resulting incinerator ashes are stored separately. It can be treated further for extracting carbon contents by installing unit called cyclonic static micro bubble flotation column and can be supplied to port reception facility. The extracted carbon can be utilized as a fuel for carbon dioxide extinguisher and many more purposes onboard ship.

The basic scope of study is to provide a comprehensive review of the present technologies and methods being used to reduce ship generated waste produced by ships. Therefore, we emphasize that promotion of waste management offers a powerful tool to provide opportunities and incentive schemes for policy makers to put a GREEN BEACON at the horizon of 21st century shipping!

2. KEYWORDS

I. SGW: - Ship Generated Waste
II. HFO: - Heavy Fuel Oil.
III. MARPOL: - International convention for prevention of pollution from ships.
IV. MGO: - Marine gas oil.
V. OWS: - Oil Water Separator

3. INTRODUCTION

Waste Management is the process of treating all types of waste and offers variety of solutions for recycling items that do not belong to trash. It is about how garbage can be used as a valuable resource. Waste Management is something that each and every household and business owners in the world needs. It includes disposes of the products and substances that you have use in a safe and efficient manner. “It is all the activities and action required to manage waste from its inception to its final disposal”. This includes amongst other things, collection, transport, treatment and disposal of waste together with monitoring and regulation. It also encompasses the legal and regulatory framework that relates to waste management encompassing guidance on recycling etc.

3.1. The types of onboard ship generated waste as per the Annexes of MARPOL:-

MARPOL ANNEX-V RELATED	MARPOL ANNEX-I RELATED	MARPOL ANNEX-IV RELATED	MARPOL ANNEX-VI RELATED
A.PLASTICS A. FOOD WASTES B. DOMESTICS WASTES C. COOKING OIL D. INCINERATOR ASHES E. OPERATIONAL WASTES F. CARGO RESIDUES G. ANIMAL CARCASSES H. FISHING GEAR	A.OILY BILGE WATER B.OILY RESIDUES C.OILY TANK WASHINGS D.DIRTY BALLAST WATER E.SCALE AND SLUDGE FROM TANK CLEANINGS	SEWAGE	OZONE DEPLETING SUBSTANCES (CFCS)

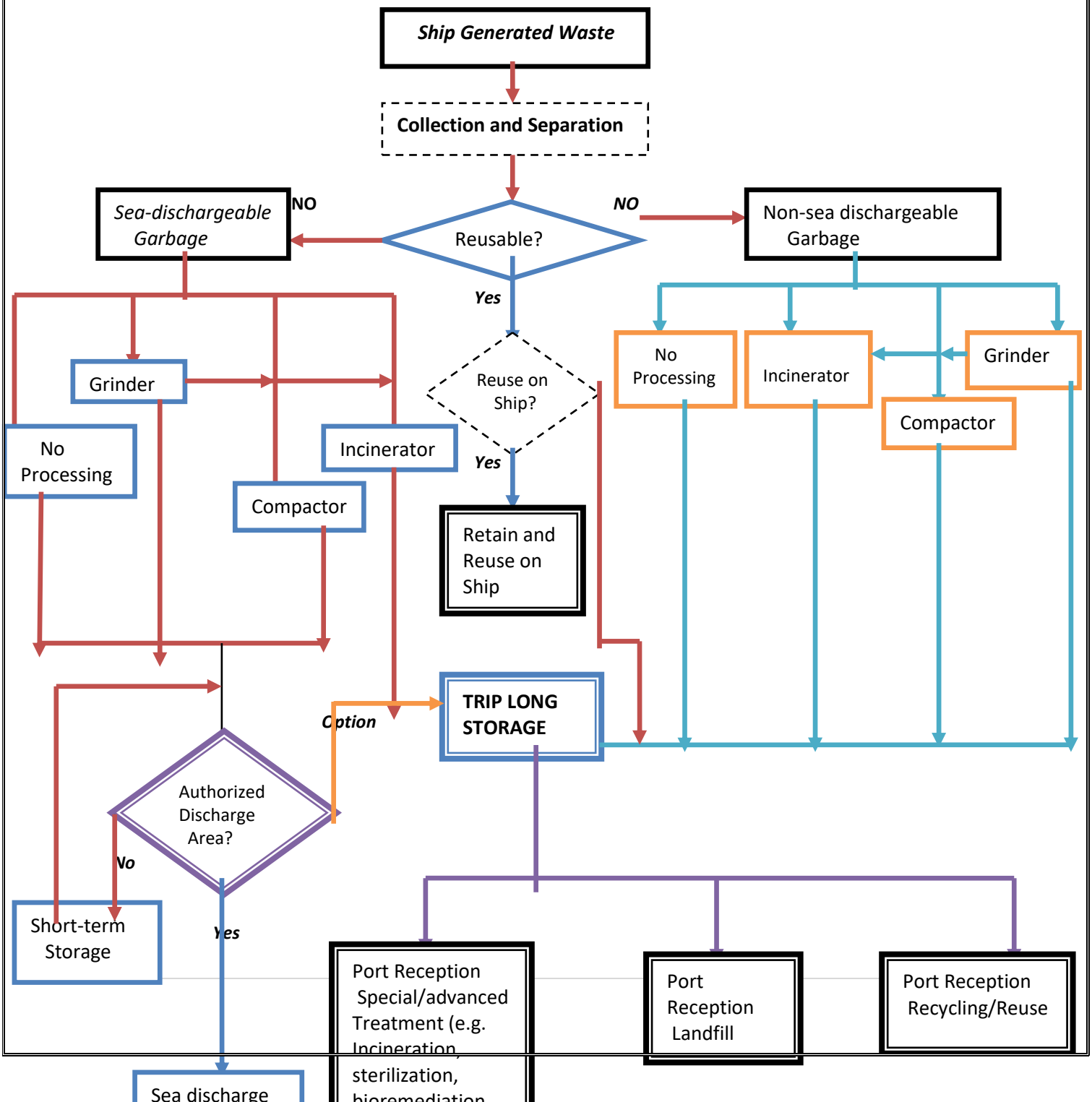
3.2. The major categories of waste generated onboard ship and their respective proposed treatment:-

