Filtration Challenges in the Marine Industry

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ABSTRACT

The national and international marine industry provides unique challenges and opportunities to filtration and separation engineers and manufacturers. Ships are portable and independent communities that essentially contain all propulsive, industrial and domestic processes that exist ashore. Just like ashore, the maritime industry has become more environmentally regulated and new regulations continue to be introduced. However, in addition to the limitations that are encountered ashore there are additional problems that are associated with shipboard installations such as international regulations, training problems, technical feedback problems and the space and time restrictions that are unique to the shipboard environment. This presentation discusses these issues and shows in which ways the maritime industry leads and lags in filtration and separations technologies and design and identifies the emerging opportunities for the filtration and separation industry.

THE MARINE INDUSTRY

Like many distinct industries such as the railroad industry, airline industry, and petrochemical industry, the marine industry can appear to be both distant and familiar. We all have some familiarity of these industries and at the same time, to most of the public, these industries are removed as far as our daily interests are concerned.

We use railroads, but only a few of us know railroads and the same goes for other industries that appear to operate within a community. These communities tend to attract their own people and their own suppliers. Think airline and we think Boeing and Airbus. Think petrochemicals and we think Exxon, BP and Shell. While we fly on Boeings and buy Exxon gas, we would never think of entering the airplane construction business or the oil exploration business without significant prior familiarity, and even providing subsidiary services to those industries could seem a daunting task if one does not have a traditional involvement in those industries.

To most outsiders the marine industry may appear similarly daunting, and switching from home construction to shipbuilding is certainly not something that any sane businessman would attempt.

However, the marine industry has some unique characteristics and aspects that could be attractive to a company that has involvement in filtration technologies.

This paper will show that there are only limited barriers to entry into the marine industry, that the marine industry requires a disciplined product development approach that transfers well to other industries and that the marine industry can be an effective mechanism for international marketing and production.

From an American businessman's point of view, the marine industry can be divided into the domestic marine industry and the international marine industry. This paper will focus on the international marine industry since, on almost any level, the domestic marine industry is a subset of the international marine industry. In many industries there is a benefit in concentrating on a specific market first and then to broaden out into larger market. The marine industry is a significant exception to this approach. This is due to the fact that the marine industry functions by international regulation and that only very rarely there are additional national regulations that would make it difficult to market a product at a national level.

In simple words: If it can succeed at an international level, it can succeed at a national level.

It is important to note that the international marine industry can be located anywhere in the world but that the actual equipment is fitted on ships that, due to their trade between different countries, are multi-national entities. Therefore international does not refer to other countries, it actually refers to all countries that have international ports, and countries that have ships that travel between those ports. Therefore "international" can mean a ship that is Greek owned, Dutch financed, Marshall Islands registered, Norwegian operated, Japanese designed, Korean built, Philippine crewed, loaded with Chinese cargo on a voyage between Brazil and Australia and fitted with US filtration equipment.

This multinational composition is much more the norm than the exception in international maritime trade. The vast majority of ships are multinational, but the marine industry does not care and neither should it be a concern to anybody who wants to enter this industry.
The marine industry is both large and small. It is extremely large in its influence on world trade, politics and general welfare, but on the other hand in equipment numbers, it is not terribly large.

The following are some of the latest shipping statistics.

Table 1 – World fleet : total number of ships, by type and size – 2006

Ship Type	Small[1]		Medium[2]		Large[3]		Very Large[4]		Total	
General Cargo Ships	5 138	20,5%	12 771	36,7%	193	2,8%			18 102	26,0%
Specialized Cargo Ships	31	0,1%	176	0,5%	33	0,5%			240	0,3%
Container Ships	1	0,0%	2 165	6,2%	1 319	18,9%	475	17,7%	3 960	5,7%
Ro-Ro Cargo Ships	34	0,1%	978	2,8%	526	7,5%	50	1,9%	1 588	2,3%
Bulk Carriers	436	1,7%	3 344	9,6%	2 713	38,9%	747	27,9%	7 240	10,4%
Oil and Chemical Tankers	2 081	8,3%	5 871	16,9%	1 691	24,2%	1 013	37,8%	10 656	15,3%
Gas Tankers	51	0,2%	880	2,5%	170	2,4%	196	7,3%	1 297	1,9%
Other Tankers	158	0,6%	218	0,6%	3	0,0%			379	0,5%
Passenger Ships	3 320	13,2%	2 594	7,5%	244	3,5%	95	3,5%	6 253	9,0%
Offshore Vessels	1 264	5,0%	2 834	8,1%	47	0,7%	99	3,7%	4 244	6,1%
Service Ships	1 804	7,5%	2 196	6,3%	35	0,5%	7	0,3%	4 122	5,9%
Tugs	10 724	42,7%	767	2,2%					11 491	16,5%
Total	**25 122**	**100%**	**34 794**	**100%**	**6 974**	**100%**	**2 682**	**100%**	**69 572**	**100%**

