Abstract: Disclosed is a process and system for conveying water on oil tanker ships to deliver drinkable water to oil-rich but water-poor destinations. Employing the present method, water is loaded into empty oil tankers and such water is treated while in route or upon arrival so that at the destination port, drinkable water is delivered.
Method and System for Conveying Water on Oil Tanker Ships to Deliver Drinkable Water to Destinations

FIELD OF THE INVENTION

This invention is directed to the conveyance of water in empty oil tanker transport ships, and more particularly, to the treatment of such conveyed water, while in transit and/or at a destination point, so that drinkable water can be delivered to the oil-rich but water-poor regions of the globe.

BACKGROUND OF THE INVENTION

Water is the most abundant compound in the human body, making up from 50% to 80% of the human body. Thus, water is essential for life. Without water, a person will die of dehydration within a few days. Thus, clean drinking water is a valuable commodity, especially in the hot, dry climate of the Middle East where much of the world's oil is found.

While a little more than 70% of the Earth's surface is covered by water, much of it is undrinkable (The Hydrologic Cycle, United States Geological Survey Pamphlet, U.S. Department of the Interior, 1984). In fact, 97% of all water on the planet is found in the oceans and has a salt content of greater than 30,000 milligrams per liter (mg/L) (Gleick, P.H. (2000), The World's Water 2000-2001, the biennial report on freshwater resources, Island Press, Washington, D.C., USA.). Techniques, such as reverse-osmosis, do exist for removing salt and other minerals from seawater (desalination) rendering it drinkable.

Perhaps the greatest environmental problem confronting humanity in the 21st century is a shortage of fresh water - particularly in the developing world. Recent studies have made alarming predictions, such as that 2.7 billion people (out of a total 6 billion) on the planet will face severe water shortages by 2025 if consumption continues at current rates. While world's population is projected to be approximately nine billion in 2050, the amount of fresh water on Earth is not increasing. Nearly 97 percent of the planet's water is salt water in seas and oceans. Close to 2 percent of Earth's water is frozen in polar ice sheets and glaciers, and a fraction of one percent is available for drinking, irrigation, and industrial use.
Today an estimated 1.2 billion people drink unclean water. More than five million people die each year from water-related diseases such as cholera and dysentery. Every 20 seconds, a child dies from a water-related disease.

Cities and farmers, the later accounting for 70 percent of all water use, are pumping water out of the ground faster than it can be replenished. American farmers are withdrawing water from the Ogallala aquifer, which underlies the Great Plains, at an unsustainable rate, with a third of the Texas portion already significantly depleted. The average American uses 101 gallons (382 liters) of water a day - more than 15 times that used by many people in developing countries. The water table under the North China Plain, which produces about half of China's wheat and corn, is steadily dropping. Continuing groundwater depletion could reduce China's and India's grain production by 10 to 20 percent in the coming decades.

The world over, proposed solutions to problems merely create still other problems. For example, Spain has built over 1,200 major dams and piped water long distances to supply farms and municipalities. A multi-billion dollar project is underway to save southern aquifers, such project involving pumping 1 billion cubic meters of water a year from the Ebro River in the north to burgeoning regions along the Mediterranean coast. But the Ebro has already lost half its flow and the Ebro Delta, a prime Mediterranean fish nursery and vital bird habitat, is threatened. While many hope that the desalination of seawater will solve the problems faced by a water-stressed world, only two-tenths of one percent of the water people use today is desalinated, and most of that is produced in desert kingdoms and island nations.

The economic and environmental costs involved in desalination have been and will continue to be prohibitive. Such techniques are also complicated, producing large volumes of wastewater per volume of drinkable water, and in addition, these techniques are energy-intensive and expensive. Indeed, one study concluded that you would need to lift water by 2000 m, or transport it over more than 1600 km (approximately 1000 miles) to get transport costs equal to the desalination costs (Zhou, Y., Tol, R.S.J., Evaluating the costs of desalination and water, (Working paper), December, 2004, available at http://www.uni-hamburg.de/Wiss/FB/15/Sustainability/DesalinationFNU41_revised.pdf. Thus for much of the world, the seas are not a viable option for obtaining water.
Oil rich regions of the world typically share the distinction of also being some of the most water poor regions of the world. As the oil industry has developed to transport vast quantities of oil from such oil rich regions to those nations requiring such oil, some of the largest ships ever constructed are employed to transport the oil: oil tanker ships. Most of the time, however, the return trip of the ship is made with no cargo on-board, and despite the need for water in the oil producing nations, no water is transported in the oil-emptied hulls of such ships. The reasons for this are varied, but include the fact that if one fills an empty tanker with water relatively drinkable water is immediately contaminated with the refuse of the oil remaining in the tanker ships, thus rendering it unfit for human consumption.

As water has traditionally been a fairly inexpensive resource, there has been little thought as to how one could commercially provide water being transported in oil tankers, especially in view of the belief that to do so, an extensive, time-consuming and expensive cleaning process would need to occur, where the confines of the ship would need to be cleaned to an extent that drinkable water could be transported therein. Some others have even devised systems where interval ship bladders could be employed to retain relatively pure water so that contamination of which water by residual oil in the ship's hull would not occur. Such bladders, however, are expensive in their own right; require some expertise in deploying within a tanker ship; are subject to breakage and leakage, and are otherwise considered to be impractical for the purpose of hauling such a conventionally considered "cheap" commodity such as water. Sadly, such a belief has stymied the investment and innovation that is required to solve the significant problems related to the lack of water in oil-rich regions of the world. Military conflict and civil strife are both real and potential aspects of a population being deprived of drinkable water. Thus, the commodity price of water, while admittedly varying across the globe at any given time, is mostly undervalued in certain regions of the world as pricing models often fail to include the true costs of what a cessation of water supply entails.

When a vessel or tanker returns empty or partially empty after a voyage dedicated to the transportation of cargo, the vessel uses ballast water weight to maintain stability to compensate for a lack of cargo weight. For example, in a typical transport operation, a vessel docks at a first port where it is loaded with cargo that is transported to a second port where the cargo is unloaded. The vessel then travels
empty from the second port back to the first port to pick up another cargo. The vessel is equipped with ballast tanks that can be filled with water (typically sea water) to maintain stability when the vessel travels empty. The ballast tank water is then discharged when the cargo is loaded. Problems may arise when the ballast water from one port is discharged at a second port and the original water contains microorganisms and bacteria that are not native or present at the second port. The introduction of invasive marine species into new environments by ships' ballast water is one of the four greatest threats to the world's oceans. Shipping moves over 80% of the world's commodities and transfers approximately 3 to 5 billion tones of ballast water internationally each year. A similar volume may also be transferred domestically within countries and regions each year. Ballast water is absolutely essential to the safe and efficient operation of modern shipping, providing balance and stability to un-laden ships. However, it also poses a serious ecological, economic and health threat. (GloBallast, The Problem, http://globallast.imo.org/index.asp?page=problem.htm) The problem of introducing invasive marine species into new environments by ships' ballast water has become so large that a diplomatic conference at the International Maritime Organization (IMO) adopted the International Convention for the Control and Management of Ships' Ballast Water and Sediments to make the obligation of implementing ballast water control apply to ships built from 2009 onward. ("The New Convention: Ballast Water Convention Adopted," Global Ballast Water Management Programme, http://globallast.imo.org/index.asp?page=mepc.htm )

There is therefore a need for a method and system that addresses the problems stated above. The ability to provide water-starved regions of the world with fresh water, delivered via ocean transport vessels in a manner that employs previously underutilized resources, reveals that the present invention is critical to the stability of various regions of the world. Indeed, it is not an exaggeration to suggest that the employment of the present method and system portends a unique and practical way to address long-felt but unsolved needs of millions of people in water scarce regions in a manner that reduces the opportunities for national conflicts caused by such water scarcity. The present invention further provides an economic as well as humanitarian rationale to provide a second source of water to regions of
the world that are largely dependent upon either desalinization plants or remote and unpredictable water supplies from rivers.

**SUMMARY**

An objective of certain embodiments of the present disclosure is to use the deadheading portion of crude oil tankers round trips to carry fresh water to the water-starved regions of the world, specifically the desert regions of the Middle East. According to the 2006 Review of Maritime Transport by the United Nations Conference of Trade and Development, Geneva, in 2005 total world shipments of tanker cargoes reached 2.42 billion tons of which 76.7 percent was in crude oil for a total of 1.85 billion tons. The specific gravity of Texas crude oil at 15.5° c. is 873 kg/m3 whereas pure water at 4° c. 1000 kg/m3. Thus the worlds tankers could transport roughly the equivalent of 1.62 billion tons of pure water which is 1.62 BCM.