S.NO.	TYPES OF WASTES	GENERATION RATE	DRIVERS	PROPOSED ONBOARD TREATMENT
1.	**OILY BILGE**	0.01-0.13 m^3 per day, Larger ships generate Larger quantities	Condensation and Leakages in the Engine rooms; Size of the ship.	The amount can be reduced by 65-85% by using an oil water separator and discharging the water fraction into sea.
2.	**OILY RESIDUES (SLUDGE)**	0.01 to 0.03 m^3 of sludge per tonne of MGO (marine gas oil)	Types of fuel; Fuel consumption.	Evaporation can reduce the amount of sludge by up to 75%. Incineration can reduce the amount of sludge by 99% or more.
3.	**SEWAGE**	0.01to 0.06 m^3 per person per day. Sewage is sometimes mixed with other waste water. The total amount ranges from 0.04 to 0.45m^3 per day per person .	Number of persons on-board; types of toilets; length of voyage.	Effluent from Treatment plants is often discharged at sea where permitted under MARPOL Annex V.
4.	**INCINERATOR ASHES**	0.004 to 0.06 m^3 per month.	Use of incinerator; cost of using incinerator.	The incinerator is not used for all types of waste, mostly for paper sometimes for oily

		sludge.	
5.	**DOMESTIC WASTES**	0.001 to 0.06 m^3 per day per month.	Number of persons on-board; type of products used.

Hence, different types of wastes can be treated by using suitable methods and proposed treatments as per the conventions of MARPOL Annexes.

4. Overview of proposed waste management plan and shipboard handling and discharge of Garbage



5. OILY BILGE WATER

5.1. *Introduction*

A Ship's bilge is defined as the interior region of the ship's hull that exists between the lowest point and the bottom of the vertical side of the ship. It is defined as all of the drained liquid that accumulates within the confines of this area and generally consists of sea water, solvents, fuel, hydraulic and lubricating oils and liquids from the ship's cargo. Bilge water is a mixture of liquids that are collected in the bilge of ship. It is made of a mixture of fresh water, sea water, oil, sludge, chemicals and various other fluids that drain into the bilge. Sea water and fresh water can find its way to the bilge wells due to drainage from deck, leakage in the pipelines, leaky pump and valve glands from machinery or spillage in the engine room.