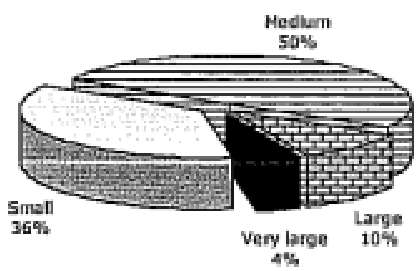
Source: Equasis processed by EMSA / [1] GT<500 - [2] 500≤GT<25,000 - [3] 25,000≤GT<60,000 - [4] GT≥60,000

Table 2 - World fleet : gross tonnage (in 1000 t), by type and size - 2006

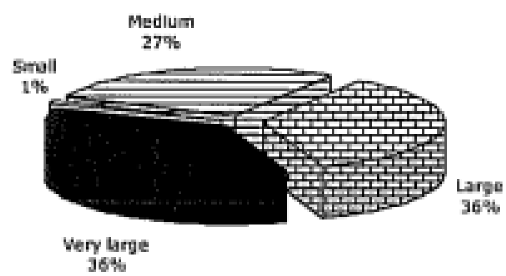
Ship Type	Small[1]		Medium[2]		Large[3]		Very Large[4]		Total	
General Cargo Ships	1 677	25,0%	52 703	26,5%	5 660	2,2%			60 040	8,2%
Specialized Cargo Ships	12	0,2%	1 108	0,6%	1 145	0,4%			2 266	0,3%
Container Ships	0	0,0%	25 138	12,6%	50 581	19,3%	37 039	14,2%	112 759	15,5%
Ro-Ro Cargo Ships	13	0,2%	9 039	4,5%	23 128	8,8%	3 184	1,2%	35 363	4,9%
Bulk Carriers	166	2,5%	47 015	23,6%	94 577	36,2%	65 017	24,8%	206 775	28,4%
Oil and Chemical Tankers	670	10,0%	34 229	17,2%	67 229	25,7%	117 290	44,8%	219 418	30,1%
Gas Tankers	19	0,3%	4 183	2,1%	7 145	2,7%	19 455	7,4%	30 801	4,2%
Other Tankers	43	0,6%	656	0,3%	96	0,0%			796	0,1%
Passenger Ships	834	12,4%	12 049	6,0%	8 644	3,3%	8 487	3,2%	30 014	4,1%
Offshore Vessels	361	5,4%	5 270	2,6%	2 051	0,8%	10 696	4,1%	18 378	2,5%
Service Ships	506	7,5%	7 015	3,5%	1 288	0,5%	496	0,2%	9 306	1,3%
Tugs	2 420	36,0%	772	0,4%					3 192	0,4%
Total	**6 721**	**100%**	**199 179**	**100%**	**261 544**	**100%**	**261 663**	**100%**	**729 108**	**100%**

Source: Equasis processed by EMSA / (1) GT<500 - (2) 500≤GT<25.000GT - (3) 25.000≤GT<60.000 - (4) GT≥60.000

Graph 1 - World fleet : total number of ships, by size – 2006



Graph 2 - World fleet : gross tonnage, by size - 2006



As can be seen, if I were a filter manufacturer with an absolutely novel product that could be installed on every ocean going vessel, at maximum, I would sell 10,000's of units and would never achieve a million units.

Depending on the product's cost and profit margin, this could be a significant market or a negligible market. If the product is air handler filters at $10 per unit, such as are also used ashore in homes, I might be able to sell 50,000 units per year as compared to millions per year in the United States alone. That would be a $500,000 a year market segment.

On the other hand, as this paper will show there are distinct needs in the marine industry for products that run in the $20,000 per unit cost range and that could find a ready market of 1000 units per year resulting in sales of $20,000,000. Not a huge business, but far from a negligible business segment.

As will be described later, acceptance of a particular product in the marine industry could actually assist in market penetration in foreign countries, but first the particular filtration needs aboard ships will be described.

FILTRATION NEEDS IN THE MARINE INDUSTRY

Ocean going ships are actually small stand alone self propelled villages. As such, just about any filtration need that exists ashore in a community, or in a propulsion device, also is needed aboard ships. Furthermore, while environmental filtration ashore is generally confined to municipal or factory systems, these filtration devices are also needed aboard ships due to international regulations. As such, filtration devices aboard ships might be present for pure operational reasons or for regulatory reasons.

There are distinct marketing and design differences between filters for operational needs and filters for regulatory needs.

A partial listing of shipboard operational filtration needs includes the following:

Fuel filtration

Ships use fuel to provide propulsive and electrical power aboard the vessel. The fuel can range from diesel fuel to heavy fuel oil. Fuels come from often unreliable and non-uniform sources and, as such, generally require some level of shipboard treatment prior to use in prime movers. Fuel treatment can range from simple water and solids exclusion filter for diesel powered vessels to complex arrangements of settlers, strainers, filters and centrifuges for heavy fuel oils. At present the more complex fuel treatment systems are provided by only a few manufacturers and are probably led by Alva Laval and Westphalia. The simpler fuel filter systems for diesel engines are covered by a wider range of suppliers and operate on a more commoditized level.

