Fresh water distillate pump

INTRODUCTION .

There was MOD vessel on the port and this vessel required a fresh water for the 50 crew on the ship. So i have to make a system to produce fresh water on that ship. But the problem is that the ship is at port and there is lot of waste present in the port sea water such as organic waste which contain mainly garbage , untreated sewage which can discharge directly or indirectly in the sea. treaces of heavy metals also present mercury, cadmium,, chromium these heavy metals are dangerous to health and also to the environment. heavy metals such as zinc and lead may causes corrosion . beside of these there was sone anthropogenic source of waste present which are listed below.

Mining effluents

Domestic effluents

Industrial effluents

Shipping activities including those of motorised boats and canoes.

Fertilizers’ pesticides

Atmospheric sources such as gas flaring, incineration of domestic waste manly garbage.

Petroleum industries activities.

According to uk water regulation the perctange of some heavy metals must be at certain level

CALCULATION

Before choosing any generator I have to calculate the water which fulfil the requirement of 50 persons.

In a ship one person can MAXIUM 600 to 800 litres per day. A person can use the fresh water for washing clothes, washing utensils, wash room, drinking, cooking, bathing, and etc.

If we calculate the fresh water for the 50 persons is………!

800*50= 40000 litres per day

so i have to chose a system which is capable for the production of minim 40000 liter per day

TYPES OF FREH WATER GENERATOR

in an efficient engine, only about half of the heat in the fuel is converted into useful work some of the Heat energy is lost in the cooling systems and exhaust gas. but some of the heat lost is recovered . the Modern highly pressure charged engines have a large amount of energy in scavenge air cooling wateer and this can be provide as the source of heating to the bunkering . an other source of heat is jacket water cooling and it also contain considerable amount of heat and this heat can be recovered in the fresh water evaporator system which operate at the pressure giving a corresponding saturation temperature fo water lower the the jacket water entering in to the heating medium . gasses dissolved when water is heated to its saturation temperature.

There are two methods for generating fresh water,

1. Reverse Osmosis

2. distillation.

is generally used were large quantities of relatively low quality water is required. Typical examples of water produced are;

Treatment

Total Hardness

Calcium Hardness

Silica

Sodium Chloride

TDS

Sea Water

250

200

14

15000

15000

Evaporator

<0. 2

<0. 2

<0. 2

<20

<20

Reverse Osmosis

20

5

<1

<750

<750

After Demineraliser

0

<1

Trace

<2

<3

•

Distillation

The most commonly use freshwater generation is evaporative distillation, which uses engine jacket cooling water or steam heat from exhaust or gas fired boilers to evaporate sea water, which is then condensed into fresh water. Evaporation distillers comes in two main forms, 1. multistage flash

2 multi effect evaporators.

Simple single effect evaporator

The system above shows an evaporator typically heated by Main Engine Jacket water with means to supply steam when the engine is shut down

Single and multi stage tube distillation was one of the early types of fresh water generation. It uses heat passing through submerged coils or tube bundles immersed in sea water to produce the distillate, which when condensed becomes the fresh water.

Single Stage Flash Evaporator

flash evapourator

it consist of two parts

1. condensor

2. evaporator

generally the heating method used is main engine heat or by heating oil usually the water boils at 100 degree. But in the freshwater generator the water inside the system usually boiled at 60 to 70 degree. By using ejector or edecutor. basically an alternative arrangement to the shell evaporator is the flash evaporator were heating takes place externally, the hot brine enters the low pressure chamber into a weir where some of the water flashes off. Water overflowing the weir is either out or passed on to a second stage. Multi stage units with each stage maintained at a lower pressure allow improved efficiency and high outputs. to check the percentage of salt salinoemetre is used. its is important to use salinometere because if the percentage of salt in water became high then it can detect it and raised the alarm

Multi Stage Flash Evaporator

flash flow diagramr

in this process we use two evaporation stages in order to get a better typical multi stage flash system is based upon preheating of a pressurised sea water stream, or more typically a recycle brine stream to which the feed sea water is added the stream is heated in the heat input section brine heater. Double stage FWG is similar to the single stage FWG, the only difference being that the whole single stage process is repeated twice in 2-stage generator From here the recycle stream is passed into the first stage of a series of flash chambers. Here the pressure is released, permitting a portion of the brine stream to flash to form salt-free vapour which is condensed to give the fresh water. In condensing the vapour gives off its latent heat to the recycle brine stream. From the first stage the flashing brine stream is passed to the second stage which is kept at a slightly lower pressure more vapour flashes off. In the same way the flashing brine stream passes to the next stage and so on through the plant with a portion of the vapour flashing off at each stage. A heat balance shows that the heat supplied in the brine heater has to be rejected. This is done in the last two stages of the plant which are cooled by a sea water stream which subsequently passes to waste.