Bilge Water is generated through condensation, leakage and cleaning. As a general rule, bilge water contains oil from the engine room; hence the term 'oily bilge water'. Any liquid entering the bilge system including bilge wells, bilge piping, tank top or bilge holding tanks is considered to be oily bilge water. All vessels have oily bilge water, although the quantities for recreational vessels are minimal. Vessel-related operational discharges, including discharge of bilge water, represent one of the largest anthropogenic inputs of oil into marine environment and are estimated to be even higher than accidental oil spills. Although oil enters the marine environment though both spills and chronic releases, greater effort and treatment can reduce frequent small releases whereas catastrophic and accidental oil spills are less easy to prevent. Less work has been done to understand the threat posed by these chronic releases that we are suspected of causing notable environmental impacts. The toxicological effects of oil in the environment are a function of not only the volume of oil released but also other factors such as the nature of oil released and the physical and biological system exposed.

Bilge water, one chronic oil pollution source, has been estimated to an account for 20% of the only water released by the vessels into the ocean worldwide. It is a mixture of complex suite of compounds including oily fluids and other pollutants such as metals, detergents and solvents, which come from a variety of sources and accumulate in ship-board bilges. Oil in bilge water appears in several forms based primarily on the size of oil droplets: free, disposed and emulsified. Emulsified oil (oil droplets smaller than 20μm) is the hardest to treat because its neutral buoyancy makes it difficult to separate by gravity alone. Since, bilge water cannot be retained onboard; vessels must treat it with an oily water separator (OWS) prior to discharge.

In addition to oil and hydrocarbons, bilge water contains a mixture of other contaminants and the amount of contaminants varies based on ship's operations, equipment performance and repairs. It also contains multiple pollutants including metals, conventional pollutants (e.g. nitrogen and phosphorus containing compounds, suspended solids etc. and organics along with significant concentration of detergents), solvents and polyaromatic hydrocarbons (PAHS).

5.2. *Oily Bilge Water Management and Technology*

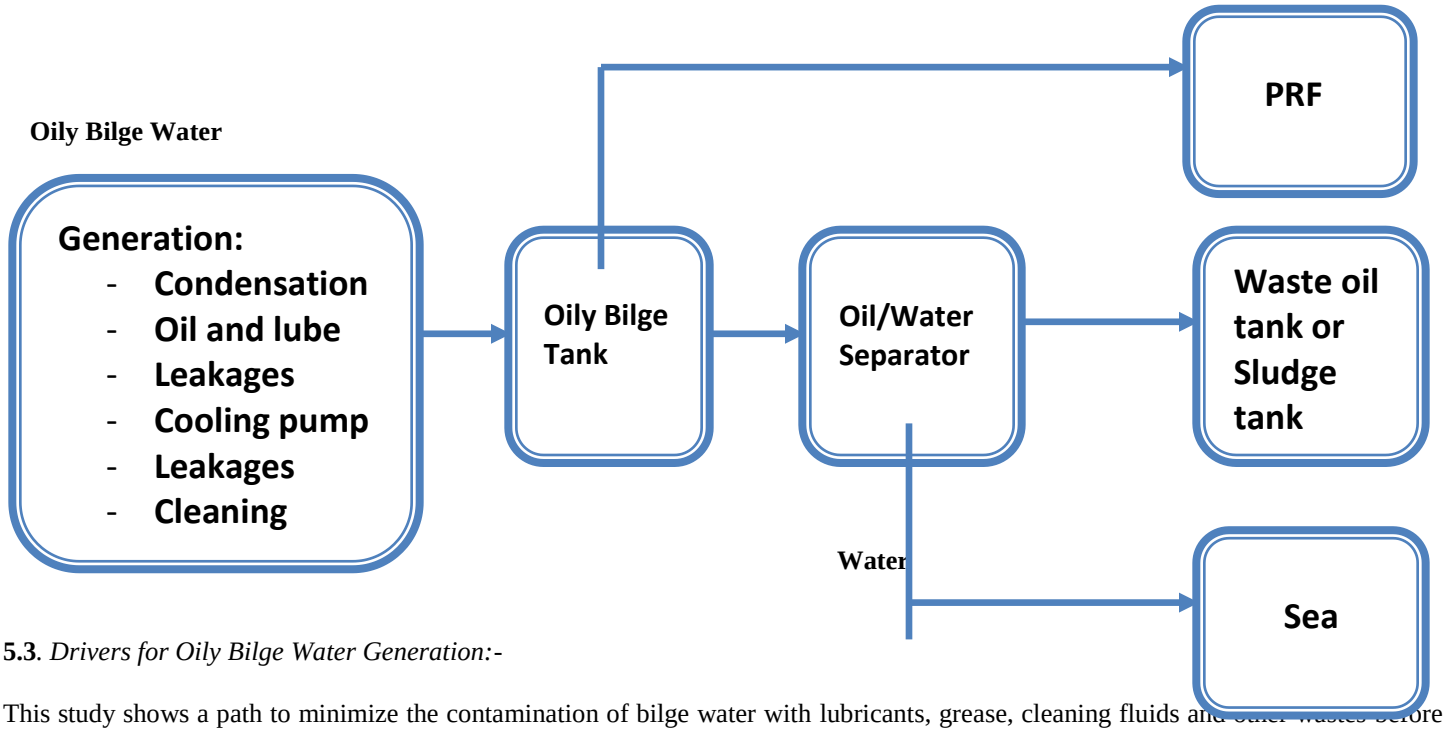
The bilge water can be managed by retaining it onboard in a tank and discharging it to a PRF or it can be treated onboard with an OWS. This on-board treatment system is designed to remove the oily part from the vessel bilge water prior to the discharge of treated bilge water.