The reality is that without water, entire cities and nations can be threatened to such an extent and in a very short period of time, such that military actions can be predicted. The logistical challenges associated with transporting mass quantities of water throughout the world are known by many. Weighing in at 1,000 kg per cubic meter, and given the need to preserve its purity, providing fresh, pure water across oceans is a long felt but unsolved need. But such a solution is critical as a second source of water is desired by nations for many reasons, one of which is to deter military strategies directed to the destruction of land based water treatment facilities and water supply.

In some embodiments, fresh water is at least transported as ballast in tankers deadheading to homeports in the oil-rich but water-poor areas of the world. An objective of this invention is to use carbon free, renewable energy sources to at least partially treat transported water in route or at a water-poor region.

In various embodiments, systems and methods are employed on an oil tanker ship to treat vast quantities of water within the ship's hull and/or ballast tanks and/or tugged barges, and/or very large bags, etc. while the ship is in its return transit to re-fill with oil. Traditionally, large tanker ships return to oil-bearing nations across the seas with an empty hull and ballast tanks full of seawater because it was considered impracticable to transport drinkable water in such oil-contaminated hulls. One aspect of the present invention, however, relates to the provision of systems on such tankers such that water can be hauled back to the
typically water-starved regions of the world from whence oil is extracted and shipped, with such water being treated on-board ship so as to deliver potable water upon arrival at the return destination. In certain embodiments, the water is only partially treated in a fashion that permits it to be fully treated at the destination port, thus lessening the time and costs involved of performing all water treatments upon arrival. In other embodiments, however, the transported water is largely or substantially treated in a fashion so that minimal additional treatment is required at the destination port. One of skill will appreciate the various and multiple treatment steps that may be included during transport of the water in view of differing conditions, facilities, type and quality of water, type of oil residues, the capacity to segregate treated water from untreated water, etc. Various types of oil removing systems can be employed within the scope of the present invention, with preferred systems being those that can readily be installed aboard an oil-tanker vessel. As many oil tankers currently deliver a payload and return empty, re-supplying such vessels with water not only provides economic viability for an otherwise empty return voyage, but also increases the ship's ballast and fuel efficiency.

In various embodiments, a method of shipping/transporting water is provided, the method comprising a first location, a second location, and a shipping vessel. In particular embodiments, the first location comprises substantial quantities of oil and the second location comprises substantial quantities of fresh water. Shipping vessels of the present invention may therefore be provided with cargo comprising oil at a first location and transported to a second location. Subsequently, in various embodiments, a shipping vessel is at least partially emptied of the cargo comprising oil and provided with cargo comprising water at the second location. In various embodiments, the shipping vessel is repeatedly transported from the second location back to the first location.

One focus of the various embodiments of the present invention is to address the long-felt but unsolved need in the industry for a reclamation process for treating undrinkable but available water that is transportable in oil tankers such that water can be delivered to water-starved regions of the world where such oil tankers frequently return. The ability to reduce the need to desalinate water at the point of commercial use is urgently needed, not only due to the significant costs associated with such land-based plants, but also due to the political and military risks that such
water treatment plants have in the politically volatile areas of the middle east where water is most needed. The bombing of an expensive water desalinization plant by an enemy would result in tremendous instability to local populaces. The present invention provides a significant secondary source of vital water supplies so that such a prospect is not used by competing nations to achieve political or military aims.

In one embodiment, water treatment systems include those that are suited to reclaim waste fluids in a continuous flow fashion for treatment within a ship positioned container, whether on-board the tanker or on a ship that may meet the tanker at the destination port. Some systems employ immersible transducers producing ultrasonic acoustic waves in combination with a high level of injected ozone. Water can also be treated by directing it into a ship positioned centrifuge for enhanced solid waste removal. Preferably, such systems are mobile and containerized and suitable for installation aboard an oil tanker ship and/or on an accompanying vessel at the destination port.

In practice, the difficulties of separating oil-contaminants from water to arrive at drinkable water will vary to some extent on the nature of the kind, degree and type of contamination of water that occurs from the filling of an empty oil tanker with water. Various water treatment systems and methods, however, can be used to achieve desired water quality standards. For example, oftentimes water from the hull of an oil tanker will need to first be clarified and separated from substantial amounts of suspended and emulsified oil, bitumen and other impurities like salts, silica, etc. To achieve this end, a high intensity acoustic energy and triatomic molecules can be introduced into the water via a conditioning container to provide a mechanical separation of materials by addressing the non-covalent forces of particles or, van der Waals force. The conditioning tank may provide a first level of separation including an oil skimmer through an up flow configuration with discharge entering a centrifuge. Water from the centrifuge may then be directed through a filtration process, sand or multimedia, for removal of large particulates before introduction through activated carbon filters for removal of organics and excess ozone. Discharge from the carbon filters is directed to a clean water tank. Piping can be employed to transport water to very large bags (as otherwise described herein) to accompanying vessels at a destination port or directed to onshore treatment and/or storage systems.
Methods of determining and quantifying purity are known in the art. For example, contaminants can be measured in parts per million (ppm). In one embodiment, contaminants are present in the water at a level of no more than 1000 ppm, 500 ppm, 250 ppm, 100 ppm, 75 ppm, 50 ppm, 25 ppm, 10 ppm, 5 ppm, 2.5 ppm, or 1 ppm. Such levels can also be expressed in terms of percentages. For example, 1 ppm is equal to 0.0001% on a volume per volume or weight per volume basis. Methods of measuring such levels of contamination are known to those skilled in the art. It should be recognized, however, that the present invention is not limited to any type or purity of water. Rather, all forms of drinkable and undrinkable water are contemplated by various embodiments of the present invention. Systems can be revised depending upon the desired end goal of the type of purity required for various water needs. In one embodiment, water is filtered through natural clay, such as that described in U.S. Patent Application Publication No. 2011/0091607 to Szydlowski, and as described and pictured in Figure 7.

The instant invention provides for a cost efficient and environmentally friendly process and apparatus for cleaning water transported in an emptied oil tanker without the traditional concerns for cleaning the confines of the oil tanker so as to make it suitable for transport of potable water. Such a task has been, and admittedly is, an expensive and technologically, time-consuming and impractical exercise. What is needed, and what the present invention provides, is a method and system to achieve the ultimate goal of having drinkable water delivered to water starved but oil rich regions without the need to thoroughly clean the interior confines of an oil tanker ship prior to transport. Moreover, the oil tankers used throughout the world are huge vessels that have excess power capabilities, which can run water purification systems onboard and while in transit. Thus, without entailing additional valuable time that would be required to clean the confines of a tanker so that it could potentially carry varying degrees of "clean" water on a return trip to be re-loaded with oil, the present invention provides a method and system for cleaning water conveyed in the hulls and ballast tanks of such tankers while the tankers are on the open sea, utilizing the power of the internal ship systems to run the water treatment processes as described herein.

Thus, one aspect of the present invention is directed to the provision of an on-ship (e.g. oil tanker vessel) on-site process to treat water contaminated with oil
residues remaining after an oil tanker ship is emptied of its oil cargo. One will also appreciate, however, that while the present invention finds particular application in the use of oil tankers, especially in view of their abundance, size, sophistication and the fact that they traverse between oil rich and water rich countries, other container or transport ships can also be utilized for various embodiments of the present invention, e.g. those transporting other fluids, grain, produce, etc.

One objective of the invention is to provide an on-ship process that will lessen the time required to treat water on-site and will lower the cost of water to consumers by reducing the current and expensive land based processes used for the provision of water in water-starved regions of the globe.

In one embodiment, the treatment of oily water comprises adding an effective amount of a natural coagulant selected from the group consisting of tannins, chitosan, and a cationic or anionic flocculants. Preferably, the pH of the oily water is optionally adjusted to a range of about 2 to 8, prior to the natural coagulant being added, preferably the pH adjusted to between about 6.5 to 10 subsequent to the addition of the natural coagulant. Oil contaminated water is preferably separated in a mechanical separation process such as in flotation, filtration, reverse osmosis, cyclonic, gravity separation, and centrifugal force separation devices. One such device that may be employed is available from Enviro Voraxial Technology, Fort Lauderdale, Fla. The oily water can also be purified through the use of a purification apparatus and an operation method therefor, for coagulating and separating particularly the pollutant matter in water including oil and the like, which can regenerate and reuse the coagulant within the apparatus, without scarcely resupplying the coagulant. By way of example and in further support of the present disclosure, U.S. Patent No. 7,410,573 to Norihide is incorporated herein by reference in its entirety.