Modern Developments.

Large Multi-effect Alfa laval evaporator

In 1990 Alfa-Laval Desalt introduced its D-TU concept-a ME desalination system based on tube type distillers, by using the evaporation under vacuum with the rising film principle. This is thath means the inner surfaces of the tube are always covered with a then film of the feed water . heating medium is circulates on the outside of the tubes in the heat exchangerss. and The vacuum is created by water ejectors connected to each effects. A controlled amount of sea water is led to the bottom of each of the effect. where it is mixes with the brine from the previous effect and into the tubes in the heat exchanger, where it is heated. The generated vapours enter a separator where the brine droplets from the wet vapour are separated. The dry vapour pass through the separator to the following effect where they condense. The remaining sea water which has been converted to brine, flows to the next effect as feed water. The brine is taken out and discharged overboard. The latent heat in the vapours from the previous effect is used as a heating medium in the following effects. The process continues until the last effect where the generated vapours condense cooled by sea water. The condensate vapours flow from one effect to the next, and are retained in a collecting tank as distilled water. If a low temperature evaporator is to be used for domestic purposes certain restrictions apply. Operation is not allowed within 25 miles of the coast or 50 miles of an estuary. Chromate jacket water treatment must never be used. The condensate must be treated in order to destroy bacteria. Care must be taken if chemicals are used to inhibit marine growth in pipe work.

Vapour Compression

The boiler section is initially filled with fresh water. When the system is operating feed water is supplied via the level control valve. Hot steam is created in the boiler which passes over into the main section. Here the steam is mixed with a brine spray. Some of the steam is condensed and some of the brine spray is flashed off. The combined steam passes over to the vapour section via a scrubber. Flow of vapour occurs due to the action of the compressor which increases the vapour pressure increaseing its saturation temperature.

Reverse Osmosis

Osmosis describes the process whereby a fluid will pass from a more dense to a less dense solution through a semi-permeable membrane. It is very important to the water absorption processes of plants. RO is a process which uses a semi permeable membrane which retains both salt and impurities from sea water while allowing water molecules to pass. Filtration of up to 90% is possible thus making the produced water unsuitable for boiler feed without further conditioning. Improved quality is possible using a two or more pass system.

diagram showing osmotic headThe parchment paper acts as the semi-permeable membrane and allows the water molecules to pass but not the larger salt molecules.

Reverse osmosis is the process whereby a pressure greater than the osmotic head pressure is applied to a solution of high density. Fluid is forced from the high density side to the less dense side. For desalination plants the pressure is applied to sea water and the water is forced through the semi-permeable membrane.

The semi permeable membrane which is typically made of polyamide membrane sheets wrapped in a spiral form around a perforated tube resembling a loosely wound toilet roll.

Design of the cartridges is therefore such that the sea water feed passes over the membrane sheets so that the washing action keeps the surfaces clear of deposits. A dosing chemical is also injected to assist the action.

Make up of membrane

The two membranes sealed on the outer three edges, enclose porous under-layer through which the permeate spirals to central collecting tube

Schematic of RO plant

Pressurised feed water passes lengthways through the tubular spiral wound membrane element. Freshwater permeate travels through the membrane layers as directed along a spiral bath inot a central perforated tube, while brine is discharged out the end of the membrane element..

The fluid could be water and the solutions sea water. Under normal conditions the water would pass from the less saline solution to the more saline solution until the salinity was the same. This process will cease however if the level in the more saline side raises to give a difference greater than the Osmotic height.

For practical use to allow the generation of large quantities of water. It is necessary to have a large surface area of membrane which has sufficient mechanical strength to resist the pressurised sea water.. The material used for sea water purification is spirally wound polyamide or polysulphonate sheets. One problem with any filtration system is that deposits accumulate and gradually blocks the filter. The sea water is supplied at a pressure of 60bar, a relief valve is fitted to the system. The Osmosis production plant is best suited to the production of large quantities of water rather than smaller quantities of steam plant feed quality.