Bilge Separator technologies can be improved by an addition of combined gravity oil water separator or centrifuge with one or more additional unit operations that 'polish' the bilge water effluent to reduce the concentrations of emulsified oils. Even though, there are several technologies to separate the water and oil such as absorption/adsorption, biological treatments, coagulation/flocculation, flotation and membranes.

Traditionally, Bilge water was treated by gravity OWS which use the different specific gravities of oil and water and their immiscibility to separate them. While gravity OWS can effectively separate discrete phases of oil and water, they do not separate emulsified oil because the buoyancy differences are too small. Additionally, gravity OWS are ineffective at removing colloidal metals and soluble compounds. Finally, gravity OWSs work less effectively in a shipboard environment where the motion of the vessel may agitate the oil- water mixture. But centrifugal OWSs also utilize the difference in density between oil and water to separate oil from bilge water, but the centrifugal force imposed on the bilge water being treated causes the immiscible liquids or solids to separate more effectively than by gravity alone. We emphasize polishing treatment include absorption, adsorption, biological treatments, coagulation/flocculation, flotation, electrochemical, demulsification and purification and ultra filtration. Adding such polishing units will effectively treat bilge water to very low effluent oil concentrations although the influence of operation parameters may differ may differ among treatment technologies. Furthermore, the addition of chemicals of microorganisms which help to reduce oil

concentrations may influence the effluent quality in regards to other pollutants. This method will optimized for removing oil and can also remove other pollutants. As it includes ultra flirtation and electro coagulation which effectively remove turbidity, suspended solids, organic carbon and several trace metals. Conversely, an air stripping and photo catalysis system attached to it will increase in volatile-organic compound (voc) emissions, a gaseous pollutant and biological treatments require an additional clarifier to remove the bacteria used to degrade the oil. Because of the interactions among these other pollutants, developing a better understanding of the chemistry of both the influent and effluent of these bilge water treatment systems should be considered to optimize the efficacy of the OSWs and prevent the discharge of these pollutants into the environment.
Hence, it is most efficient method and as it is based on the density difference between oil and water. This type of treatment can reduce the quantity of bilge water by 65-85%.
As per the regulations of MARPOL, all ships over 400 GT are required to have equipment installed onboard that limits the discharge of oil into oceans to 15 ppm when a ship is enroute. They are also required to have an OCM (oil content monitor) and a bilge alarm to detect if the treated bilge water meets the discharge requirements. Therefore, the system consists of a three-way valve that makes it possible to retain treated bilge water onboard in case the discharge does not comply with requirements.

5.2.1. *Waste Flow Diagram for Oily-Bilge Water*



5.3. *Drivers for Oily Bilge Water Generation:-*

This study shows a path to minimize the contamination of bilge water with lubricants, grease, cleaning fluids and other wastes before it accumulates in the lowest part of a vessel. Oily bilge water generation varies and depends on factors such as the size of ship, engine room design, preventative maintenance and the age of components on the ship.
As per the general interaction with engine crew members, it reveals that the overall procedure is to keep the bilge clean in practice; the main drivers for oily bilge water generation are condensation and leakages in the engine room. This is determined by the weather conditions and change in temperature as well as by cleaning and maintenance of the machine room. The online survey of various marine portals also indicates that other drivers for oily bilge water such as the type of engine, the age of the engine and type of fuel burnt as well as the engine running hours per day.

5.4. ***Conclusion***

The most efficient method for treatment of oily bilge water is to check with combined gravity and centrifuge OWS and one more additional unit called polished units which even reduce the concentration of emulsified oils. By these methods, amount can be reduced by 65-85% and it also assists in discharging water fraction into sea.