In another embodiment the treatment and purification of oily water involves two steps: (1) pretreating the oily water to remove the organics, algae, fine particles, oil, gas, and waste material; and (2) treating the non-drinkable water to make potable water. Any conventional process can be used for the pre-treatment in step one. One such example is using a mobile water-treatment plant on a converted oil tanker that separates out contaminants as by settling, to leave clean water that can then be transferred to step two of the process and contaminants that must be
disposed of once the tanker arrives at its port. Natural filtration is used in other embodiments, such as by subjecting oily water in the oil tanks to natural filtration techniques, such as those identified in U.S. Patent Application No. 12/905,590, incorporated herein by this reference. Other methods include reverse osmosis and multi-stage flash exhibit.

Both reverse osmosis and multi-stage flash exhibit lower performance in produced or tracking water treatment, where a much higher salinity in the produced or tracking water increases energy consumption and causes increased membrane fouling. By instead mixing the oily water with the directional solvent, most of the water can be extracted in substantially pure form using relatively low energy and heat inputs and at a reasonable cost, leaving a much more concentrated and lower volume waste product and allowing the extracted water to be conveyed to population centers or stored in vessels, very large bags, etc. By way of example and in further support of the present disclosure, WIPO Patent Application Publication No. 2011/066193 to Bajpayee is incorporated herein by reference in its entirety. Additionally, a mobile water treatment apparatus that includes a filtration system, a motor, a fluid storage container, and a fluid delivery pump is used to treat the water onboard the tanker and/or in an associated water treatment barge at or near the destination port. By way of example and in further support of the present disclosure, U.S. Patent Application Publication No. 2011/0089123 to Kennedy is incorporated herein by reference in its entirety. High temperature electrolysis to dissociate water to hydrogen and oxygen may be used and to separate the non-water material, and the combusting of generated hydrogen and oxygen at elevated pressure forms a high pressure high temperature superheated steam, creating a closed loop heat recovery system to recycle the heat generated by the combustion process to the high temperature electrolysis unit for the dissociation of non-fresh water. The standard requirement for eliminating hazardous material in typical incineration process is by keeping the material at 2000 degrees Celsius for at least two seconds. The present system in one embodiment provides such conditions for oily, pretreated water. By way of example and in further support of the present disclosure, U.S. Patent Application Publication No. 2010/0272630 to Rosenbaum is incorporated herein by reference in its entirety.
In one embodiment, the on-board treatment of oily water is performed by an apparatus that includes a funnel, a system effective for achieving submersion of a majority of the slant height of the funnel within the carrier fluid, and a pump in fluid communication with the interior volume of the funnel proximate the smaller end of the funnel for pumping fluid collected at the smaller end of the funnel. By way of example and in further support of the present disclosure, U.S. Patent Application Publication No. 2009/0314725 to Parro is incorporated herein by reference in its entirety.

In another embodiment of the present invention, an oil tanker ship has a purification treatment unit disposed on the hull and configured to collect, purify, and treat oily water (e.g. the water stored in the empty, dirty oil tanks). The purification treatment unit includes a floated oil collecting tank to collect floated oil collected from water in a dirty oil tank, a stirring tank having a cylindrical straight drum and a funnel-shaped bottom to stir oily water taken out from the dirty oil tank together with a coagulant and a collecting path to discharge precipitates, a plurality of filter treatment tanks to be used in multistage filtering treatment of oily water in the stirring tank, and purified water tanks. By way of example and in further support of the present disclosure, U.S. Patent Application Publication No. 2011/0147293 to Imahashi is incorporated herein by reference in its entirety.

In the production of oil and gas, great quantities of water are produced. The water produced by the process is called "produced water" and often contains hydrocarbon and other materials. Of particular concern for use in common well-treatment operation is the avoidance of water containing undesirably-high concentrations of inorganic ions having a valence state of two or more. As one aspect of this invention, water pumped into an oil tanker's dirty, but empty, oil tanks is without undesirably-high concentrations of inorganic ions having a valence state of two or more. The purpose for this pre-treatment is to prevent deterioration of the oil refilled in the oil tankers after the water is removed. By way of example and in further support of the present disclosure, U.S. Patent Application Publication No. 2010/0319923 to Slabaugh is incorporated herein by reference in its entirety.

In various embodiments, devices of the present invention comprise the ability to convert and/or utilize energy available not only from the oil-empty tankers in route to oil ports, but also from naturally occurring resources such as solar, wind,
wave, and thermal resources. In various embodiments, energy captured and/or converted from these sources may be used for various on-board functions, such as propulsion, heating, and various purification techniques.

In various embodiments, devices and methods of the present invention may be used to store, as well as transport, quantities of water transported via oil tankers on their return voyage. As will be recognized by one of ordinary skill in the art, varying supply and demand for water or other liquids will fluctuate based on numerous conditions. Accordingly, the present invention contemplates methods and systems for housing or storing water off-shore and/or at port.

One of skill in the art will recognize that storage, as well as transport, of the water to the oil tankers is an important and necessary feature of present invention. Therefore, it is yet another aspect of the present invention to provide means for mooring, stabilizing, and/or parking devices adapted for use with the present invention. For example, U.S. Patent Application Publication No. 2004/0157513 to Dyhrberg, which is hereby incorporated by reference in its entirety, discloses a mooring system for mooring a vessel to a floor portion of a body of water. These and similar devices may be incorporated into various embodiments described herein in order to accommodate, for example, issues related to dock or on-shore storage restrictions, weather and tidal conditions, unpredictable transit times, legal and insurance issues related to positioning a device on-shore or at a dock, and physical restrictions associated with shallow water ports. As used herein, a substantially immovable object refers to mooring devices (despite their general ability to drift or float within a certain radius) as well as more traditional fixed objects such as docks, land, anchored vessels, anchors, etc.

One of skill in the art will recognize that where quantities of water are to be stored, degradation of water quality may become a concern. Accordingly, various embodiments of the present invention contemplate a device, which is adapted for preventing growth and propagation of mold, mildew, algae and other deleterious effects caused over time to a quantity of water. By way of example and to further provide support and disclosure, the following references are incorporated by reference in their entireties: U.S. Patent Nos. 7,731,847 to Huy, 5,229,005 to Fok et al, 4,512,886 to Hicks et al., 6,580,025 to Guy, 7,690,319 to Wingate, 7,686,539 to Aristaghes et al. In various embodiments, methods for maintaining purity and
sterility of water are provided. For example, in one embodiment, ultra-violet light is periodically applied to stored quantities of water so as to neutralize or destroy various bacteria, viruses and protozoan cysts such as giardia and Cryptosporidium.

Another aspect of the present embodiment also includes loading the oil tankers with water through very large bags of water. These bags of water may be brought to where the tanker has unloaded its oil. Alternatively, these "water islands" can be positioned at various predetermined locations and after an oil tanker has delivered its oil cargo, it can then travel to one or more water islands to then take fresh water on-board and then continue to a destination where such fresh water is desired. The water may also be loaded through buoys or filled by lighters, which are smaller oil tankers. These loading techniques significantly reduce the cost of loading the water because it minimizes the large oil tankers' travel. For example, U.S. Patent Nos. 7,841,289 and 7,500,442 to Schanz, which are hereby incorporated by reference in its entirety, discloses water transporter and storage systems for liquids, such as water, by means of a very large bag-like structure. In various aspects of the present invention, methods and systems employ a lightweight towed submerged water transporter and storage system for liquids, which employs a streamlined towable hull with optional air and liquid storage bladders used not only to adjust buoyancy, but to allow the simultaneous transport and storage of different solids and liquids.

One aspect of the present invention is directed to identifying surface currents, particularly along particular coasts, to determine those currents that are favorable to vessels transporting or towing bulk containers of non-salt water, preferably fresh water (whether or not contaminated by oil residue from an oil tanker's last shipment of oil). Vessels transporting bulk fresh water may include a combination of tankers and very large bags (VLB's). As described herein, the combined usage of tankers and VLB's facilitates the long-felt but unsolved need of conveying non-salt water to regions of the globe in need thereof. Such a system and method, for example, can be employed to recharge the over-taxed aquifers of some Pacific islands until they are able to regain their sustainable hydrostatic pressure.