Air filtration

Any type of equipment that ingest air aboard a ship such as HVAC units, engines and compressors uses some type of air filter to exclude particulate matter. Ships in deep sea operation generally have lower air particulate matter levels than land based applications, but this can vary dramatically, taking into account that transit of the Suez canal during a sandstorm is a textbook argument for reliable air filtration aboard ships. One particular type of air filtration aboard ships relates to removal of oil mists and vapors in engine rooms. Another specific air filtration need relates to breathing apparatus for crew members that work in environments that can contain toxins or carcinogens.

Water filtration

Ships generally generate their own fresh water. Traditionally this was produced by evaporation, and filter needs were limited to salt water intake filter requirements. Today more and more vessels are switching to Reverse Osmosis (RO) water makers and filter requirements have become more complex. Besides the RO membrane most shipboard RO fresh water systems have pre and post filters and treatment to ensure reliable fresh water production.

Dehumidification

Ships generally operate in high relative humidity conditions and accommodations, equipment and cargoes might require water vapor removal. Specifically ships that carry high value cargo for long periods of time (maritime prepositioning ships that are often laid up for long periods of time with military equipment aboard) could require very extensive dehumidification systems.

Cargo air filtration

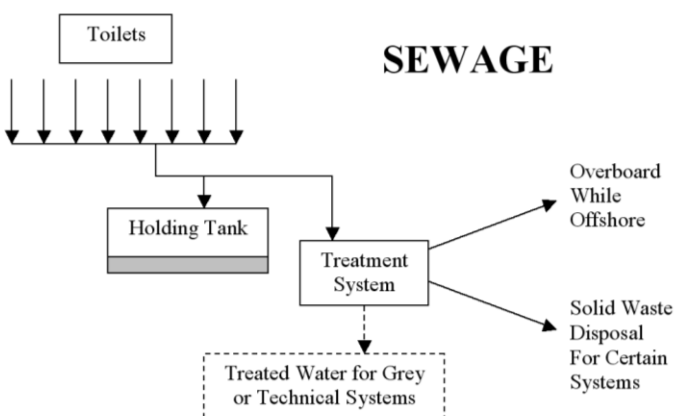
Many cargoes have specific requirements regarding the air that comes into contact with the cargo. Refrigerated cargos, such as bananas, require air exchanges to keep fruit ripening organic compounds low. Crude oil is transported in tanks with low oxygen content. Other chemical cargo could require a high nitrogen atmosphere.

Besides operational filtration requirements, which in many cases are supported by mature technologies, recently the focus on environmental responsibility by international regulators has introduced additional shipboard filtration requirements.

The introduction of these legally mandated systems has placed a significant burden on ship operators and ships' crews. These systems are sometimes referred to as "for the public" systems since they do not assist the ship's crew in making the ship operate more efficiently, but instead are fitted for the public benefit.

The following "for the public" systems that have significant filtration aspects are recent additions to typical ocean going ships:

Sewage treatment systems (Marine Sanitary Devices, MSD)



Just like in shore based sanitary systems, shipboard sanitary systems need a certain level of waste water treatment, which is controlled under MARPOL IMO regulations. On US flag ships sanitary treatment systems need to be United States Coast Guard approved, but USCG approval standards are identical to MARPOL standards. As such USCG approval can be obtained through certification by other national authorities.

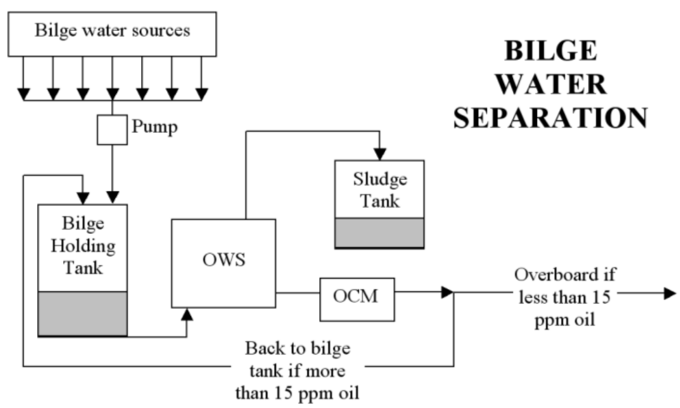
There is a wide variety of treatment approaches for sanitary treatment systems, but ultimately they all receive raw sewage and treat the sewage with biological, filtration and chemical agents to obtain a discharge liquid that is essentially pathogen free. The level of sophistication of these systems varies greatly, with some systems providing discharge water that is safe for human consumption. From an operational point of view the large systems aboard passenger vessels today are often well operated, but smaller systems on commercial cargo vessels often only receive marginal maintenance and operational supervision and it would not be unrealistic to conclude that in many cases they are not functioning on an effective level.

There is quite a range in size for shipboard sewage treatment systems from as low 10 gallons per day to 10,000 gallons per day.

There are various discharge restricted areas where even treated sanitary water cannot be discharged and, as such, ships often collect sewage in sewage holding tanks for extended periods of time.