6. Oily Residues (Sludge)

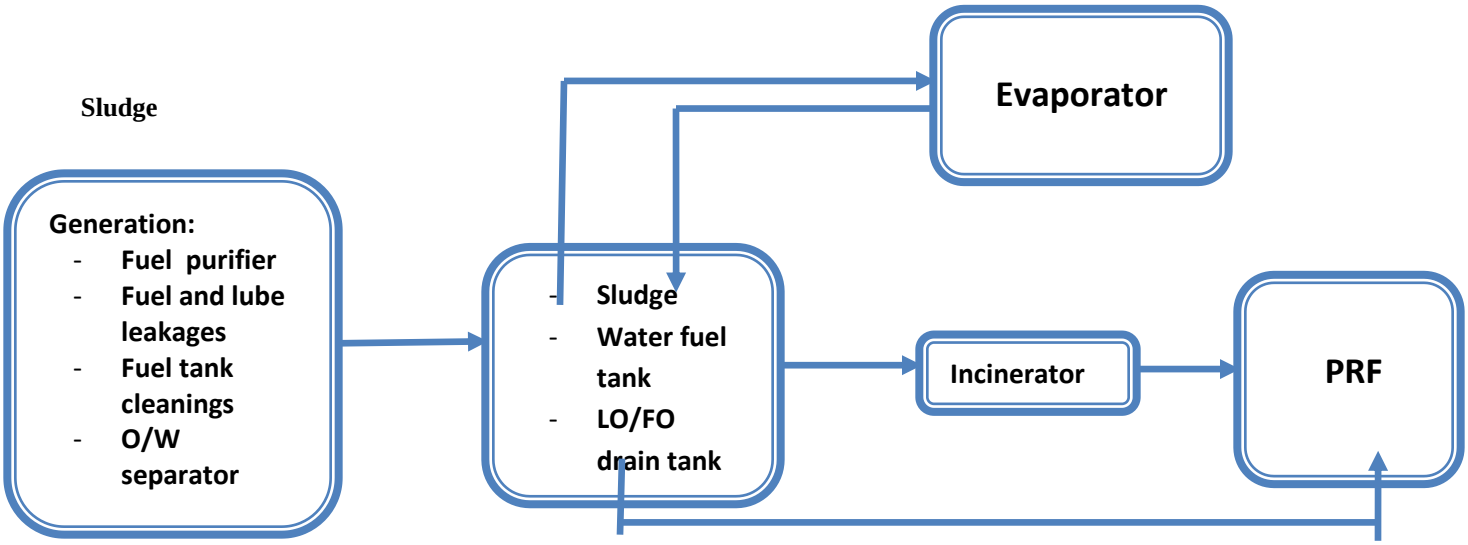
6.1. *Introduction*

Oil residue (sludge) is the waste from the purification of fuel or lubricating oil or separated waste from oil water separators, oil filtering equipment or oil collected in dip trays, waste hydraulic and lubricating oils. In addition to oil or fuel, sludge often contains water, tar, asphalts and other contaminants (both soluble and insoluble matter). Sludge is generally generated in a fuel or lube oil purifier, which centrifuges the fuel to separate these impurities. This is done to prevent damage to engine components, reduce wear and improve fuel combustion. At regular intervals, the resulting sludge is drained. Fuel from leakages, tank cleanings and in some cases, the oil fraction from the oil/water separator is also treated as sludge. All vessels produce sludge with the possible exception of vessels that run exclusively on distillates.

6.2. Oily Residues Management and Technology

Oily residues can be managed on-board by retaining them in a tank and then delivering them to PRF, or we suggest it should be treated on-board. The most frequently used technology these days is to treat oily sludge is an incinerator. Prior to incinerator, we suggest a heating system called as an evaporator should be installed that will evaporate the water fraction of sludge. It also helps in reducing the amount of sludge.
An incinerator consists of a combustion chamber with a burner unit, a sludge inlet and an electric control panel. The standard specification for shipboard incinerators intended to incinerate garbage and other shipboard wastes generated during the ship's normal service covers the design, manufacture, performance, operation and testing of incinerators.

6.2.1 Waste Flow Diagram for Oily Residues



Here sludge is generally collected in a sludge tank, a waste fuel tank, a waste oil tank or a lube oil or fuel oil drain tank. It may then be transferred directly from the tank to a port reception facility. Evaporator will evaporate water from the sludge. It can also be incinerated onboard in which case the incinerator ashes are delivered to PRF.