It is important in many embodiments of the present invention to properly gauge the currents through which both tankers and VLB may traverse so as to achieve desired efficiencies of energy use, avoid catastrophic episodes related to adverse ocean conditions, etc. For example, the present inventors have first
appreciated that the traditionally mean currents of the Humboldt Current will not provide adequate, useful estimates of the surface currents for the transporting vessels. Historical satellite-tracked surface drifters deployed in the Pacific Ocean may show the seasonal variable character of the surface currents, but are deemed to be inadequate to accurately predict the near surface current in real time. Thus, the use of computer model results that predict global surface currents forced by real time satellite sensed winds and sea level height anomalies, which are available in real time, provides a better estimate of the near surface current for the transporting vessels. In certain embodiments, the use of satellite-tracked drifter along a vessel's course is employed to provide valuable additional information of the current for a particular voyage. In addition or in lieu thereof, long-range radar instrumentation may be installed along the subject coastline(s) to further provide useful maps of the currents. Specifically, the ability to track bodies and debris, e.g. which led to the successful location of Air France 447 on the sea floor at a depth of 3900m in the Equatorial Atlantic Ocean, can be used to predict real time surface currents.

In certain embodiments, data from satellite-tracked surface drifters deployed during 1980 to the present in the Pacific Ocean are employed in a high-tech version of the "message in a bottle". Using a surface buoy and a subsurface drogue (sea anchor), attached by a long, thin tether, the buoy measures location, temperature and other properties, and has a transmitter to send the data to passing satellites. The drogue dominates the total area of the instrument and is centered at a depth of 15 meters beneath the sea surface. The drifters are minimally affected by the wind and give direct estimates of the near-surface velocity. The velocity at the surface of the open ocean is nearly the same as the velocity at a depth of 15 m because there is normally a near surface mixed layer 10s of meters thick in the upper ocean. A real time estimate of surface currents is useful to tanker ships transporting water - as well as VLB associated therewith, and is best accomplished by the use of direct observations and output from real-time computer models of the ocean. These modern computer models are similar to the models that have been developed to predict the weather. Real time satellite wind products using microwaves and real time ship observations and state of the art real time models of ocean circulation are
thus employed to determine preferred routes of transport so as to avoid obstacles, conserve energy and to protect the delicate nature of VLB conveyance.

In certain embodiments, a plot is produced in real time and sent to a vessel prior to departure or conveyed to a vessel at sea. In one embodiment, a five-day average current is the highest frequency output from the model, but consecutive five-day segments can overlap. A color bar showing color contours can be presented to represent the surface current speed with arrows and arrow lengths employed to represent the direction and speed. Sea surface height reflects the distribution of pressure in the ocean and the pressure gradients drive the ocean currents similar to how atmospheric pressure gradients drive the wind. For example, Fig. 20 depicts the OSCAR current for five days centered on January 1, 2011.

When a vessel's cargo hold is empty or partially empty, the vessels use ballast water weight to maintain stability to compensate for a lack of cargo weight. The vessel is equipped with ballast tanks that can be filled with water (typically sea water for ocean going ships and tankers) to maintain stability when the vessel travels empty. The ballast tank water is then typically discharged when the cargo, such as oil, is loaded. By way of example and in further support of the present disclosure, U.S. Patent Application Publication No. 2006/0027507 to van Leeuwen; US Patent Application No. 2006/0027507, which is a CIP of issued US Patent number 7,273,562 to Robinson, which is a CIP of issued US Patent No. 6,869,540 to Robinson, are all incorporated herein by this reference in their entireties.

Prior to loading their cargo, the tankers must discharge the ballast water; therefore a productive use of this deadheading portion of a tanker's round trips would be to carry water from a fresh water source, melt water, or outflow river water to the tankers' home port in an oil-rich but water-poor region. By way of example and in further support of the present disclosure, U.S. Patent Application Publication No. 2011/0036919 to Baird, is incorporated herein by reference in its entirety.

In one embodiment, fresh water is used as ballast water weight in a large sea vessel, such as an oil tanker. After the oil tanker unloads its oil cargo at its destination, fresh water is injected into the vessel's ballast tanks, the water is fully or partially treated, and the water is unloaded at the vessel's oil-loading port for human use, irrigation purposes, or other use requiring fresh water. In the present
embodiment, the water is not released into the port, but rather the water is unloaded for use on land or onboard other ships, thus solving the problem of discharging non-native microorganisms and bacteria into the port's water. Furthermore, the fresh water loaded into the ballast tanks can be either drinkable or undrinkable water. Either way, one skilled in the art can imagine different embodiments for treating the fresh ballast water: the fresh water can be treated while the tanker is in route, upon the tanker's arrival but before the water is unloaded, or the water can be treated once on land.

Crude oil tankers either fill "empty" cargo tanks with ballast water or fill dedicated ballast water tanks with water for their return trips. When an empty crude oil tank is filled with ballast water that water is typically referred to as "unsegregated" or "dirty" ballast because the ballast uses the same tanks as the crude oil rather than a separate tank. Most new tankers are designed with segregated ballast tanks, but a few older tankers are only able to carry unsegregated ballast. One embodiment of this invention is to use segregated fresh water or desalinated water as ballast in oil tankers deadheading to the water-poor regions of the world.

Various methods may be employed to fully treat or partially treat the ballast and/or transported water as it is entering the ballast tanks, sitting in the ballast tanks, or as it is removed from the ballast and/or transport tanks. One such method for partially treated the ballast water is ozonation. Ozonation has been found to be a safe and effective disinfectant method and system to treat ballast water. Ozone can be spayed into the ballast water tanks before the ballast tanks are filled. Ozone can also be used as an in-line treatment of loading and/or unloading ballast water. This in-line method can comprise injecting ozone into a line of water loading into a sea faring vessel prior to charging the water into a ballast tank; charging the ozone injected water into the ballast tanks; and adjusting a rate of injection of the ozone into the water and adjusting the rate of water loading into the vessel to provide a target biokill of species within the water. In-line ozonation is said to be more efficient and more economical than in-tank treatment. By way of example and in further support of the present disclosure, U.S. Patent No. 6,869,540 to Robinson and U.S. Patent No. 6,125,778 to Rodden are incorporated herein by reference in their entireties.
In one embodiment, a treatment system to treat ballast water using a membrane treatment unit to separate out microorganisms is employed. Such a system is described in U.S. Patent No. 7,900,780 to Ueki and U.S. Patent Application Publication No. 2007/0246424 to Hironari, which byway of example and in further support of the present disclosure, are incorporated herein by reference in their entireties.

Other embodiments employ one or more of a UV system for disinfecting ballast water (WO 02/074,692); chlorine dioxide (WO 02/44089) or pesticides (EP 1,006,084 and EP 1,447,384); at least one filter unit, at least one disinfection unit, and a detection unit (U.S. Patent Application Publication No. 2010/0116647); the infusion of combustion gases into the ballast water to kill harmful microorganisms and bacteria (U.S. Patent Application Publication No. 2011/0132849); as well as various other systems such as those found in U.S. Patent Application Publication No. 2010/0116647 to Kornmuller, U.S. Patent Application Publication No. 2011/0132849 to Husain, WIPO Patent Application Publication No. 02/074,692 to Brodie, WIPO Patent Application Publication No. 02/44089 to Perlich, European Patent Application Publication No. 1,006,084 to Fuchs, and European Patent Application Publication No. 1,447,384 to Hamann, all of which are incorporated herein by reference in their entireties.

In another embodiment, water treatment systems are employed on the oil tanker or other cargo vessel to treat the ballast and transported water as the vessel is making its return voyage. The system could treat and clean the water in one ballast tank, move the treated water to a second ballast tank either during the treatment process or after the treatment process, and then treat the water in the second ballast tank, and so forth. The very large bags as otherwise described herein can also be used to store water after water treatments, whether such bags are then further towed to a destination land port or alternatively moored in "water islands" at a predetermined destination.

In one embodiment, non-drinkable water (non-salt water) is loaded into the oil tanks of an empty oil tanker after the tanker has unloaded the oil at the desired location. This water could then be treated by the methods mentioned above, and after the water is cleaned it is put into the ballast tanks of the oil tanker. Clean ballast tanks could hold the treated and drinkable water without re-contaminating the
water. The drinkable water could then be unloaded at the tanker's next destination before the tanker is refilled with oil.