Traditionally shipboard toilets were salt water flushed, but today most systems are fresh water based.

Bilge water separation systems (Oily Water Separators. OWS)



Bilge water is water that drains from shipboard systems and leaks into the lower portion of the ship (the bilges). This water is often oil contaminated and traditionally was simply pumped overboard when too much water collected in the bilges.

The entrained oil in the bilge water would result in significant water surface oil contamination and this type of pollution was one of the first to be addressed through MARPOL in the early seventies.

MARPOL directed that during normal operations ships could not discharge bilge water overboard unless it contained less than 15 parts per million oil. This level of oil content will not separate by gravity alone and, as such, requires specialized separation equipment. Shipboard oil/water separation is not similar to shore based oil separation in that it uses a combination of heating, gravity, coalescing and filtration techniques to achieve this level of separation.

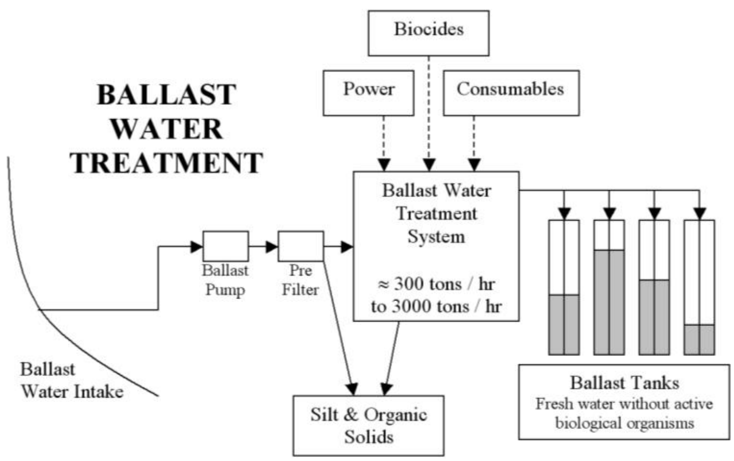
In practice oil water separation aboard ships has been found to be extremely complex for many reasons such as the unpredictability of the components in bilge water, poor shipboard equipment design, lack of training and discontinuous treatment flow.

There have been other attempts at bilge oil/water separation methods and they have shown various levels of success. In addition to the above noted more traditional methods there have also been efforts at using biological treatment and treatment by high temperature and ozone/peroxide methods.

At present the market for improved systems is wide open due to continuous criminal prosecution of alleged misuse of the OWS systems and the failure of ship operators and designers to provide systems that are fool and tamper proof.

Undoubtedly a fire and forget system that will not require any specific supervision and convinces regulatory agencies that it will not discharge to the sea would be a huge hit with ship operators.

Ballast water treatment systems



Most ships carry ballast and this ballast is generally in the form of water that is loaded in a cargo discharge port. While the cargo is being discharged the ship's pumps will take harbor water and load it into ballast tanks to ensure that the vessel floats sufficiently deep in the water to allow it to transit to another loading port. Once it arrives in the loading port it will discharge the ballast water into the loading harbor ecosystem while it takes on cargo.

This transfer of ballast water from one ecosystem to another ecosystem can, and has, resulted in invasive species propagation with often very destructive results.

At present MARPOL is engaged in a regulatory effort that prevents this transfer of invasive species. The initial methodology was referred to as Ballast Water Exchange. This required ships to discharge the fresh water ballast that was taken on board in the cargo discharge port and to exchange it at sea with salt water. Since salt water acts as an invasive species screen between various fresh water harbors it was thought that this method would prevent invasive species transfer. This method was considered to be reasonably effective for most species, but also presented a realistic danger to a ship and its crew since the ballast water exchange procedures is a delicate and manpower intensive operation for which ships were never designed.

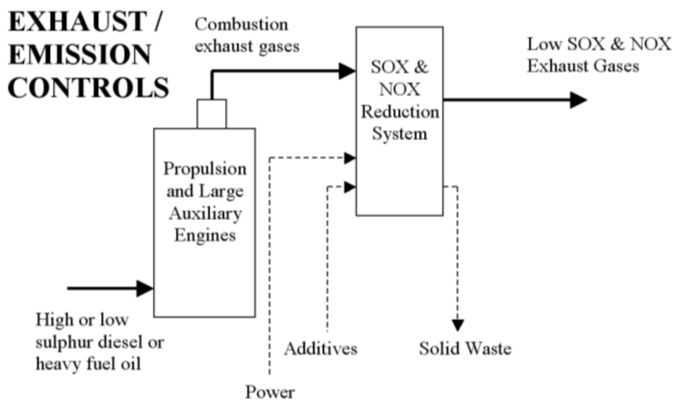
In at least one, and possibly more, situations it has resulted in ship casualties.

There are other ballast water exchange systems and in an extreme approach a ship could load fresh drinking water into its ballast tanks. However ships carry large amounts of water ballast, up to 10,000's of tons of water and this could be cost prohibitive and too time consuming for shipboard operations. Fresh water has the advantage of being much less corrosive than salt water, which reduces ballast tank maintenance cost.

