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Salt Water Converted to Purified Drinking Water by Pedal Power

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***Abstract*: This paper presents an overview on salt water converted to purified drinking water by pedal power.**

***Keywords*: Salt water, Purified drinking water, Pedal power, Reverse osmosis.**

1. Introduction

The water that is present in the world today were formed billions of years ago. Even though about 70 % of the word is covered by water only 2.5 percent is fresh, which has resulted in an abstract concept to many and harsh reality to others which is scarcity of freshwater. And the rest is saline which is not fit for drinking and ocean based. Water purification, the process by which undesired chemical compounds, organic and inorganic materials, and biological contaminants are removed from water. That process also includes distillation (the conversion of a liquid into vapour to condense it back to liquid form) and deionization (ion removal through the extraction of dissolved salts). One major purpose of water purification is to provide clean drinking water. Water purification also meets the needs of medical, pharmacological, chemical, and industrial applications for clean and potable water. The purification procedure reduces the concentration of contaminants such as suspended particles, parasites, bacteria, algae, viruses, and fungi. Water purification takes place on scales from the large (e.g., for an entire city) to the small (e.g., for individual households). Most communities rely on natural bodies of water as intake sources for water purification and for day-to-day use. In general, these resources can be classified as groundwater or surface water and commonly include underground aquif lookers, creeks, streams, rivers, and lakes. With recent technological advancements, oceans and saltwater seas have also been used as alternative water sources for drinking and domestic use.

The process of osmosis through semi permeable membranes was first observed in 1748 by Jean-Antoine Nollet. For the following 200 years, osmosis was only a phenomenon observed in the laboratory. In 1949, the University of California at Los Angeles (UCLA) first investigated desalination of seawater using semi permeable membranes. Researchers from both UCLA and the University of Florida successfully produced fresh water from seawater in the mid-1950s, but the flux was too low to be commercially viable until the discovery by Loeb and Sourirajan of techniques for making asymmetric membranes characterized by an effectively thin "skin" layer supported atop a highly porous and much thicker substrate region of the membrane. By the end of 2001, about 15,200 desalination plants were in operation or in the planning stages worldwide.

Visual inspection cannot determine if water is of appropriate quality. Simple procedures such as boiling or the use of a household activated carbon filter are not sufficient for treating all possible contaminants that may be present in water from an unknown source. Even natural spring water – considered safe for all practical purposes in the 19th century – must now be tested before determining what kind of treatment, if any, is needed. Chemical and microbiological analysis, while expensive, are the only way to obtain the information necessary for deciding on the appropriate method of purification. Distillation removes all minerals from water, and the membrane methods of reverse osmosis and nano-filtration remove most to all minerals. This results in demineralised water which is not considered ideal drinking water. The World Health Organization has investigated the health effects of demineralised water since 1980. Experiments in humans found that demineralised water increased dieresis and the elimination of electrolytes, with decreased blood serum potassium concentration. Magnesium, calcium, and other minerals in water can help to protect against nutritional deficiency. Demineralised water may also increase the risk from toxic metals because it more readily leaches materials from piping like lead and cadmium, which is prevented by dissolved minerals such as calcium and magnesium. Low-mineral water has been implicated in specific cases of lead poisoning in infants, when lead from pipes leached at especially high rates into the water. Recommendations for magnesium have been put at a minimum of 10 mg/L with 20–30 mg/L optimum; for calcium a 20 mg/L minimum and a 40–80 mg/L optimum, and a total water hardness (adding magnesium and calcium) of 2 to 4 mmol/L. At water hardness above 5 mmol/L, higher incidence of gallstones, kidney stones, urinary stones, arthrosis, and arthropathies have been observed. Additionally, desalination processes can increase the risk of bacterial contamination.

Manufacturers of home water distillers claim the opposite—that minerals in water are the cause of many diseases, and that most beneficial minerals come from food, not water.

Today fresh water demand is increasing continuously, because of the industrial development, intensified agriculture, improvement of standard of life and increase of the world population. Only about 3% of the world water is pure and this amount is not evenly distributed on the earth. The supply of pure drinking water is a growing problem for most parts of the world. More than 80 countries which between then have 40% of the world's population are being suffered from this problem. In order to solve this problem we have designed and developed a device for distillation of water (Figure 1). There are many types of water distillation equipment or devices are widely used due to their conveniences, but this is a new and efficient device for purification of water which takes power from paddling. It doesn't depend upon the electricity because it is operated by human power. With the use of this device we can purify much water for industrial and domestic purpose as well as for rural areas, where electricity and the source of pure water are not available. Development of water distillation device enables the improving availability of pure water. In this device we used manually energized flywheel motor for water distillation. For distillation of water, it is evaporated and passing through the condenser we get the pure water. This pure water is collected in a container.

Every living being on this planet need water to survive be it humans, plants, animals etc. When it comes to the human body almost 60% contains water. The use of water is vast in our day to day life be it for manufacturing purpose, agricultural purpose, construction purpose, our for personal purpose. According to a study by the United Nations in the last century the demand for the use of water has increased to twice the rate of the world population. Around the year 2025 it is estimated that almost 1.8 billion will face water scarcity in their area. This shows that humans have proved to be the most inefficient users of water which in turn causes a huge destruction the life cycle effecting all the chains of life. Therefore it is necessary to manage, utilize effectively and recycle water which can be preserved for the future generation.