Pre-treatment and post treatment.

Sea water feed for reverse osmosis plant is pre-treated before being passed through. The chemical sodium hexa phosphate is added to assist wash through of salt deposits on the surface of the elements and the sea water is sterilised to remove bacteria which could otherwise become resident in the filter. Chlorine is reduced by compressed carbon filter while solids are removed by other filters. Treatment is also necessary to make the water drinkable.

The disc tube module is supposed to have the main advantage over the spiral wound type in that it avoids the need for the difficult cleaning processes required. With long lasting membranes, typically 5 years and in built cleaning system the unit will recover 30% as pure water from sea water passing through it

Coil or Tube Seawater Evaporator

This is a modern version of the type used when I was at sea in the 1960's; they used heating coils in those days as opposed to the pipe nest heaters of today. The coils used to become scaled in salt, with the attendant loss in output of distillate. I was in charge of the vaps and I remember the old chief coming down to the engine room on my watch and balling me out for the downturn in distillate. We were having problems with the boiler feed water purity (next article will cover the testing and treatment of boiler feed water) so I was blowing down the boiler regularly with the associated make-up requirement meant we needed more water pronto. Anyway I took him up to the vaps and showed him the scaling on the heating coils, reminding him that I was pumping Foss chemicals into the beast to try and break this away. He pushed me aside and shut off the seawater supply opening up the steam supply which rapidly dried the salt layer on the coils. He then opened the seawater inlet and hey presto – the salt scale cracked and fell of the coils. I used this system several times until I was up for Seconds ticket and examiner wasn't too pleased to hear of this method, called the old Chief several unprintable names. Today we don't have to resort to these measures as there is an innovative device which uses a material that emits oscillations counteracting the natural seawater oscillations, thereby altering its properties and preventing calcium carbonate scale. (I will note the website address in the relevant section; I am too old for this new technology). A tube and coil evaporator consists of a steel vessel which has a nest of heating pipes near the bottom of the vessel being fed by steam or, hot water from the main engine. There is a tube condenser cooled by seawater installed near the top of the vessel. A vacuum is drawn in the vessel by air ejectors operated by steam or pressurised seawater. Seawater is fed into the evaporator just covering the heating pipes. Heat is supplied to the pipes and, this combined with the vacuum conditions begins to boil the seawater producing steam. The steam rises up through a demister into the tube condenser where it is evaporated to distilled water. This is collected and pumped via the salinometer to the storage

EVAPORATOR SCALE.

There are numerous types of evaporators all working to produce pure water with concentrated sea-water as waste. This concentration effect can lead to the formation of damaging scales within the evaporator. Over concentration is usually prevented by having a continuous stream of sea-water passing through the unit thus maintaining a satisfactory dilution of the sea-water side of the evaporator. However, because of the high salt content, when sea-water is elevated to temperatures above 30 C scales can begin to form on heat transfer surfaces. Additionally as the majority of evaporators operate under vacuum there is a tendency for the make-up water side to foam, which can give rise to carry-over and contamination of the pure water stream.

Four scales which are principally found in evaporators are;

Calcium Sulphate (CaSO4)-1200ppm, scale formation is principally on density, remains in solution below 140oC and/or 96000ppm. The worst scale forming salt forming a thin hard grey scale

Magnesium Hydroxide Mg(OH)2

remains in solution below 90oC

Magnesium Bi-Carbonate 150ppm

soluble below 90oC, forms a soft scale, prevention by keeping operating temperature of evaporator below 90oC

Above 90oC

breaks down to form $MgCO_3$ and CO_2 and then $Mg(OH)_2$ and CO_2

Calcium bicarbonate $Ca(HCO_3)_2$ 180ppm

Slightly solube, above 65oC breaks down to form insuluble calcium carbonate forming a soft white scale. scale formation prevented by chemical treatment $Ca(HCO_3)_2 = Ca + 2HCO_3$

$2HCO_3 = CO_3 + H_20 + CO_2$

If heated up to approximately 80oC

$CO_3 + Ca = CaCO_3$

If heated above 800C

$CO_3 + H_20 = HCO_3 + OH$

$Mg + 2OH = Mg(OH)_2$

Hence if sea water in the evaporator is heated to a temperature below 80oC calcium carbonate predominates. If it is heated above 80oC then magnesium hydroxide scale is deposited.