To prevent operational problems with ballast water exchange, IMO, under MARPOL is presently requiring ships to be fitted with ballast water treatment systems. Some systems have been approved and a few systems have been tested in shipboard operation. Nevertheless, at this stage there is no consensus for a preferred system approach. Systems have been conceived and tested that use peroxides, both generated aboard or through use of chemical additives, all filtration, UV treatment and deoxination. All these systems appear to require a certain level of pretreatment filtration to be effective and to deal with variations in silt content and turbidity of harbor water.

Transfer of ballast water can also result in pathogen transfer. At present there are no regulations that aim to control this eventuality, but ideally a ballast water treatment system removes or disables all organisms in ballast water.

Exhaust/emission control systems

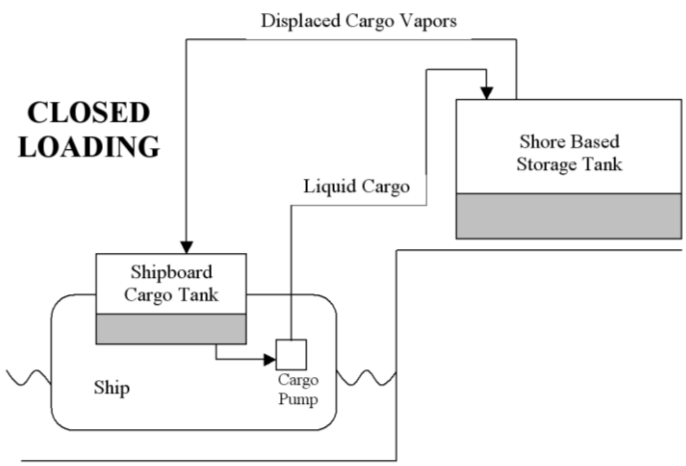


Most shipboard prime movers are diesel engines that burn the various grades of diesel fuel and heavy fuel oil. Diesel engines, especially highly efficient shipboard diesel engines that run on cheap high sulphur fuels, produce sulphur and nitrous oxides, which are considered to be major polluters.

Shore based diesel engines in first world countries are being fitted with various systems to reduce the level of SOX and NOX due to ever tightening environmental regulations. IMO also has developed regulations that limit NOX and SOX production by shipboard diesel engines. Some of the systems developed for shore use are also being applied to shipboard engines, but the great variety in fuel types and engine sizes aboard ships (100 Hp to 100,000 Hp) also is dictating other approaches.

At present engine tuning and fuel treatment can result in acceptable emissions, but in the near future undoubtedly specific exhaust gas treatment systems will need to be installed. These could be catalyzing or rebreathing types, or use chemical additives or scrubbers.

Closed Loading Systems

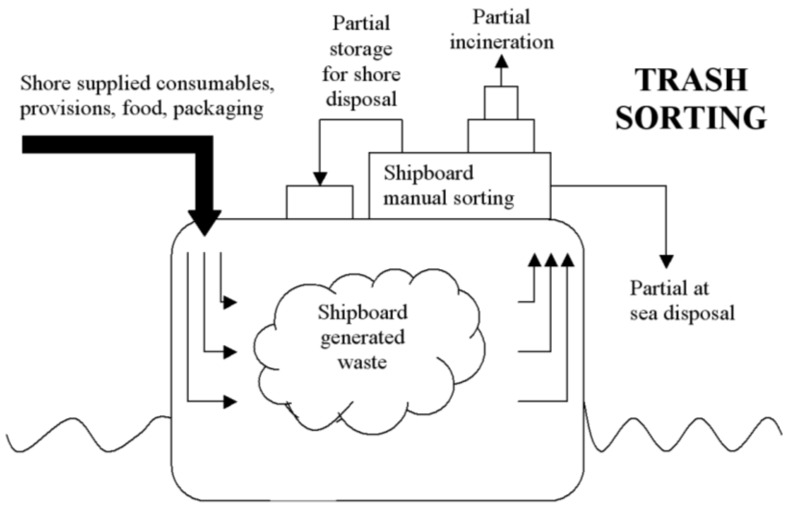


Closed loading systems prevent cargo vapors from emitting into the atmosphere when liquid cargoes (mostly hydrocarbons and chemicals) are being moved between ship and shore tanks. In its simplest form a closed loading system connects the vents of ship based and shore tanks and when cargo moves from one set of tanks to another the displaced air and vapors in the tank that is being filled will flow to the tank that is being emptied. This prevents discharge of these vapors to the atmosphere. In most cases these systems work well and are relatively straight forward.

However, there is a significant installation cost and various shore terminals have not made this investment which has resulted in odd changes in trading patterns and increased distribution inefficiencies.

While closed loading systems work for transfer of cargo between tanks they do not prevent vapor escape to the atmosphere when a tank needs to be cleaned for inspection or maintenance. At present there is no requirement to capture the vapors that will be displacement during tank cleaning, but it is becoming a valid concern. Shore based systems often use a vapor combustion system, which, while effective, also tends to be wasteful.