There are many tragedies worldwide that has led to water pollution such as,

"The pacific garbage patch" which is a semi- permanent floating island consisting of trash containing plastics, fishing nets which can cause a threat to marine species by choking them, also various items smaller dissolve which in turn pollute and interrupt the marine food chain. this garbage patch deposits all the waste on island beaches. The pacific garbage patch is circulated by the currents of North Pacific Gyre and is twice the size of Texas.

And the next one is "The Sukinda Valley" situated in Orissa, India in this case it contains 97% Of India's deposits of chromite ore which is used to make stainless steel and chrome plating, the residue from these process which contains toxic chromium hexavalent on the surface which contaminates the drinking water, the soil and the air we breathe. It is been understood that due to the carelessness and inefficiency of implementing proper disposal technique the residents of this state suffer from tuberculosis, asthma Infertility. It has also been reported by the Orissa Voluntary Health Association that 85% of deaths have occurred from mining areas and villages nearby the affected area due chromite - mine- related diseases.

Last but not the least "Chaohu Lake" which is situated in China. The power plants and factories use the lake water as coolant, and then releases the unnatural warm water without treating it back into the environment, which in turn increases the temperature or cause a thermal shock which kills the fishes and other animals as the sudden change in the water temperature doesn't give time for the fishes to adapt to the temperature change this also increases the growth of plants thereby reducing oxygen supply in water which results in dead lakes.

Therefore, it has become the responsibility of each individual across the globe to reduce, reuse and recycle water effectively and efficiently.

Water purification:

It is necessary to purify water as the raw water contains various contaminants which consumed by any living organism can be harmful. So Basically the term water purification means the removal of any contaminants present in raw water or used water which can be later used for drinking purpose, industrial purpose, domestic purpose etc.

There are various substances which can be removed through water purification such as Cryptosporidium which is a parasite, algae, bacteria, minerals which include toxic metals like copper, lead etc. and also any chemical pollutants disposed from industries. The process of water purification has become very necessary as even the natural spring water which was considered which was considered to be fresh water which could be used for all purposes in the early 1800, must now be tested before consuming the water for any purpose. It is understood that healthy water can have an optimum pH of 7.2 to 7.6.

The advantage of water purification is that water is separated from unwanted substances, which is safe for doing household chores like cooking, cleaning and can be consumed. Water purification doesn't also require a lot of energy and is a less complicated process. But there are also some disadvantages to water purification as some impurities like pesticides cannot be entirely removed and also it requires high maintenance in order to perform its functions well. Various process were developed in connection with water purification such as osmosis.

Osmosis:

Osmosis is a process through semi-permeable membranes which is related to water purification. Jean-Antoine Nollet was the first one to introduce and observe this process in the year 1748. Later in 1949 at the University of California Los Angeles the first investigation regarding desalination of seawater using semi-permeable membranes were done. The fresh water was successfully produced from seawater which was carried out by

researchers of the University of Florida and University of California Los Angeles in mid-1950's. Loeb and Sourirajan technique were discovered for making anisotropic cellulose acetate membranes which are characterized to have good solute rejection and high solvent permeability but they also have certain disadvantages as they prone to attack by strong alkalis and acids , can irrecoverably be fouled by protein solutions, limited applicability in ultra-filtration processes due to their poor resistance to sanitizing fluids and temperature. At the end of year 2001, around 15200 desalination plants were in planning stage through the world.

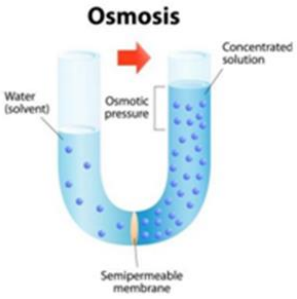

Fig. 1. Osmosis

Reverse osmosis:

This is a water purification process which uses a partial permeable membrane to remove large particles, ions, from water used for drinking purpose. It is considered as one of the most important water purification technologies

It can also remove different types of suspended chemical species also biological ones from water. In order to overcome osmotic pressure an applied pressure is used. In reverse osmosis, the membranes have a dense layer in the polymer matrix which is either interfacially polymerized layer within a thin-film-composite membrane or the skin of an asymmetric membrane.

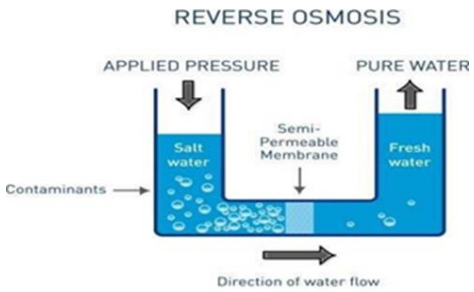

Fig. 2. Reverse Osmosis

The applications of Reverse Osmosis are as follows:

1. Used to partially clean-up tap water- As Reverse osmosis is capable of eliminating 99 percent of most pollutants.
2. Used in chemical industries- As these industries require different qualities of water depending on nature involved of chemical production process and thus reverse osmosis is used as pretreatment when higher qualities are necessary.
3. Used for making water fit for drinking: Reverse osmosis requires relative low energy and is used in desalting sea or brackish water of small and large scale which can be used for drinking purpose.
4. Used in Electronic Industries: These industries require highest quality water. Reverse osmosis extends ion exchange beds life and cost of producing highest quality water is reduced.

The Benefit of the Reverse Osmosis are as follows:

1. The ability to provide strong degustation of finished water.
2. Doesn't add any other chemicals to the water.
3. Used in purifying water in order to prevent diseases.

How does the reverse osmosis work?