Sodium Chloride 32230 to 25600ppm -generally ignored

Soluble below 225000ppm forms a soft encrustation, free ions promote galvanic action. It is unlikely to precipitate and is easily removed

Supersaturation

This is where the concentration of dissolved salts exceed their solubility at the particular temperature encountered and precipitation begins to occur. When deposition occurs under these conditions heavy scale deposits can rapidly build up and lead to a loss of heat transfer efficiency. Scale deposition due to supersaturation is often localised in areas of elevated temperature such as heat transfer surfaces in heat-exchangers. This is because of localised over concentration of salts with respect to the temperature of the thin water layer at the surface of the metal. Scale deposition can therefore occur on heat-exchange surfaces even when the conditions in the bulk of the water are not scale forming.

FINALLY SELECTED GENERATOR

VACCUM VAPOUR COMPRESSION FRESHWATER GENERATOR

MAKER…………………………. ALFA LAVAL

TYPE……………………………. ORCA OFFSHORE SERIES

CAPACITY………………………20-70m3/per day

vacuum vapour compression is the efficient method of production of fresh water for both drinking and other use. by using this method we can convert the sea water in to fresh water by vacuum distillation process using electricity. The system has simple compact designee made from titanium heat exchanger plates with combined fresh water and feed water system. the system has low maintance cost any work on start and forget operation . and can produced very high quality of fresh water .

BASIC Equipment.

titanium plate heat exchanger for the combination evaporator and condenser

stainless steel distiller shell,

air ejector

freshwater pump

compressor

UL approved panel

built in freshwater quality monitoring system.

ADDITIONAL Equipment

fresh water pH adjustment filter.

silver-ion or we can say UV sterilisers

VACCUME DISTILLATION PROCESS.

vacuum distillation is the process use to convert sea water in to fresh water. by this process constant supply of fresh water with low salinity level and be achieved with continuous controlling the water quantity.

WORKING PRINCIPAL .

0feed water enter in to the lower section of the plate packs.

plates is warmed by heating medium, heating medium is either a jacket water cooling medium or a closed circuit heating medium

water is then evaporated at 40-60 degree centigrade in the vacuum of 85-95 %

the vapour produces is raised between the plates in the middle section of plate pack. At this point seawater is almost completely removed.

these droplet falls back in to the brain sump by the gravity at the bottom of the fresh water generator.

only the clean fresh water can enter in to the condenser section and the water is cooled by flow of sea water. at that point vapour is condensed in to fresh water and pumped out by the fresh water pump.

GHARP SHOWS THE % TONS PER DAY PRODUCTION

Technical specifications (standard units without optional equipment)

Water maker type ORCA Offshore 20 ORCA Offshore 30 ORCA Offshore 40 ORCA Offshore 50 ORCA Offshore 60 ORCA Offshore 70

Length (L) mm/inch Width (W) mm/inch Height (H) mm/inch

Dry weight kg/lbs

Operating weight kg/lbs FW pump motor kW/hp

Brine pump motor kW/hp

SW pump motor kW/hp (option)

Circ. pump motor

Electric power (kW installed)

Power consumption kwh/m3 fresh water Fresh water quality

Dimensions *)

THE DRAWING SHOWS ORCA OFFSHOREE SERIES WITHOUT OPTIONS

2450 / 96 2150 / 85 2400 / 94

3700 / 8175 3865 / 8521

1. 3 / 1. 7 1. 3 / 1. 7 12. 5 / 1 1. 9 / 2. 6

78. 5

18

WHO standard, less than 5 ppm NaCl

2800 / 110

2150 / 85

2400/94

4000 / 8818 4185 / 9226

1. 3 / 1. 7 1. 8 / 2. 4 12. 5 / 17 3. 6 / 4. 9

81

18

SLOW SAND FILTER (SSF) FOR THE REMOVAL OF HEAVY METAL.