Trash sorting systems



Like shore based households, ships generate a variety of trash. Like households, a large portion of shipboard generated trash is related to packaging, and, like households, very few operators have been able to contain and reduce excess and wasteful packaging.

Traditionally, shipboard generated trash, whether plastic, organic, floating, sinking, liquid or solid, was simply thrown overboard. While only a small portion of floating plastic trash actually originated from ships, this type of trash had a very direct and immediate impact on shorelines and MARPOL developed regulations that restricted plastic disposal at sea.

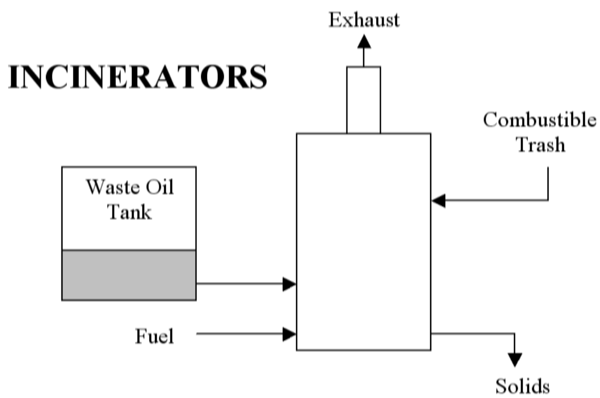
Since that time MARPOL has gone through various stages at reducing the impact of shipboard trash on the environment and today only a small portion of shipboard generated trash is actually thrown overboard. Basically only sinking organic and metal trash can be thrown overboard, and all other trash needs to be sorted and incinerated or returned to shore.

At this time ships mostly perform trash sorting at shipboard sorting stations where trash is hand sorted and distributed to the various receptacles. Passenger ships have trash shredders, compactors and freezers, while ships with smaller crews use designated trash containers to store the various types of trash.

Besides true trash, ships also need to dispose of waste liquids such as old paints, antifreeze and oils.

Often incinerators are used to dispose of combustible trash.

Incinerators



Shipboard incinerators are end stage devices that are used in various shipboard filtration systems, such as oily water separators and trash sorting systems. Incinerators can also be a component in ballast water treatment, closed loading systems and inert gas generators.

Often ships are fitted with dual mode incinerators that can burn both liquid and solid waste. Most shipboard incinerators are small, and there are no emissions standards for these incinerators.

Generally solid waste incinerators require periodic ash removal, which in turn requires appropriate disposal.

THE STATE OF THE ART

While workable solutions are present aboard ships for some of these systems, in general, it can be reasonably concluded that the design and installation for these systems is far from mature and there is quite a market for a better mousetrap for any of these systems.

In general it can be stated that none of these systems are loved by the ships' crews and, as such, it requires a combination of excellent design, proper crew motivation, low operational and maintenance manpower requirements and high reliability to succeed.

Furthermore only a very small portion of ship crews have received appropriate training to properly operate and maintain these systems.

The above diagrams show stand alone systems, but integration of all these systems into the overall ship system can be a daunting task and can result in very high complexities. Furthermore, many of these systems become interconnected for operational reasons and, as such, the installation of one sub system can have overall system impacts.

REGULATION OF THE MARINE INDUSTRY AND THE EQUIPMENT SUPPLIER

Regulation of shipboard environmental systems such as noted above takes place in only one regulatory body, which is the International Maritime Organization (IMO).

IMO is part of the United Nations and in its original form is best known as the organization that developed ship safety requirements that ensure that ships in international trade conform to minimum safety standards.

However, in the late sixties, greater awareness about the effect of ships (originally oil tankers, who used to clean tanks on the high seas and simply pump their tank cleaning residue overboard) on the ocean environment resulted in the development of additional regulations by IMO that today are mostly collected under the various MARPOL directives.

In the simplest terms, an IMO member nation makes a proposal for a new environmental regulation to the IMO Marine Environmental Protection Committee that consists of representatives from member nations and this body decides if the proposal should be enacted. Once IMO enacts the new regulation, it requires a certain number of ratifications in national legislatures. Once it is ratified by a predetermined number of national legislatures the regulation becomes international law.

For each regulation there are IMO standards that define how the regulation is to be put into effect. The vast majority of MARPOL regulations require specific equipment approvals, and the approval of equipment requires conformance with specific performance and construction requirements.

Often these performance and construction requirements are quite simple (although they might be difficult to meet in practice). Most importantly, they are identical for all national authorities. In other words, passing the test once approves the equipment for use on all international vessels.

From an international marketing point of view this is almost unheard off! A supplier can design and build one piece of equipment and it can run on ships of all nations.

While in practice there are some variables between ships of different countries (Such as 50 Hz and 60 Hz electrical power) these variables are truly minor compared to land based applications.