A high-pressure pump is used to increase pressure on salt side of the reverse osmosis which forces water across the reverse osmosis semi-permeable membrane, leaving around 95 to 99 % dissolved salts in the reject stream.

Throughout the years various methods, equipment's have been developed have been developed to purify water. A new and effective device has been developed for the purification of water, this device takes its power from paddling. The main advantage of this device is that it doesn't consume electricity as it is operated by man power. In this device manually energized flywheel motor is used for water distillation. For the purpose of the distillation of water, the water is evaporated and passed through the condenser in return we get pure water which is collected in a container. The uses which can be achieved through this device is that water can be purified which in turn can be utilized for industrial purposes, for areas which face water scarcity and lack of electricity mainly focusing on rural areas and also it can be used for domestic and agricultural purposes like cooking, rearing of cattle etc.

A. Advantages

- Less maintenance is enough.
- The water pumped is of higher pressure.
- Quite running and smooth operation is achieved.
- Full efficient positive displacement pump.
- Effective working principle.
- It does not have any prime mover, like electric motor related to the unit.
- As the air is freely available, we can utilize the air to pump the water and hence it is economical.

B. Limitations

- Leakage of air in pneumatic cylinder will affect the working of unit.

C. Applications

- Domestic Application

2. Literature Review

The following journals were reviewed for the following

project work.

[1] Jean-Antoine Nollet; He was the first one to observe osmosis through semi permeable membranes in 1748, from which various threads of research and articles emerged.

[2] Liao et al; His article is based on the applications of membrane technology in forest bio refinery (IFBR). The advancements made in accordance with the Integrated forest bio finery can recover other beneficial by-products. The main aim is to sustain and conserve resources by reducing hazardous gas emissions or pollutants which are disposed. Tall oil, inorganic and inorganic compound, bio butanol and bio ethanol are some of the recoveries made in this technology. This technology processes the bio mass into bio energy such as bio fuels, heat etc. some of the intermediaries in this process are biogas which result from anaerobic digestion and hydrogen from water electrolysis and fermentation.

[3] Kurihara and Sasaki's; Since there is scarcity of water and also the quality of water is degrading which makes it unhygienic and unfit for use, has lead to a growing concern worldwide. From this review we can understand that there is a need to support the growth of Reverse Osmosis plants as these plants will secure the water supply Therefore the "Mega-ton Water System" venture was completed which converts 65% of sea water into drinking water and also has been able to reduce energy consumption overall. This system is of low cost. Reverse Osmosis enable electron microscopy and various other functions for the innovation of new RO membrane by studying and evaluating the physicochemical properties of the membranes.

[4] Khulbe and Matsuura; It is reviewed that there are bigger particles, molecules which contaminate the water and make it unfit for drinking purpose so, there is a recent progress been made in Reverse Osmosis which is basically a technology which purifies the contaminated water containing bigger particles molecules etc., the principle membrane made for this purpose is from cellulose acetate. The polyamide thin film composite membrane is preferred for this purpose at the moment due its properties such as stability which can withstand in harsh chemical environment, wide pH ranges. In order to enhance the performance nano composite membranes are developed in which nano-sized fillers are added like grapheme, silica, multi -walled carbon nano-tubes (MWCNTs) etc. The drawback of this is that, it is difficult to characterize and distinguish the membrane from its properties and performance but nowadays, due to the advancement of techniques it has made it possible to evaluate each membrane and distinguish based on their property and performance.

[5] Shirazi et al; An article that focuses on the two areas that are desalination and wastewater treatment which can be achieved through electro-spun nano-fibrous membranes which is the best option in the water industry according to the emphasis given in this article also in which the electro-spun layers enhance the membrane which is based on desalination and wastewater treatment frameworks. These are preferred over regular polymeric membranes as they are less costly, they consume very less energy and the execution is not complicated. Pressure driven and osmotic membrane processes coalescing filtration and adsorptive utilization of nano fiber, osmotic membrane processes are done to achieve the desalination and wastewater treatment purpose.

[6] University of California, Berkley- Water consumption related deaths are one of the largest causes of death in the word in which a number of deaths are due to consuming non pathogen water pollutants. There is a decrease in the availability of drinking water due to this growing concern worldwide many charitable organizations have contributed to this cause in which various methodologies were developed to convert the contaminated and brackish water to clean portable water.

This is an article which gives importance to the "The Reverse Osmosis Process". This Reverse Osmosis Systems remove smaller dissolved particles and heavy like sodium, nitrates, phosphate, fluoride, cysts, total dissolved solids (TDS), petrochemical and agrochemical and pharmaceutical contaminants in just a one- step procedure. Reverse Osmosis Systems also remove salinity and various microbial and biological contaminants. This has been used in hospitals and food and pharmaceutical industries. Reverse Osmosis Systems removes biological contaminants. But even though the Reverse Osmosis Systems overcomes these issues the major drawback is that the start-up cost is high, there is major dependency on the electricity and there is always a need to replace the filters which are the obstacles to this technology.

Reverse Osmosis Systems are very useful in areas where there is no centrally purified pipe-borne water supply or areas which are left with water contaminated after flood and natural calamities as it can filter contaminated water, removing minerals, chemicals, toxins, and dissolved and un dissolved substances The Reverse Osmosis Systems aims at contributing in providing safe and useable water to the communities.