Slow sand filters (SSFs) are probably the most effective, simplest and least expensive water treatment process. Micro-organisms and other particulate materials are effectively removed by SSFs. Considerable development has been done on SSFs with respect to particle removal, but only a few works have been reported in the context of the removal of heavy metals which are a severely toxic pollutant of surface waters. No extensive laboratory or pilot studies have been carried out to determine the performance or the mechanisms of removal of heavy metals by SSFs. This research is concerned with an experimental investigation of the removal of heavy metals from surface water by SSFs. Four laboratory scale SSFs were built and run according to standard design criteria. Removal of four common heavy metals [copper (Cu), chromium (Cr), lead (Pb) and cadmium (Cd)] were monitored. The filters were fed synthetic water made from tap water mixed with settled sewage, and each filter was dosed with one of the heavy metal salts. The concentrations of Cu, Cr, Pb and Cd in the influent were selected as 10 mg/l, 100 Î¼g/l, 60 Î¼g/l, and 100 Î¼g/l respectively considering their relative toxicity and WHO guidelines in drinking water. Settled sewage was added to vary the total organic carbon (TOC) of the feed water. The reduction of heavy metal concentrations were monitored at various TOCs, filtration rates and filter bed depths. The results showed that SSFs succeeded in removing heavy metals from water. The removals of Cu, Cr, Pb and Cd at the conventional flow rate and filter depth are 99. 6, 97. 2, 100 and 96. 6 % respectively. The results also showed that an increase in TOC in the feed water improved metal removal while increases of flow rates caused a decrease of the removal of metals. The removal of heavy metals also decreased with a reduction in sand bed depth. The optimisation of design parameters for SSFs for the removal of heavy metals depends on the individual heavy metal and on the TOC content of the feed water. Model equations were developed for, and linear correlation was observed between each of the three control parameters and the removal of the selected metal. The removal of heavy metal by SSFs was achieved through the combination of a number of mechanisms. Settlement, adsorption to both sand and organic matter and microbial

WORKING PRCEDURE

slow and sand filter work through the formation of a layer know as hypogeal layer or schmutzdecke . hypogeal layer contain microorganism that remove bacteria and trap condiments particles. it consist of bacteria, fungi, portozoa, rotera and a range of aquatic insect larva. the hypogal layer provides effective purification in potable water treatment.

as the water passes through the hypogeal layer particles of foreign matter are trapped in the mucilaginous matrix and dissolved organic material is adsorbed and metabolised by bacteria, fungi and protozoa. Water produced form a well managed slow sand filter is free from heavy metals and other hazards. Slow sand filter are simple, are easily used by small systems, and have been adapted to package plant construction . Slow sand filter are similar to single media rapid-rate filters in some respects, but there are crucial differences in functional mechanisms(other than the obvious difference in flow rate): the “ schmutzdecke” removes suspended organic materials and microorganisms by biodegradation and other biological processes, instead of relying solely on simple filtration or physic-chemical sorption. Advantages of slow sand filtration include its low maintenance requirements (since it does not require backwashing and requires less frequent cleaning) and the fact that its efficiency does not depend on actions of the operator. However, slow sand filters do require time for the “ schmutzdecke” to develop after cleaning, during which the filtration performance steadily improves; this interval is called the “ ripening period”. The ripening period can last from six hours to two weeks, but typically requires less than two days. A two day filter-to-waste period is recommended for typical sand filters . Since few remedies are available to an operator when the process is ineffective, slow sand filtration should be used with caution and should not be used without pre treatment or process modifications unless the raw water is low in turbidity, algae, and colour . Package plant versions with a granular activated carbon layer located beneath the slow sand filter can absorb organic materials that are resistant enough to biodegradation to pass through the schmutzdecke. When used with source water of the appropriate quality, slow sand filtration may be the most suitable filtration technology for small systems (6). Slow sand filtration has demonstrated removal efficiencies in the 90 to 99. 9999% range for viruses and greater than 99. 99% for Guardia

FILTER DISCRUPTION.

Square tank

Media depth: 2-3 ft

Surface area: <2, 100 ft2

Filtration rate: 2-10 gal/min-ft2

Flow through filter: 350-3, 500 gpm

Backwash frequency: every 24 houre

CALCULATION

We have required maximum 40000 litter per day production per day. and the filtration rate of this filter is max 51000 litter per day which fulfil our requirement. and we have to put two filter in parellal for the standby and maintaince purpose. So that if one filter stop working we can use the other standby filter to run the system as per requirement.