While from a US, or a first world perspective, the environmental regulations that have been and are being enacted by the IMO do not appear to be all that much different from those that are being enacted ashore, from a second or third world perspective it needs to be noted that the international maritime regulations that apply to those countries actually are much more advanced than the land based regulations for those countries. In other words, for third world countries the maritime regulations that their ships and crews respond to are the cutting edge.

This has peculiar marketing implications. If I go to a third world country and try to market a certain filtration technology for land based use I might get nothing more than a blank stare, but if I go to a ship equipment wholesaler in the same country the ship equipment supplier might have an immediate need for the equipment and in the future would be able to market the equipment for land based use once regulations catch up ashore.

Furthermore, an installed base of a certain type of equipment aboard ships would also support land based acceptance of the equipment since, in general, operational equipment knowledge flows from shipboard employment to shore based employment. Very often it is retired and semi retired shipboard personnel that first provides the operational expertise ashore for emerging technologies.

Even in the United States this is not uncommon. Shipboard radio operators were very important in shore based radio equipment installations between the wars, and ex US Navy shipboard nuclear engineers overwhelmingly operate shore based nuclear power installations.

THE CHALLENGE

The challenge that the marine industry provides the filter industry is that there is a deep need for improved filtration and separation technologies aboard ships.

Many systems are ineffective, some systems do not exist yet and other systems are proving not to work well in the real shipboard environment.

Still ships are quickly becoming as, if not more, environmentally friendly than the shore and efficient filtration and separation systems will benefit not only the ships but also international land based customers.

While there is no real regulatory barrier to entry into the marine business there sure is a design challenge, and better solutions will be eagerly accepted by ship owners and regulators.

THE WAY TO SOLUTIONS

The solutions for ships will follow a similar path that takes place in land based systems, but there is a twist.

Land based system design drivers are generally the following:

- Low purchase cost
- Reliability
- Ruggedness
- Simplicity (thereby reducing implementation and training costs)
- Low operating costs (power requirements and consumables)
- Low maintenance costs (repair, inspection)

Ship based systems have similar design drivers, but the trade off is much more complex.

A shipboard system should also be low cost, but often an Owner is willing to pay more for a shipboard system since failure of the other design drivers tends to have a more significant effect aboard ships.

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Reliability is much more important aboard ships, since crews are small and heavily committed to other tasks and therefore will not have much time to deal with this equipment, which by nature is considered to be less vital to the crew than safety equipment and vital ship operational equipment such as cargo gear and propulsion equipment

While a land based system can be considered to be non-moving, a ship board system is in constant motion, is subjected to wide temperature and operational cycle variations and is in a rather corrosive salt water environment. This requires extra attention to detail in design, particularly with the selection of materials and strength considerations.

Compactness in design is also very important. Space, especially foot print space, is often difficult to find in an engine room. Ideally, equipment should be able to fit through a door, since often a suitable retrofit location is behind a door. Ships are often quite weight sensitive and therefore weight should also be as low as possible. Taking into account that equipment often needs to be shipped long distances to arrive at the ship for installation, reductions in size and weight will also reduce shipping costs.

Since ships are generally designed with electrical power generation equipment that is sized for the original shipboard loads, new retrofitted equipment cannot draw a lot of additional power or it will overload the ship generator capacity.

While a certain filtration system ashore is often operated by a specialist (for example, shore based sewage treatment systems are run by dedicated operators), aboard ship, it should be expected that the unit is run by a propulsion engineer, who does not have in-depth knowledge of the system and only has marginal interest in having it work as well as possible. This demands maximum simplicity in design and operation and excellent operating and maintenance instructions.

I am sure that many filtration manufacturers use the computer printer business model; sell the filter system (printer) cheap and make money on the filters (ink cartridges). Unfortunately this business model does not always work so well in international shipping for two reasons. First the moment a shipboard system becomes popular, there will be a whole world of filter knock-off manufacturers. Second, I doubt that a system manufacturer will make themselves popular with a ship's crew that spends the better part of their day ordering replacement filters by shipboard low speed email, getting permission to buy their filter from the shore based supervisor, exchanging numerous emails with shore based supervisors and filter suppliers in trying to figure out in which port they will take the filters aboard, discovering that the filter did not make it to berth until after the vessel has departed the port, redirecting the filters to the next port, carrying the filters up the gangway into the ship's stores, carrying old filters down the gangway to a commercial disposal receiver and filling out paperwork to prove that they correctly disposed of the filters.