A. Literature summary

In the above literature it was found that they primarily focus on converting salt water or unclean water into purified drinking water. The increase in salinity and waste which contaminate the water are from various sources and factors which make it unfit for drinking. However various scientific researches both theoretically and experimentally are carried out by experts and researchers such as the "Reverse Osmosis process''.

B. Problem statement

By referring previous literature it was found that the complete salinity and contamination of water cannot be removed it can be reduced but not completely removed. It will be effective only if outmost care is taken by industries hospitals in proper disposal of waste for this purpose proper disposal system needs to be implemented and the cost incurred is high for the installation of high end disposal system specially designed for hazardous chemical industrial waste and for water

treatment purpose however on the bright side if necessary steps are taken water can be preserved which is used for various purpose and mainly for the existence of mankind.

C. Objectives

- To design develop and establish approach towards conversion of salt water or contaminated water to purified drinking water.
- To understand how water can be utilized effectively and efficiently.
- To develop an effective working principle.

D. Scope of the project

- To spread awareness word wide about the need to preserve water.
- The machines are of less maintenance.
- As air is required for working of the machine and since it is freely available we can utilize air to pump the water and hence it is economical.
- Can be used in domestic and industrial applications.

3. Methodology

A. Methodology

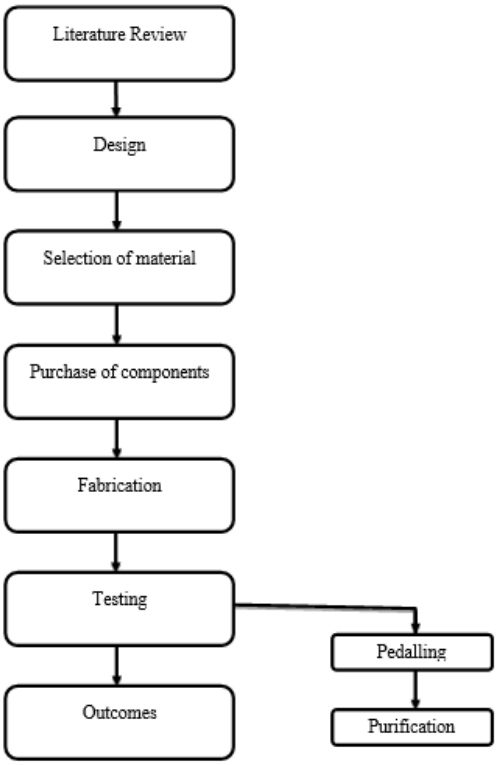

Fig. 1. Flow chart of methodology

In these section procedures of development of reversible osmosis water purification machine by pedal power is explained.

Literature review: A number of journals and technical paper have been referred to know the advancements made in the field of reversible osmosis water purification machine.

Design: A Suitable design was developed for reversible osmosis water purification machine. In this part many designs was developed and selected simplest and most suitable design.

Selection of material: We selected most suitable material with least cost. Most of the materials are of mild steel. Various parts consist of various materials are selected here.

Purchase of equipment: Materials such as steel bars, gears, RO filter and carbon filter, etc. are purchased for the fabrication.

Fabrication: Fabrication of the designed parts with suitable dimensions are done. Fabrication include various machining processes such as drilling, welding, etc.

Testing: After the fabrication the machine is tested for any errors and if there is any function is not proper then it will be corrected. The testing includes pedalling and other mechanical testing and also include finding error in the purification system. Testing include collection of water and pH determination.

Collection of water: The water used in this experiment was collected from the Arabian sea in kerala-Karnataka border and it is also tested in the pure water that mixed with salt.

Outcome: The outcome that we can expect he is the purified water. The salt water will be purified and the outcome must be pure drinking water.

B. pH determination

Water reaction is usually expressed as concentration of ions in the water which is hydrogen ion. The reaction is neutral when the pH is equal to 7 and if pH is greater than or less than 7 means the reaction change is in alkaline or acidic direction respectively. In neutral water the concentration of hydrogen ions depends on the dissociation and hydrolysis of combination that occur inside it. pH meter was used for determining the pH values of purified and un purified water.

4. Components and Description

A. Components

The major parts that are effectively employed in the design and the fabrication of this saltwater purification machine are described below,

- Pneumatic cylinder
- Non return valve
- Bearing cap
- Sprocket and chain
- Reverse osmosis filter
- Carbon filter

1) Pneumatic cylinder

Pneumatic cylinder is the mechanical device which uses compressed gas to produce force in a reciprocating linear motion, i.e. Pneumatic power is converted into mechanical power by reducing the pressure of air to that of atmosphere.

Fig. 2. Pneumatic cylinder

Single acting cylinder:

Single acting cylinder has capable working in medium operations and produce power only in one direction. It works with compressed air to actuate the piston in one direction and it requires a spring force to return the piston to its initial state. Only one port is used for both supply and vent compressed air. Since it has one port still can be do production in several fundamentally different designs. The single acting cylinder develop power in one direction only, therefore there should not be heavy control equipment attached to these cylinders.

Double acting cylinder:

Double acting cylinder has capable of working in heavy duty operations compared to single acting cylinder. This cylinder does not require a spring force to return the piston. It uses force of air for both extend and retract stroke. These double acting cylinders have two ports for the air flow, one is for out stroke and one is for in stroke. A double acting cylinder is employed in control system with the full pneumatic cushioning and it is essential when the cylinder itself is required to retard heavy messes. This can only be done at the end of piston stroke. The stroke length for this kind of design is not limited, but the piston and rod is very much vulnerable to buckling and bending.