While an emphasis of most embodiments of the present invention are directed to the ability to utilize recently emptied oil tankers to deliver non-salt water back to destinations other than the destination where oil was delivered, it is considered a teaching away from conventional thought to simply fill an empty oil tanker with fresh water as the water would immediately become fouled with the remaining remnants of oil and oil debris left over from the coatings on the tanker's internal surfaces. Thus, conventional wisdom was that such oil tankers, large as they are and despite the need for water to be transported to water-starved regions, were not believed to be viable candidates due to the time and expense of having to somehow clean or coat the internal surfaces of oil tankers so as to preclude water contamination. But in various embodiments of the present invention, such cleaning or coating methods may be employed in certain circumstances so as to at least lessen the ultimate task of cleaning the water either en route or at its final destination. Thus, while not necessarily being the preferred embodiment, various embodiments employ systems and methods whereby internal surfaces or portions of transport ships, and in particular oil tankers, may be coated with various materials to prevent or minimize risk of cross-contamination (i.e. the oil residue contaminating the water and vice versa). For example, various spray-coatings may be applied once a quantity of oil is emptied from a portion of the vessel to create a virgin surface for the holding and contacting with water or similar fluid cargoes. By way of example, industrial waterproof coatings provided by the Procachem Corporation may be provided to coat, cover, or seal a surface that was exposed to or in contact with oil so as to render the surface capable of accommodating water without significant risk of cross-contamination. In various embodiments, internal volumes of storage tanks or similar structures are coated with a layer of material, the layer of material comprising an appropriate thickness to substantially eliminate the risk of cross-contamination between a liquid or material to be stored and a liquid or material previously stored in the same tank. In various embodiments, the layer of material applied is not so thick as to substantially impact the overall internal volume of the container, tank, vessel, etc. Thus, in certain embodiments, one or more tank cleaning apparatus are employed to cleanse the inside of a container or tank. For example, various features
as shown and described in U.S. Patent Application Publication No. 2009/0308412 to Dixon, which is incorporated by reference herein, may be employed to prepare various oil tankers and similar containers for the transport of cargo other than oil.

In still other embodiments, one or more bladders are provided wherein the one or more bladders are adapted to be placed within an emptied volume of a oil shipping container (e.g., tank, hull, etc.) and further filled with water to provide ballast and/or valuable shipping contents for a return or additional voyage. Accordingly, in various embodiments, significant value is provided to shipping activities by supplying a vessel with a valuable return-shipment, such as water. In one embodiment, at least portions of oil contained within an oil tanker are emptied or extracted at the appropriate location. Thereafter, emptied portions of an oil shipping vessel or container are provided with a liner suitable for preventing or minimizing contamination from previously and/or contemporaneously stored gas. For example, various liners available from Fab-Seal Industrial Liners, Inc. may be provided to accommodate water to be stored within an oil tank and isolate the water from various materials, tar, oil, debris, etc. Liners suitable for use in the present invention include, but are not limited to, P.V.C. flexible membrane liner materials.

In various embodiments, bags or liners that may find use in certain situations are designed for isolating water from oil surfaces and may be fabricated in any desired manner, including in a completely flattened conformation. For example, two sheets of fabric may be cut to the desired plan shape and joined at their adjacent edges by suitable means consistent with the material of construction. For example, heat welding or solvent welding may be used if certain polymeric materials have been employed as the substance coating the fabric. Sewing may be necessary in addition. It is possible that the overall cost of a bag may be reduced if the center section and the edges are fabricated separately, i.e., not the flattened conformation.

In various embodiments, liners of the present invention comprise a water-resistant, elastomer-coated mesh material, such mesh material being constructed of polymeric material having some inherent elasticity, such as polyester or nylon. A warp knit mesh construction is preferred in certain embodiments. The mesh material also may be steel mesh, preferably hexagonal netting of drawn steel wire or similar high modulus material, such as extended-chain crystallized polymer.
In another embodiment, a system whereby use is made of a double bottom tank, in fluid communication with a bag made of reinforced elastomeric material to provide segregated ballast space in the cargo space of a ship. The double bottom space and bag are filled with ballast water when the cargo space is empty, thereby making use of the cargo space in which the bag is located to carry ballast water in space previously occupied by cargo, without having any cross-contamination of the ballast water by the cargo residues or gases. The outward and upward movement of the bag is restricted by a rigid guide cage. An open, or partially open, topped rigid container is placed around the guide cage to restrict the "free surface effect" of the ballast water in the unlikely event of failure of the ballast bag. A header tank is provided to keep a positive pressure head on the water in the bag when in the ballast condition. A semi-flexible float assists in guiding the bag during ballasting and de-ballasting operations. Furthermore, fresh or potable water could be used in the place of ballast water. The fresh or potable water would function as ballast water and is delivered to the destination uncontaminated by the oil residue remaining in the oil tanks. By way of example and in further support of the present disclosure, U.S. Patent No. 4,409,919 to Strain issued on October 18, 1983, is incorporated herein by reference in its entirety.

In another embodiment, methods for optimizing the transportation of cargo, such as oil and water, are employed to further reduce costs, achieve the most economical transport of water to water starved regions and to coordinate tanker availability around the globe for such purposes. By way of example and in further support of the optimization methods available in the present disclosure, U.S. Patent Application Publication No. 2010/0287073 to Kocis is incorporated herein by reference in its entirety. Thus in one embodiment, the present method employs a process for optimal transporting of water that includes optimizing a plurality of transportation decisions and mechanically transporting water through movement of a plurality of water going vehicles in accordance with a set of optimized transportation decisions, including transportation routes and schedules for oil tankers, allocation of water to be transported to one or more demand locations by the transportation vehicles, and nomination of water pickup by the oil tankers, with such decisions optimized by collecting data relating to the various transportation decisions, using the data collected as part of a mixed integer linear programming
model, and obtaining a solution to the model to arrive at a set of optimized transportation decisions.

In one embodiment of this invention, glacier melt water is transported to desert regions to be used for irrigation of said desert and/or municipal water use.

Aspects of such an embodiment are included in pending applications by the same inventors and such applications are incorporated herein by reference.

As a practical matter, one will appreciate that the large and economically well-off oil industry, using the present invention, may play a critical role in advancing the transport of desperately needed water resources to nation-states where water is scarce. Thus, while oil rich nations and large oil companies are typically the favorite despised entities due to the profits inherent in the oil trade, the prospect of employing the present invention by these very entities provides a meaningful commercial and public relations opportunity that demonstrates how the existing oil industry infrastructure can be used to provide water to water-sensitive regions of the world so as to eliminate long-felt hardships by millions of people and in a manner that may very well avoid future military conflicts based on the destruction of desalinization plants in a water-dependent nation.

Various embodiments of the present invention include a system and a method for storing bags, a method for trading water, and a method of shipping water by employing pre-existing tanker vessels. Representative figures for each of these are incorporated herein by this reference to PCT Application No. PCT/US2010/052864. (See figures therein).

**BRIEF DESCRIPTIONS OF THE FIGURES**

FIG. 1 is a side view of a crude oil tanker.

FIG. 2 is a plan view of a crude oil tanker.

FIG. 3 is a mid cross section of a crude oil tanker.

FIG. 4 is a schematic of a bladder for segregating oil and fresh water in the hold of an oil tanker for alternating trips to and from home ports.

FIG. 5 is a schematic according to one embodiment of the present disclosure.

FIG. 6 is a schematic according to one embodiment of the present disclosure.

FIG. 7 depicts one embodiment of a filtration system according to the present disclosure.
FIG. 8 depicts one embodiment of a shipping method according to the present disclosure.

FIG. 9 is a top plan view of a shipping vessel with one or more internal storage volumes.

FIGS. 10-11 depict a cross section of ships showing ballast tanks and ballast water cycles.

FIG. 12 is a cross section of a ship provided with a ballast water intake and treatment system according to one embodiment.

FIG. 13 is a perspective view of a shipping vessel in accordance with the present disclosure.

FIG. 14 is a top plan view of a shipping vessel according to one embodiment.

FIG. 15 is a side elevation view of a shipping vessel according to one embodiment.

FIG. 16 schematically shows a bypass injection of ozone into a diverted portion of water loading to or unloading from a ballast tank.

FIG. 17 is a side view of a transport system according to the present disclosure.

FIG. 18 depicts various trade routes in accordance with the present disclosure.

FIG. 19 is a perspective view of an oil tanker and a non-rigid container according to one embodiment.