6.3. *Drivers for Oily Residues generation*

The amount of oily residues generated depends on the type and the amount of fuel consumed. Most of the survey of waste treatment indicates that as a rule of thumb, 1-3% heavy fuel oil is sludge. This has also been found by recent survey of Maersk Line, who also confirmed that fuel quality is a driver. In addition other drivers have been presented including oily bilge water landed as sludge, increased waste oil production due to machinery failure leaks, cleaning operations and maintenance jobs. Other technical factors could also affect sludge production for example desludging intervals, back pressure setting on the purifiers, running of a bilge water separator and operating efficiency of various purifiers and filters. The same range applies to ultra low sulphur fuel oils.
The amount of sludge from lube oil depends on the type of lube oil and the lube oil consumption. It is generally several orders of magnitude less than oil residues from fuel. Through an automatic lubrication system it is possible to decrease usage by 70% by choosing the exact dosage required for the installation to achieve a sound performance. This enables installations to achieve significant lubricant savings. The amount of fuel consumed is driven by the engine efficiency and the energy demand of the vessel e.g. propulsion and electric power. Hence, lower fuel consumption will result in lower production of sludge.

6.4. *Conclusion*

Oily sludge is residual waste as a result of consuming fuel and is applicable to all types of vessels. The treatment of oily sludge can be achieved through evaporation and or incineration. Most of the sludge is stored and disposed at a PRF without treatment. Therefore, evaporation can reduce the amount of sludge by up to 75%, while incineration of remaining sludge reduces the amount by 99% or more.

7. Incinerator Ashes

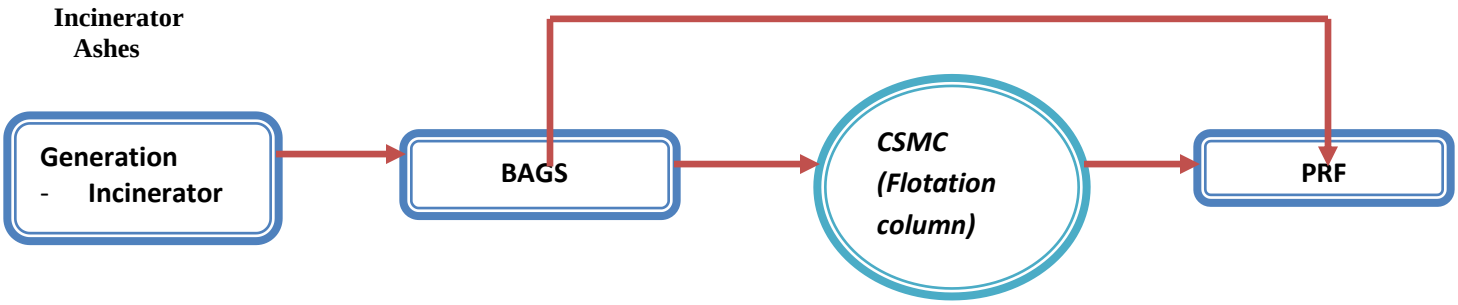
7.1. *Introduction*

Ships can be equipped with incinerators to burn sludge, domestic, operational waste and other types of waste. The resulting incinerator ashes are reported separately in garbage record book.

7.2. Incinerator ashes and management technology

Ashes are generated in the incinerator, collected in bags and delivered to PRF. But incinerator ashes can be utilized by extracting carbon contents from it. It can be extracted by installing a unit called cyclonic static micro bubble flotation column (CSMC) or also a device with the characteristics of internal recycling process and multiple mineralization steps. It has separators which effectively remove unburnt carbon from ash. Extracted carbon can be utilized for various purposes onboard (e.g. as a fuel for carbon dioxide extinguisher and many more equipments). Extracted carbon can also be delivered to PRF so that, it can further utilized for shore purposes also.

7.2.1 Flow-Diagram



7.4. Drivers for incineration ashes generation

The driver for generation of incineration ashes is the amount of incineration of oily sludge (including the oily part of bilge water), plastics, domestic waste including cardboard and operational wastes including oily rags onboard a vessel.

7.5. *Conclusion*

Incineration ashes only occur if ship uses an incinerator, which can be used for garbage and or sludge incineration, which can be used for garbage and or sludge incineration. The ashes are generally collected in bags and disposed to PRF. But treatment of ashes by extraction of carbon contents can reduce the cost of delivery of ashes to PRF.

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