2) Non return valve

A Non return valve fitted to make sure that flows through a pipe in the right direction, where pressure condition may cause a reverse flow, then non return valve will avoid the flow in opposite direction.

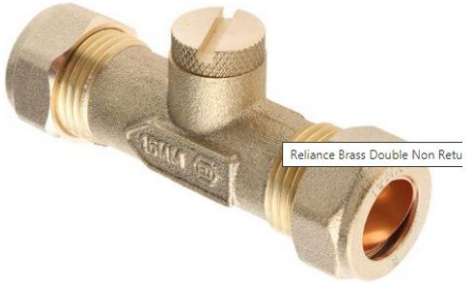

Fig. 3. Non Return Valve

3) Bearing cap

A bearing cap is a rigid and semicircular part that is fixed around the bearing for securing it.

4) Sprocket and chain

Sprocket is a toothed wheel mounted onto a shaft which used for the rotational motion. The chain sprocket is coupled with another shaft and this shaft allows the rotational movement. Here it is a cycle chain sprocket is used.

Chain is used to connect the two sprockets and convert the rotational power to pulling power or vice versa. The chain is connected between driver sprocket and driven sprocket. Chains that are used to transmit force and motion from one to another are known as power transmission chain.

The various groups of power transmission chains are:

- Standard general purpose roller chain.
- Lube free chains.
- High performance roller chain.
- Environmentally resistant chain with corrosion resistance.
- Special chains which are used as bicycle chain, automotive chains, miniature chains, leaf chain, inverted tooth chain, etc.

Fig. 4. Sprocket and Chain

5) Reverse osmosis filter

Fig. 5. Reverse Osmosis filter

Reverse osmosis is a water purification technology which uses a semi permeable membrane to remove the unwanted particle or large particle from the drinking water. This filter is also called as RO filter. In reversible osmosis filter a pressure is applied to overcome the osmotic pressure. The reverse osmosis can remove various types of particles such as molecules and ions which include bacteria. As a result, the solute retained at the pressurized side of the membrane and pure solvent will be passed through the other side. This membrane should not allow large molecules or ions but it should allow smaller particles such as solvent. In osmosis process the solvent travel from high water potential area to low water potential area. Applying an external pressure to reverse the natural flow of

pure solvent is called reverse osmosis. This reversible osmosis involves diffusive mechanism so that the particle separation efficiency for the drinking water will depend on the solute concentration, water flux rate and pressure. The reversible osmosis is commonly known for the purification of salt water especially sea water purification method.

6) Carbon filter

The carbon filtering is a method by which absorb the unwanted particle, so it works by absorption mechanism. The pollutant in the fluid are trapped inside the pore structure of carbon substrate. It uses a layer of activated carbon inside the filter. These layers are made of many carbon granules. Each granule of carbon provides a large surface area/pore structure, which allows maximum possible exposure to the active site within the filter media. The carbon filter is also used for various operations such as respirator mask, sugarcane purification, and recovery of some metals. Removal of chlorine, sediment, taste and ador from water are best with active charcoal.

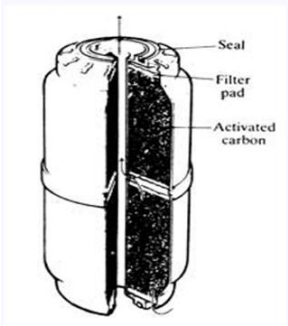

Fig. 6. Carbon filter

B. Product description

1) Double acting pneumatic cylinder

- Stroke length: Cylinder stoker length 160mm = 0.16m
- Piston rod: 18mm = 18×10^{-3} m
- Quantity:2
- Seal: Nitric Elastomer
- End cones: Cast iron
- Piston:EN – 8
- Media: Water
- Temperature: 0-80 ° C
- Pressure range: 8 N/ m²

2) Connector

- Max working pressure: 10×10^{5} N/m^2
- Temperature: 0-100 ˚ C
- Media: Water/Air
- Material: Brass

3) Hoses

- Max pressure: 10×10^{5} N/m^2
- Outer diameter: 6mm
- Inner diameter: 3.5mm

4) Mild steel

The term mild steel is also used to carbon steel in commercially which is not by standard specifications. The commercial mild steel has the property to readily weldable and it also has cold bending property. Now days mild steel is commonly used because of its not brittle nature and cheap price. Mild steel is not readily tempered still it have enough strength.

Mild steel composition:

- Mild Steel contain - C45
- Carbon 0.35 to 0.45%
- Manganese 0.60 to 0.90%
- Silicon maximum 0.40%
- Sulphur maximum 0.40%
- Tensile strength 63-71 kgf/mm^2
- Yield strength 36 kgf/mm^2
- Brinell hardness (HB) – 229

C. List of materials

Table 1
List of materials

S. No.	Parts	Material
1	Pneumatic Double Acting Cylinder	EN8
2	Sprocket	Mild Steel
3	Non-Return Valve	Brass
4	Bearing cap	Mild Steel
5	Carbon filter	-
6	Reverse osmosis filter	-
7	Connector	Brass
8	Flexible Hoses	Polyurethane
9	Hose Collar	Plastic
10	Gears	Cast Iron
11	Chain	Mild Steel
12	Bolt and Nuts	Mild Steel
13	Cam with Cam shaft	Mild Steel
14	Frame Stand	Mild Steel
15	Seat	Plastic

D. Design and calculation

While designing this Reversible osmosis salt water purification machine, some assumptions are considered which is standard for their parts such as gear fixing. We made safe design for this machine by calculating the dimensions of each parts and considering formulations. Material selection based on availability, durability, cost and ease of fabrication were also considered.