FIG. 20 is a side elevation view of one embodiment of a shipping vessel.

**DETAILED DESCRIPTION**

FIG. 1 is a side view of a crude oil tanker. Crude oil tankers 100 are designed for the bulk transport of oil. Crude oil tankers 100 move large quantities of unrefined crude oil from its point of extraction to refineries. Crude oil tankers carry oil in their cargo tanks 101 from the point of extraction to refineries on the outward leg of their journey. After offloading their crude oil 102 cargo at a refinery, empty oil tankers have to take on ballast water 103 to ensure vessel trim and stability during the deadheading portion of their voyage. Prior to loading their cargo, the tankers must discharge the ballast water 103 therefore a productive use of this deadheading portion of a tanker’s round trips would be to carry desalinated water 101 from an OTEC platform, melt water 96 or outflow river water 83 to the tankers home port in the Middle East and North America.
FIG. 2 is plan view of a crude oil tanker. A ballast tank 110 is a compartment within a boat, ship or other floating structure that holds water.

Crude oil tankers 100 either fill "empty" cargo tanks 101 with ballast water 103 or fill dedicated ballast water tanks 110 with water for their return trips. When an empty crude oil tank 101 is filled with ballast water 103 that water is typically referred to as "unsegregated" or "dirty" ballast because the ballast 103 uses the same tanks as the crude oil 102 rather than a separate tank. Most new tankers 100 are designed with segregated ballast tanks 110, but a few older tankers are only able to carry unsegregated ballast.

Although every effort is made at the refinery to completely unload the oil 102 from the cargo tanks 101 prior to loading the tanks with ballast water 103, some residual oil 102 inevitably remains on the tank walls and floor and mixes with the ballast water 103, creating an oily water which would be unsuitable for irrigation purposes or for human consumption. A vessel may have a single ballast tank 110 near its center or multiple ballast tanks 110 typically on either side. A large vessel typically will have several ballast tanks 110 including double bottom tanks, wing tanks as well as forepeak and aft peak tanks. Adding ballast to a vessel lowers its center of gravity, and increases the draft of the vessel.

Oil tankers 100 generally have from 8 to 12 tanks. Each tank is split into two or three independent compartments by fore-and-aft bulkheads. The tanks are numbered with tank one being the forwardmost. Individual compartments are referred to by the tank number and the athwartships position, such as "one port", "three starboard", or "six center."

FIG. 3 is a mid cross section of a crude oil tanker. In FIG. 11(b) shows a crude oil tanker 100 in cross section through its three mid cargo tanks 101.

FIG. 4 is an elevation view of a bladder for segregating oil and fresh water in the hold of an oil tanker for alternating trips to and from home ports. Once cargo has been discharged, tankers 100 must load ballast 103 (for weight stabilization) into their tanks. This ballast 103 is required for safety reasons when the tanker is at sea. Ballast stabilizes the ship for its return journey to the loading terminal. The amount of ballast loaded is usually about one third of the cargo carrying capacity of the tanker. The ballast also helps to immerse the hull, propeller, and rudder, in the sea,
thereby improving the maneuvering characteristics of the ship in the light (unloaded) condition.

A ballast bag 121, which is shaped to conform with the contours of a ship's ballast hold 101. A manhole 122 allows access to the interior of the hold 101 for inspection and maintenance purposes. The transverse bulkheads 123, and port bulkhead 124, in conjunction with containment barrier 125, are used for emergency containment of the ballast water 103, in the event of a ballast bag 120 failure in the ballasted condition. The containment barrier 125 reaches approximately the top of the cargo hold 101. The containment barrier 125 is attached to the side frames 126, which in turn are connected to the starboard ship's side plating 127 assuming that there is not protective ballast tank on the ship's side at this position. Remotely controlled container valve 128, is fitted as low as possible on the containment barrier 125 in order that the frame spaces may be efficiently drained of cargo oil. The container valve 128 is left open in the cargo loaded condition, and is closed in the ballasted condition.

Referring initially to FIG. 5, in one embodiment, hydrogen and oxygen that is generated by the high temperature electrolysis process is combusted at elevated pressure to produce high-pressure high temperature superheated steam. The heat generated through the combustion of hydrogen and oxygen is then extracted by the heat exchanger system and is recycled to be used in the high temperature electrolysis process. The extraction of the heat by the heat exchanger system condenses the superheated steam to produce fresh water. The process can be summarized as follows:

\[
\text{H}_2\text{O} + \text{HEAT}^{\text{HT}} \rightarrow \text{H}_2 + \frac{1}{2}\text{O}_2
\]

Combustion

\[
\text{H}_2 + \frac{1}{2}\text{O}_2 \rightarrow \text{H}_2\text{O} + \text{HEAT}
\]

FIG. 6 illustrates the details of a unit that also has the combustor and the water pipe. The wall that the water pipe and combustor share in common is covered by ceramic tiles so as to prevent heat transfer between them so as to eliminate heat.
losses. Conversely, the wall that the water pipe and the HTE unit share in common is not covered by ceramic tile so that there is maximum heat transfer from the water pipe to the high temperature electrolysis section. The higher the amount of heat transfer to the high temperature electrolysis section the lower the amount of electricity that is required for electrolysis. This embodiment may be furthered refined by excluding the evaporation section from the HTE unit. The selection of the ceramics that can withstand the heat and thus could line the surface of the combustor and the water pipe is within the knowledge of a person of ordinary skill in the art. The selection of appropriate materials suitable for the water pipe is within the knowledge of a person of ordinary skill in the art. This is the only situation in which part of the surface of the water pipe is covered by ceramic tiles so as to prevent heat transfer. In all other embodiments the contain heat exchanger system none of the water pipe surface is covered by ceramic so as to maximize the heat transfer from the water pipe to the heat exchanger system.

FIG. 7 depicts another embodiment of the present invention where the source of ice or water is filtered through natural clay, further filtered through a constructed additional clay filter, and selectively diverted by a control valve based on whether or not additional filtration is desired. The control valve may be selectively adjusted to divert water and ice that the user does not desire to undergo additional filtration to bottling or processing facilities. Alternatively, the control valve may also be selectively positioned so that water and ice are subjected to further constructed filter iterations. The resulting water and ice may then be diverted to processing and bottling facilities, subjected to further filtrations, or subjected to additional control valve and filtration steps as previously described.

FIG. 8 depicts one embodiment of the present invention wherein a tanker is utilized to transport cargo from a country, region, or port rich in such resources to a region having a demand for the same. In one embodiment, the region having demand for oil-based cargo also comprises a supply of fresh water or similar liquid having value. In various embodiments, such a liquid is transported from the region back to the oil rich origin or to various other destinations by utilizing features, volumes, and functionality in a vessel that previously conveyed water from the oil-rich region. Thus, in one embodiment, shipping vessels
are utilized to convey two or more resources from one location to another in a generally cyclical manner, increasing efficiency of the overall transportation method.

FIG. 9 is a top plan view of a shipping container 200 with one or more internal storage volumes 202. In various embodiments, internal storage volumes 202 are adapted to house large volumes of oil or other cargo in a first state and accommodate large volumes of water or various other liquids in a second state. In one embodiment, one or more drop-in liners 204 are provided after LNG or oil (herein used interchangeably) is emptied from portions 202 of a vessel 200, the liner(s) being adapted to receive volumes of water or liquid. The liner(s) prevent or mitigate the risk of cross-contamination between the water and previously stored LNG. In various embodiments, portions 202 of a LNG tanker are segregated by barriers 206. Barriers 206 allow for separation of various liquid cargoes. Accordingly, in various embodiments, tankers of the present invention may comprise or transport various combinations of liquid cargoes based on user preference. As one of skill in the art will recognize, an entire shipment of LNG need not be offloaded in order to transport different cargo. For example, two of four compartments comprising LNG may be offloaded at a particular port, the emptied two compartments re-filled with a volume of water, and the vessel may be conveyed to an additional port carrying a combination of LNG and water (or similar). Accordingly, in various embodiments, a dynamic shipping method is provided which may comprise different quantities and types of liquids based on shipping routes, economic conditions, and various other factors.

In one embodiment, internal surfaces 208 of portions 202 may be coated with various materials to prevent or minimize risk of cross-contamination. For example, various spray-coatings may be applied once a quantity of LNG is emptied from a portion 202 of the vessel to create a virgin surface for the holding and contacting with water or similar fluid cargoes. By way of example, industrial water-proof coatings provided by the Procachem Corporation may be provided to coat, cover, or seal a surface that was exposed to or in contact with LNG so as to render the surface capable of accommodating water without significant risk of cross-contamination.