IMPORTANT POINTs

there is one bypass line in slow sand filter before the water enter in to the sand filters. and this bypass meet the discharge line of distilled pump. The reason for this bypass is that if the ship is in the sea we can open the bypass valve and the fresh water then straight go to the mineraliser unit. because in the roiling and pitching condition the slow sand filter does not work properly

the sand filter unit is completely fixed with proper fitting. so that when the main engine runs it does not move from his place.

one the important is that the system will take at least 2 day to start working . so for days the ship master has to arrange some external sources of drinking water.

CLEANING METHOD

There is two method of cleaning of sand filter

1. the top few millimetres of fine sand is scraped off to expose a new layer of clean sand. Water is then decanted back into the filter and re-circulated for a few hours to allow a new Schmutzdecke to develop. The filter is then filled to full depth and brought back into service

2. The second method, sometimes called wet harrowing, involves lowering the water level to just above the Schmutzdecke, stirring the sand and thereby suspending any solids held in that layer and then running the water to waste. The filter is then filled to full depth and brought back into service. Wet harrowing can allow the filter to be brought back into service more quickly.

POSITION.

we can fit the sand filter before the discharge of distilled pump.

CHEMICAL TREATMENT.

VAPTREAT.

chemical known as vaptreat is add in to the system before the point where sea water is going inside the system . because this chemical make the sea water soft.

IMPORTANT PROPERTIES

Odour: Odourless

Appearance: Liquid, pale yellow, soluble in water

Contact with eyes: Mildly irritating to eyes

Contact with skin: In cases of severe exposure, irritation may develop

Inhalation: Vapours or aerosols may cause irritation of eyes, nose and respiratory tract

Ingestion: May cause gastro-intestinal disturbances

MINERALISER AND CHLORINE UNIT

After the discharge of distilled pump the water then pass through the mineraliser after the mineraliser chlorine is added to the water.

capacity of mineraliser= 3800liter/hour

capacity of chlorine unit.= 3800liter/hour

PUMPS REQUIREMENTS

Ejector Pump

The ejector pump is a single-stage centrifugal pump which supplies the

condenser with sea water and the brine/air ejector with jet water as well as

feed water for evaporation.

Fresh Water/Distillate Pump

The single-stage centrifugal fresh water pump extracts the distillate from the condenser and pumps it to the fresh water tank.

POSITION OF EJECTOR PUMP

The pump is fitted after the suction of low sea chest. because at the low sea chest suction there is no oil present . and is the best point of taking the main sea water suction .

TYPE OF PUMP.

TEHNICAL DATA

CASING………….. Cast iron, Nodular cast iron, Bronze, Stainless steel

IMPELLER……………….. Cast iron, Bronze, Stainless steel

MAXIMUM CAPACITY………. 850m3 per hour

MAXIMUM DELIVER HEAD…………105M

MAXIMUM LIQUID TEMPERATURE…………120 CENTIGRADE

MAXIMUM PRESSURE……. 1000KPa

MAXIMUM SPEED………3600 rpm

Salinometer

The salinometer continuously checks the salinity of the produced water.

The alarm set point is adjustable. salinometer continuously check the quality of the distillate, a salinometer is provided at the outlet side of the distillate pump.

If the salinity of the produced fresh water exceeds the chosen maximum value,

the solenoid valve is activated to automatically dump the distillate to the bilge

and an alarm is sounded

Control Panel

The control panel contains motor starters, running lights, salinometer and contacts for remote alarm.

DISTILLED WATER TRANSFER AND DISTRIBUTION

Each fresh water generator distillate pump discharges through a salinometer and a flow meter. Positioned before the flow meter is a solenoid valve. This opens when the salinometer detects too high a salinity level, diverting the distillate pump output to the bilge.

The discharge from the FW generators flows to either the distilled water tank which is situated in the steering gear room on the starboard side though inlet

valve or to the fresh water tanks which are both situated on the port and starboard sides of the steering gear room.

The distilled water tank supplies water to the boiler feed water tank via valve

Fresh water produced in the generator that is to be used for domestic purposes is directed through a mineraliser and a chlorination sterilising unit before entering the fresh water tanks. The fresh water tanks supply water to the d