1) Double acting Pneumatic cylinder

- Stroke length: 0.16m
- Piston Rod: 18mm
- Temperature: 0-80 ° C
- Pressure Range: 8 N/m²

2) Connector

- Max working pressure: 10 x 10 ⁵ N/m²
- Temperature: 0-100 ºC
- Material: Brass

3) Hoses

- Max pressure: 10 x 10⁵ N/m²
- Outer diameter: 6 mm = 6 x 10 ⁻ ³m
- Inner diameter : 3.5 mm = 3.5 x 10 ⁻ ³m

4) Mild Steel Composition

- Mild Steel contains –C45
- Carbon 0.35 to 0.45 %
- Tensile strength 63-71 kgf/mm2
- Yield stress 36 kgf/mm2
- Brinell hardness (HB) – 229
- Frame work calculation
- Base bar – 3cm×1cm
- L angle bar – 15 inch
- Support bar 1 – 1cm×1cm
- Support bar 2 – 2cm×1cm
- Square pipe – 1×1 inches
- Two bearing – 0.03 inner diameter and 0.04 outer diameter
- Support for seat – 1×1 inch

5. Experimental Works

A. Construction procedure

1. For constructing base, cut a bar of 3 feet with 3cm×1cm in dimension. An L angle bar of 15-inch length is fixed as a support for the bottom base with 1cm×1cm in dimension.
2. Cut 2 pieces of 2cm×1cm square pipe which is to be attached to the bottom base to give the model the required strength and hold.
3. 3 square pipes of 1×1 inches dimension are cut of length of 1 meter. These 3 square pipes are welded to form a 3 bar mechanism with link 1, 2, 3.
4. A bearing is constructed of 0.03m internal diameter and 0.04m external dia. This bearing is welded as one of the nodes of 3 bar mechanism.
5. Another bearing is constructed of same dimension which is welded on one of the pipes of 2cm×1cm square pipe.
6. Sprocket and chain are attached between the two bearings. A pedal is also given to operate. This chain converts rotational power to pulling power along with the sprocket.
7. A seat is provided at the extreme end using a 1×1 inches support from all the way from bottom base.
8. A carbon filter is attached in the frame which uses activated carbon to purify fresh water from impurities using chemical absorption. It works under phenomenon called adsorption. Particle sizes that can be removed using this process vary from 0.5-50 micro meters. The water is injected into the filter at decent rate of time.
9. Reverse osmosis filter will be welded on the frame. RO membrane filter uses the technology that semi permeable membrane removes larger particles from water transferred. A specific amount of pressure is needed to be applied. It is used to purify many minerals, ions, toxicity from the solution along with bacteria also. It works exact opposite of osmotic process that is salt moves from low concentration to higher concentration end.
10. A pneumatic cylinder will be attached which is used to pump the water to the carbon filter and RO membrane. Single acting cylinder is used here to pump the water.
11. Non return valves will be used in the inlet and outlet of pneumatic cylinder. So that it will restricts the multi directional flow that is it allows only one directional flow of water.
12. Two gears, one driver and other driven will be placed in bottom which helps in the reciprocating motion of the pneumatic cylinder. The rotating motion is converted to reciprocating motion using these gears.
13. A tube will be attached from pneumatic cylinder to carbon filter then to the RO membrane through which fresh water is received.

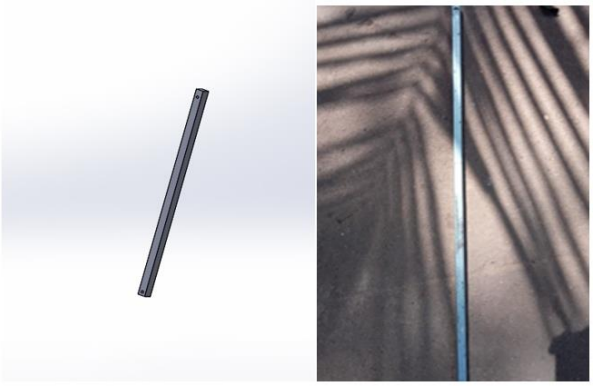

Fig. 7. Mild Steel bar

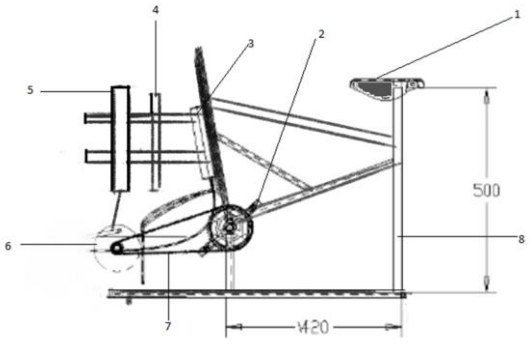

Fig. 8. 2D drawing

1. Seat
2. Pedal
3. Carbon filter
4. RO filter
5. Pneumatic cylinder
6. Gears and cam plate
7. Chain
8. Frame

B. Working procedure

The mechanism is done by using pedal power. While pedalling the rotational motion producing using sprocket and chain is converted to reciprocating motion using the gears given. The space between gears and pneumatic cylinder is occupied by the connecting rod. When the work starts reciprocating it sucks the water from the tank through a non-return valve and during delivery stroke it injects the water to carbon filter through another non return valve. High pressure is required to produce in the low concentration side of RO membrane to purify the water. 30-250 psi of pressure required for fresh or brackish water and 600-1000 psi of pressure required for sea water. Carbon filter filters most of the impurities present in the water and pass that water to RO membrane through a tube where the ions, bacteria etc. were separated and fresh water is supplied to the tank.RO membrane contain three chemical layers which are responsible for the purification of water. The layers consist of polymer base, poly amide and poly sulphide respectively. Carbon filter uses similar mechanism that is using activated carbon. These carbon beds have larger sized granules which prevent the impurities while its movement. The cycle is repeated until we obtain quality assured fresh water. This water is used in many industrial applications, aquatic marine systems since direct sea water may contain highly toxic chemicals.