FIGS. 10-11 depict a cross section of ships showing ballast tanks and ballast water cycles.
FIG. 12 illustrates a cross section of a ship provided with a ballast water intake and treatment system related to the presently disclosed embodiments and illustrates how a membrane treatment unit is arranged in the water intake that is conventionally hollow.

Numeral 1 is the hull of a ship such as a tanker. The hull 1 has one or more intake parts 2 at the side part and the bottom part near the ship bottom in the engine section. An intake part 2 consists of a water intake 100 and a slit 101 which prevents foreign matters from flowing in and is usually installed at the side part and the bottom part of the hull 1 in the number of one respectively as illustrated.

During the intake of ballast water, sea water or fresh water around the hull 1 is sucked by a pump 4 from the water intake 100 of the intake part 2 via an intake pipe 3 and stored in a ballast tank 102. If necessary, the intake pipe 3 may have a filter 5.

The water intake 100 is provided with a membrane treatment unit 6 equipped with a plurality of membrane modules 600. Microorganisms of no smaller than a given size are separated by the membrane treatment unit 6 and smaller microorganisms (e.g. bacteria) are killed by means of ozone oxidization. Ozone oxidization treatment methods include, but are not limited to, injection of fine bubbles into the intake pipe 3. During the injection of water into the ballast tank 102, air originally existing in the ballast tankl02 is discharged into the atmosphere through a breather pipe 7.

During the intake of water, the intake part 2 to be used is switched between the one at the side part and the other at the bottom part, depending on how deeply the ship sits. It is not always necessary to actuate the pump 4 for taking water since only opening of a valve sometimes allows water in by the force of water pressure.

Alternatively, the ballast water is discharged through a drain pipe 8 by the use of the same pump 4 as used for taking the water after a valve is switched to reverse the flow. The drain pipe 8 has two exits, i.e. a drain pipe exit installed on the ship and the intake part, which are used alternately, as appropriate. During the drainage, air flows in through the breather pipe 7 as the ballast tankl02 loses water.

The above explanation is given to an embodiment in case of a ship having one train of the ballast tank 102 and the pump 4; however, it does not exclude other embodiments. A ship may have a plurality of trains of the ballast tank 102 and the
pump 4.

FIG. 13 shows vessel 10 including stern 12, bow 14 and a double hull formed from outer hull 16 and inner hull 18. Vessel 10 is representative of the types of vessels encompassed within the invention and is a conventionally proportioned double-hulled oil tanker having cargo compartments within inner hull 18. However, the present invention can be applied to any sea faring ship or vessel that has ballast tanks or bilge water. The vessel 10 is typical of vessels that transport partly or fully refined or residual petroleum or other bulk liquid products such as seed oil.

Ozone generator 30 is illustrated located on vessel 10 aft deck 102 with main ozone feed line 130 shown as part of the ozone injection system of the invention. Generator 30 can be structured and can generate ozone according to known ozone generators such as described by Rodden U.S. Pat. Nos. 6,125,778; 6,139,809; and PCI-WEDECO (PCI-WEDECO Environmental Technologies, 1 Fairfield Crescent, West Caldwell, N.J. 07006) type SMO/SMA series generators and WEDECO Effizon® technology high concentration ozone production generators as examples. The disclosures of these patents are incorporated herein by reference in their entirety.

Ozonated gas is pumped through generator 30 and subsequently through line 130 for injection into water in respective ballast water intake/discharge conduits 116, 118 and 120 via respective connector lines 110, 112 and 114 in accordance with the FIGS. 1 through 3 and 4A and 4B embodiment of the invention. Intake/discharge conduit 116 conveys water from stern intake/outlet sea chest 132 to forward battery 124 of ballast tanks. Intake/discharge conduit 118 conveys water from starboard intake/outlet sea chest 134 to a starboard battery 126 of ballast tanks. Intake/discharge conduit 120 conveys water from port intake/outlet sea chest 136 to a port battery 128 of ballast tanks.

Ballast water is loaded into the vessel 10 via the sea chests 132, 134, 136 and is then pumped to load respective ballast tank batteries 124, 126, 128 through the system of conduits 116, 118 and 120 shown. At a destination location, the process is reversed and water is pumped from tank batteries 124, 126, 128 through the respective conduits 116, 118, 120 for discharge through respective sea chests 132, 134, 136 to the sea. Or, discharge can be effected through another, separate conduit and sea chest system (not shown) from tank batteries 124, 126, 128. After injection with ozone, the water is conveyed by one of
the main conduits 116, 118, 120 to respective tank batteries 124, 126, 128. As each main conduit 116, 118, 120 passes through each ballast tank 124, 126 or 128, a smaller footer pipe (not shown) can be taken off to provide a suction/discharge conduit. Valving for the footer pipe can be contained in a tunnel or cofferdam area, or actually placed in the tank itself, if space is an issue.

FIGS. 14 and 15 show that conduit 118 delivers ozone treated water to each ballast tank of a starboard battery of tanks 126 and conduit 120 delivers ozone treated water to each ballast tank of a port battery of tanks 128. Water enters through respective sea chests 134 and 136 and is treated and charged into a tank of either the starboard battery 126 or the port battery 128 until each respective tank is sufficiently filled and balanced to compensate for off-loaded cargo. Similarly, as shown in FIGS. 4A and 4B, water enters through stern sea chest 132, is treated with ozone delivered via line 110 and charged into a tank of forward battery 124 until each tank is filled to balance the vessel 10.

FIG. 16 shows detail of bypass injection of ozone into a diverted portion of water loading to or unloading from a ballast tank. The bypass injection allows for ozone injection, provides proper mixing and solubilization of the ozone gas into the ballast water and proper remixing of the ozonated diverted portion with the main water flow. Shown in FIG. 5 is exemplary aft load/discharge bypass injection system 550. The system 550 includes a bypass conduit 594 that diverges from main conduit 116 at an upstream point 622 and reconverges with the main conduit 116 at a downstream point 624. Bypass conduit 620 includes pump 560, venturi 564, mixer 566 and main conduit re-injector 568.

FIG. 17 is a side view of a towing and attachment arrangement for a transporter embodiment.

FIG. 18 depicts various trade routes where oil tankers or LNG vessels travel and where water can be delivered via various aspects of the present invention.

FIG. 19 is a perspective view of an oil tanker connected to a very large bag to facilitate transfer of water there-between in certain embodiments of the invention. In one embodiment, the oil tanker will tow a very large bag full of fresh water. The fresh water may or may not be potable and ready for consumption upon arrival.

FIG. 20 depicts one embodiment of a barge with water filtration and treatment equipment on board. The barge contains a conditioning tank 191 to provide a first
level of separation including an oil skimmer through an up flow configuration with discharge entering a centrifuge 192. Water from the centrifuge may then be directed through a filtration process, sand or multimedia, 194 for removal of large particulates before introduction through activated carbon filters 193 for removal of organics and excess ozone. Discharge from the carbon filters is directed to a clean water tank 195 and 196. Piping 197 and 198 can be employed to transport water to very large bags (as otherwise described herein) to accompanying vessels at a destination port or directed to onshore treatment and/or storage systems.

One of skill in the art will appreciate that the entire disclosure, as well as the incorporated references, pictures, etc. will provide a basis for the scope of the present invention as it may be claimed now and in future applications.

While specific embodiments and applications of the present invention have been illustrated and described, it is to be understood that the invention is not limited to the precise configuration and components disclosed herein. Various modifications, changes, and variations which will be apparent to those skilled in the art may be made in the arrangement, operation, and details of the methods and systems of the present invention(s) disclosed herein without departing from the spirit and scope of the invention. Those skilled in the art will appreciate that the conception upon which this disclosure is based, may readily be utilized as a basis for designing of other structures, methods and systems for carrying out the several purposes of the present invention. It is important, therefore, that the claims be regarded as including any such equivalent construction insofar as they do not depart from the spirit and scope of the present invention.
What is claimed is:

1. A method of delivering non-salt water to a destination utilizing oil tankers, comprising:
   a) providing an oil tanker with cargo comprising oil at a first location and having a second location as a destination port for delivery of the oil, wherein said oil is delivered at said destination port and substantially all of the oil within the oil tanker is emptied from the oil tanker, except for residual oil residue left behind;
   b) substantially filling the oil tanker with non-salt water in both a ballast section of the oil tanker and in a second section of the oil tanker that previously held oil for transport;
   c) at least partially treating said non-salt water contained in said oil tanker while en route to said second destination, said water treatment selected from the group consisting of at least two of the following: filtering through a natural clay filter; centrifugation; reverse osmosis; gravity separation; contact with a natural coagulant; adjusting pH to between about 6 to about 11; and ozonation; and
   d) segregating water treated in accordance with step c) from water that has not been treated in accordance with step c), said segregation accomplished by at least one of: conveying said water treated in accordance with step c) to a substantially oil-free storage section of the oil tanker; and conveyance of said water treated in accordance with step c) to a substantially flexible storage container adapted for containing water.