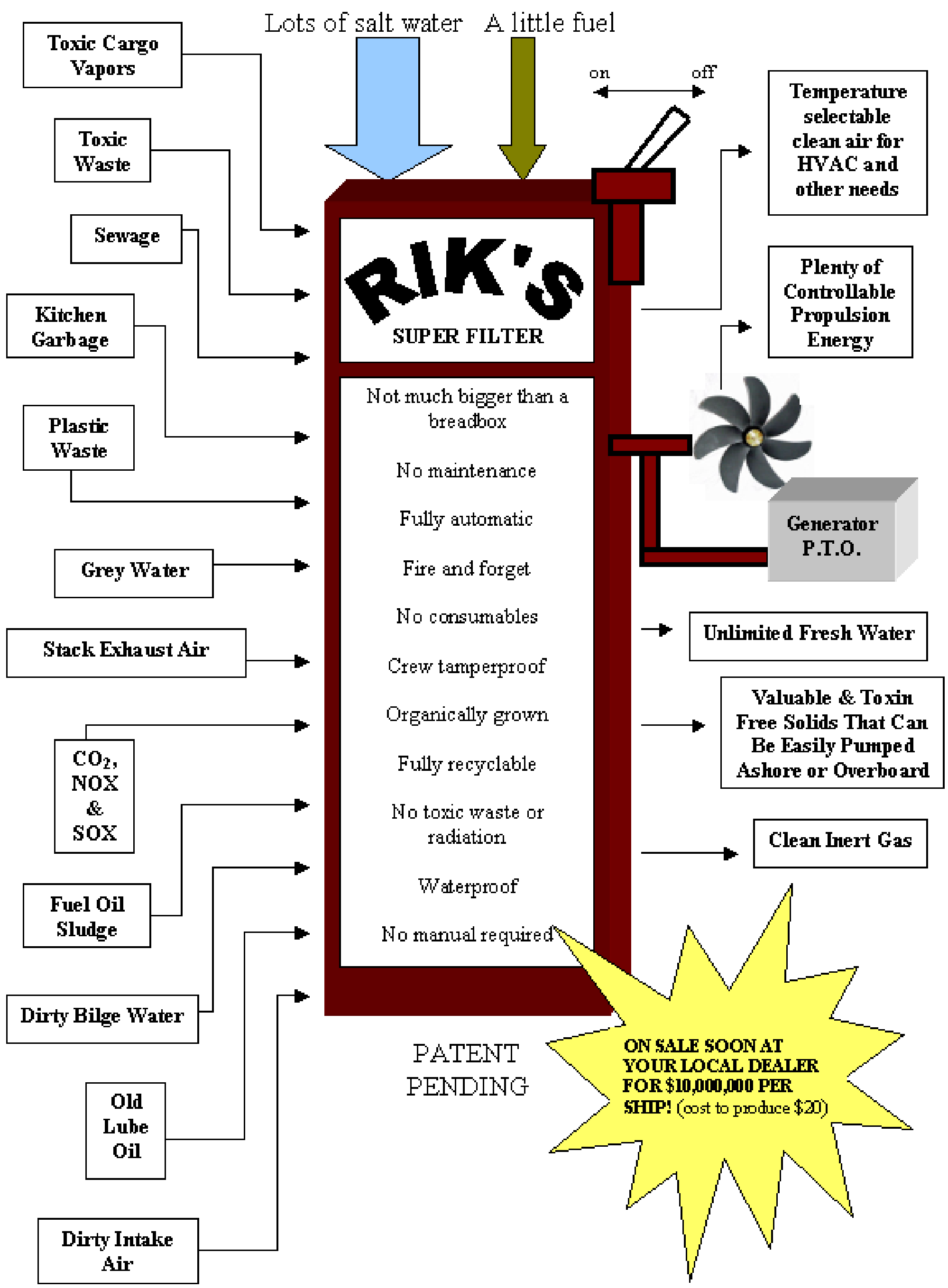
In short: Aboard ship, consumables and disposables are hell.

Finally it has to be remembered that ships are sort of like Las Vegas. What happens aboard a ship stays aboard a ship, and this can motivate crews to behave in a fashion that is contrary to the intent of the system.

In some cases the desire to monitor crews has spun out of control. OWS systems are now so deeply covered in lockouts, seals, recorders, monitors, reports, calibrations and logs that it now is even more difficult to make sense of what crews are actually doing.

To some, all these additional shipboard restrictions may be a sign to head for the hills and to never think about water again, but undoubtedly there are some manufacturers, designers and engineers who are now licking their lips at the thought of a new challenge.

While I am no filter specialist I do know what the perfect shipboard filtration system looks like and herewith provide a patent pending diagram of the perfect shipboard filtration system.



At first glance this diagram can be interpreted as a silly joke, but it should be noted that there are shipboard systems that actually accomplish a fair number of the noted tasks, although none exist that can perform the majority of these tasks in one system.

The diagram is worthy of study since it contains some technical truths. For example, cooling can be a problem for shore based systems, but the foreseeable future shipboard systems have ample access to a plentiful cooling medium (the ocean).

The above system, if perfected, would only be a transitional system since the truly ideal system is the Mr. Fusion popularized in "Back to the Future"

This device would be the deathblow to all filter and separation systems, but fortunately progress on the commercialization of the Mr. Fusion has been slow.

THE REWARDS

While designing and manufacturing optimal shipboard systems is a daunting task, it provides an interesting prospect; make it work on ships and you will be able to come back to shore and sell your shore based customers a much more optimized and efficient product.

The shipboard experience will result in a more optimized product that will compete more effectively ashore both nationally and internationally. It will make any filtration and separation supplier a better competitor.

NOTES