Municipalities and other industries use RO membrane for supply of drinking water and use for microelectronic, food, beverage, pharmaceuticals etc. It can also be used for removing bacteria's and organic impurities. RO membrane is commonly used in aquatic system as domestic water may contain impurities which are not suitable for fresh water animals and toxins for most of salt water fish. So RO membrane removes these toxins and feed out the required

Pharmaceutical industries who requires highly purified water indeed water is the main ingredient for pharmaceutical drugs. RO purifies water and removed bacteria, organic solids dissolved in water. Agriculture is another field where RO is used. Fortunately, agriculture water does not require to be highly purified. Therefore, amount of water to be cycled is less. As part of natural filtration crops itself purifies water

The frame and body is made of mild steel for better yield and resistance to external force. It is of composition of carbon, manganese, silicone, sulphate and C45 mild steel. It can with stand yield stress of 36 kg f/mm^2 and tensile stress of 63.71kg f/mm^2. When the work starts reciprocating it sucks the water from the tank through a non-return valve and during delivery stroke it injects the water to carbon filter through another non return valve. Pneumatic cylinder used here consist of double acting cylinder of stroke length 0.16m. The cones are made of cast iron, it can bear a temperature of 0-80 degree Celsius and pressure range of 8N/m^2.High pressure is required to produce in the low concentration side of RO membrane to purify the water. 30-250 psi of pressure required for fresh or brackish water and 600-1000 psi of pressure required for sea water. Carbon filter filters most of the impurities present in the water and pass that water to RO membrane through a tube where the ions, bacteria etc. were separated and fresh water is supplied to the tank.RO membrane contain three chemical layers which are responsible for the purification of water. The layers consist of polymer base, poly amide and poly sulphide respectively. These three barriers act as polymer matrix where purification occurs. Solutes will be trapped in the membrane while water goes out (such as salt ions). RO membrane is used to remove dissolved impurities from feed water. Carbon filter uses similar mechanism that is using activated carbon. These carbon bed have larger sized granules which prevent the impurities. The non-return valves are fitted on both sides of cylinder to ensure the direction is in desired path. It prevents reverse flow of water. Horses are connected between RO membrane, carbon filter and water tank for the passage of water from one place to another. Hose of maximum pressure 10×10^8 N/m^2 is used here. The cycle is repeated until we obtain quality assured fresh water. This water is used in many industrial applications, aquatic marine systems since direct sea water may contain highly toxic chemicals.

C. Works done

The works has done include various operations for the construction and working of the machine. These processes are listed below.

1) Welding

Welding is the process of joining two materials by the application of thermal energy or heat. Welding is the least expensive operation and it is the process used now days for fabrication. There are various types of welding available now days and it uses electrical energy or gas torch. Different welding processes are used in automobile bodies, general machine repair, structural works, etc. There are about 35 different welding and brazing process and there are several soldering methods used in industries today. Various types of welding are classified as follows:

1. Gas Welding
- Air Acetylene
- Oxy Acetylene
- Oxy Hydrogen Welding

2. Arc Welding
- Carbon Arc welding
- Plasma Arc welding
- Shield Metal Arc Welding
- T.I.G. (Tungsten Inert Gas Welding)

3. Resistance Welding
- Spot welding
- Seam welding
- Projection welding
- Resistance Butt welding

4. Solid State Welding
- Cold welding
- Diffusion welding

- Forge welding
- Fabrication welding
- Hot pressure welding
- Roll welding

5. Thermo Chemical Welding

- Thermite welding
- Atomic welding

6. Radiant Energy Welding

- Electric Beam Welding
- Laser Beam Welding

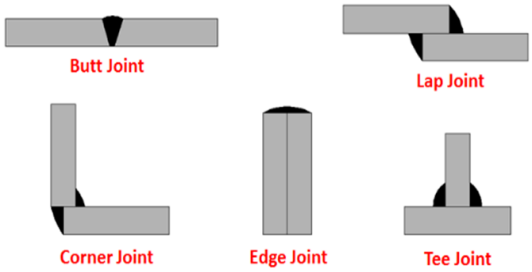

Fig. 9. Types of weld joint

2) Metal cutting operations

1. Blanking:

Blanking is the operation of cutting a flat surface or flat shape from sheet metal. The product punched is called blank and the required product of the operation the hole and the metal remaining behind is discarded as waste.

2. Punching:

Punching is similar to blanking except the punching; the hole is the desired product in punching. The material punched out from the hole is taken as waste.

3. Notching:

It is cutting operation by which metal pieces are cut from the edges of the sheet.

4. Trimming:

This operation consists of cutting excess of material which is unwanted from the periphery of a previously formed component.