2. The method of Claim 1, wherein upon arrival at said second location, said water treated in accordance with step c) is further treated to remove oil therefrom.

3. The method of Claim 1, wherein the substantially flexible storage container comprises a bag adapted for towing through a larger volume of water.

4. A method of shipping, comprising:
   providing an ocean-faring shipping vessel comprising at least one internal storage volume adapted for transporting cargo;
   supplying the at least one internal storage volume with a first cargo comprising a hydrocarbon;
   conveying the shipping vessel from a first location to a second location and removing a substantial portion of the first cargo at the second location;
modifying the at least one internal storage volume such that the at least one internal storage volume is adapted for transporting a second cargo;

subsequent to said modifying, substantially filling the at least one internal storage volume with a second cargo and transporting the shipping from vessel from the second location.

5. The method of claim 4, wherein the first location comprises a port proximal to an oil-producing region and the second location comprises a port proximal to a source of fresh water.

6. The method of claim 4, wherein the modifying step comprises providing a liner in the at least one internal storage volume, the liner comprising substantially the same surface area as the at least one internal storage volume.

7. The method of claim 4, wherein the modifying step comprises cleaning the internal surfaces of the at least one internal storage volume.

8. The method of claim 4, wherein the second cargo comprises potable water.

9. The method of claim 4, further comprising treating the second cargo by at least one of: filtering through a natural clay filter; centrifugation; reverse osmosis; gravity separation; contact with a natural coagulant; adjusting pH to between about 6 to about 11; and ozonation.

10. The method of claim 4, wherein the modifying step comprises providing an enclosed non-rigid water-impermeable device within the at least one internal storage volume.

11. The method of claim 4, wherein the hydrocarbon comprises at least one of crude oil, refined oil, natural gas, and liquid natural gas.

12. A method of delivering water to a destination utilizing at least one sea faring vessel, the method comprising:

receiving a sea faring vessel with at least one internal storage volume comprising a first cargo, the first cargo comprising at least one hydrocarbon, at a first location;

removing substantially all of the first cargo from the at least one internal storage volume;

at least partially filling the at least one internal storage volume with water;

treating water contained in said at least one internal storage volume, said treating step comprising at least one of: filtering through a natural clay filter;
centrifugation; reverse osmosis; gravity separation; contact with a natural coagulant; adjusting pH to between about 6 to about 11; and ozonation; and segregating treated water from water that has not been treated, said segregation accomplished by at least one of: conveying said treated water to a substantially oil-free storage section of the oil tanker; and conveyance of said treated water to a substantially flexible storage container adapted for containing water.

13. The method of claim 12, wherein said treating step occurs en route to a second destination.

14. The method of claim 12, further comprising two or more internal storage volumes and wherein at least one internal storage volume is not provided or in contact with a first cargo.

15. The method of claim 12, wherein the at least one internal storage volume is provided with a barrier prior to at least partially filling the at least one storage volume, the barrier comprising a water impermeable material.
Fig. 5

Fig. 6
Cross section of ships showing ballast tanks and ballast water cycle

1. At source port
2. During voyage
3. At destination port
4. During voyage
INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 12/48166

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - C02F 1/00; B60P 3/22 (2012.01)
USPC - 137/899: 210/600
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC - C02F 1/00; B60P 3/22 (2012.01)
USPC - 137/899; 210/600

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC - 210/20*

Electronic database consulted during the international search (name of data base and, where practicable, search terms used)
PatBase; Google Scholar, Google Patents

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>WO 2008/010762 A1 (Mesbahi) 18 September 2008 (18.09.2008) page 1, lines 11-17; page 2, lines 8-20, page 3, in. 15-25, page 8, lines 9-20, page 9, lines 4-7</td>
<td>12-14, 1-17, 1-3, 15</td>
</tr>
<tr>
<td>Y</td>
<td>JP 2003/081 177 A (Ha et al.) 19 March 2003 (19.03.2003) abstract</td>
<td>1-3, 15</td>
</tr>
</tbody>
</table>

Further documents are listed in the continuation of Box C.

* Special categories of cited documents:
  "A" document defining the general state of the art which is not considered to be of particular relevance
  "E" earlier application or patent but published on or after the international filing date
  "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
  "O" document referring to an oral disclosure, use, exhibition or other means
  "P" document published prior to the international filing date but later than the priority date claimed
  "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
  "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
  "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
  "&" document member of the same patent family

Date of the actual completion of the international search
02 November 2012 (02.11.2012)

Date of mailing of the international search report
19 DEC 2012

Name and mailing address of the ISA/US
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Authorized officer: Lee W. Young
PCT Helpdesk: 571-272-4300
PCT OSP: 571-272-7774

Form PCT/ISA/2 I0 (second sheet) (July 2009)
Continuation of Box III

c) at least partially treating said non-salt water contained in said oil tanker while en route to said second destination, said water treatment selected from the group consisting of at least two of the following: filtering through a natural day filter; centrifugation; reverse osmosis; gravity separation; contact with a natural coagulant; adjusting pH to between about 6 to about 11; and ozonation; and d) segregating water treated in accordance with step c) from water that has not been treated in accordance with step c), said segregation accomplished by at least one of: conveying said water treated in accordance with step c) to a substantially oil-free storage section of the oil tanker; and conveyance of said water treated in accordance with step c) to a substantially flexible storage container adapted for containing water.

Group II: claims 4-11 directed to a method of shipping, comprising:
 providing an ocean-faring shipping vessel comprising at least one internal storage volume adapted for transporting cargo;
 supplying the at least one internal storage volume with a first cargo comprising a hydrocarbon;
 conveying the shipping vessel from a first location to a second location and removing a substantial portion of the first cargo at the second location;
 modifying the at least one internal storage volume such that the at least one internal storage volume is adapted for transporting a second cargo;
 subsequent to said modifying, substantially filling the at least one internal storage volume with a second cargo and transporting the shipping from vessel from the second location.

Group II does not include water transport, nor treating the water of group I.

Group I does not include the modifying the storage volume of group II.

The inventions listed as Groups I-II do not relate to a single general inventive concept under PCT Rule 13.1 because under PCT Rule 13.2 they lack the same or corresponding technical features for the following reasons:

The common feature of groups I and II of an ocean-faring shipping vessel with a first cargo comprising a hydrocarbon; conveying the first cargo and removing the cargo; and filling the cargo space with a second cargo is taught by US 2011/0036919 A1 (Baird) published 17 February 2011 (para [0232]); therefore the common feature is not an improvement over the prior art.

None of these technical features are common to the other groups, nor do they correspond to a special technical feature in the other groups. Therefore, unity of invention is lacking.
This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. □ Claims Nos.: because they relate to subject matter not required to be searched by this Authority, namely:

2. □ Claims Nos.: because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. □ Claims Nos.: because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

This International Searching Authority found multiple inventions in this international application, as follows:

Group 1 claims 1-3 and 12-15 directed to a method of delivering non-salt water to a destination utilizing oil tankers, comprising:

a) providing an oil tanker with cargo comprising oil at a first location and having a second location as a destination port for delivery of the oil, wherein said oil is delivered at said destination port and substantially all of the oil within the oil tanker is emptied from the oil tanker, except for residual oil residue left behind;
b) substantially filling the oil tanker with non-salt water in both a ballast section of the oil tanker and in a second section of the oil tanker that previously held oil for transport;

—Please see supplemental box—

1. □ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. □ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. □ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. X No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos. 1-3, 12-15.

Remark on Protest

The additional search fees were accompanied by the applicant’s protest and, where applicable, the payment of a protest fee.

The additional search fees were accompanied by the applicant’s protest but the applicable protest fee was not paid within the time limit specified in the invitation.

No protest accompanied the payment of additional search fees.