3) Forming process

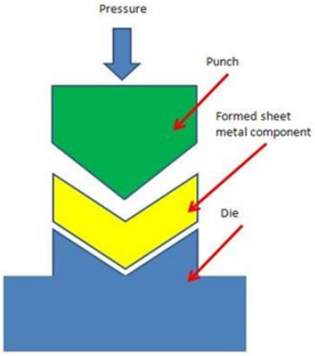

Fig. 10. Forming process

These are solid state manufacturing process that involve minimum amount of material wastage. In forming process material is heated to a certain temperature. A large force is applied to this heated material to form desired shape. The desired shape is controlled by means of a set of tools which may be not used during manufacturing.

This kind if processes are generally used for large scale production. And these forming technique are economical and in many cases improve mechanical properties. These are some metal forming process listed below:

- Rolling forming
- Drop forming

4) Material removal processes

Material removal process is also called as secondary removal process which removes unwanted material in the form of chips from the material by hard tools to obtain final desired shape. Material removal is generally most expensive manufacturing process due to high consumption of power and lot of waste material is generated in this process. Still this process is widely used because it delivers good accuracy in dimensions and will give a good surface finish. Material removal processes are also called as machining process. Different types of material removal process in this category are listed below.

1. Turning
2. Drilling
3. Shaping
4. Planning
5. Milling
6. Grinding
7. Broaching
8. Sawing
9. Trimming

1. Turning

Turning is a form of machining process which used for material removal. In this process it is used to create rotational parts by cutting unwanted material.

2. Drilling

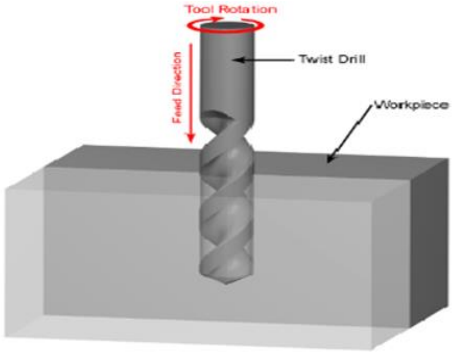

Fig. 11. Drilling process

Drilling is a cutting operation that uses a drill bit to make hole in solid materials. The drilling operation produce hole in circular cross section in work piece. The drill bit will rotate and hence it is called as rotator cutting tool. It may often have multipoint. The drill bit is pressed against the work piece and rotated in a required rpm. This will force the cutting edge against the work piece and the unwanted portion will be

removed in the form of chips. Various types of drilling process are given below:

1. Centre drilling
2. Deep hole drilling
3. Gun drilling
4. Trepanning
5. Vibration drilling
6. Micro drilling

3. Shaping

Shaping is the process by which removing excess material in the work piece and produce desired shape. In this technique work piece is stationary and the cutting tool takes mass and form desired shape.

4. Milling

Milling is the process of machining using rotary cutters to remove unwanted material from the work piece by advising a cutter into work piece. This may done varying direction on one or more axes, head speed and pressure.

5. Grinding

Grinding is an abrasive machining process that uses a grinding wheel as the cutting tool. A grinding machine is used to remove unwanted material by rotating the grind wheel. It is used to give shape and finish for the work piece.

6. Result and Discussions

We are proud that we have completed the work with the limited time. The "Salt water converted to purified drinking water by using pedal power" will work with satisfactory conditions. We are able to understand the difficulties in maintaining the tolerances and also quality. All the parts are connected in such a way that the equipment can be maintained and assembled easily. In this present work, the amount of salt water input will be purified and come out through one output valve and the impure water will come out through another valve.

The result obtained showed that the salt water conversion by reversible osmosis using pedal power design will provide drinking water for an individual for a day.

The graph shows that the pH values of saline water before and after filtration. The first box indicates the pH value of saline water and the next box indicate the pH value of purified drinking water. Three tests are conducted with different concentration of salt water and the purified water pH will be getting value of 7 and 7.1 which is drinking water. To remove impurities, the water is again treated with carbon filter.

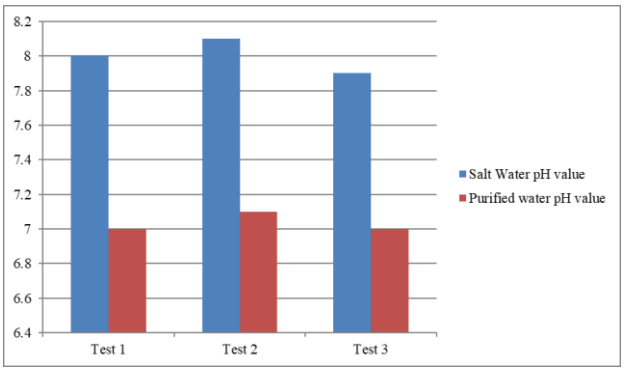

Fig. 12. pH variations

7. Conclusion and Scope for Future Work

A. *Conclusion*

We have done to our ability and skill making maximum use of available facilities. In conclusion remarks of our project work. Thus we have developed "Salt water converted to purified drinking water by using pedal power". By using more techniques, they can be modified and developed according to the applications.

This project work has provided us an excellent opportunity and experience, to use our limited knowledge. We gained a lot of practical knowledge regarding, planning, purchasing, assembling and machining while doing this project work.

B. *Scope for future work*

The further improvement can be made by incorporating the following suggestions to obtain better results.

- A motor can be fixed instead of pedal system.
- Speed regulators can be fixed for controlling rotation speed.

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