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Reverse Osmosis Water Purification by Cycling Action

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Abstract: *Pure water is very much essential to survive, but now a days the water is getting contaminated due to Industrialisation which leads to many water-releated diseases. Reverse Osmosis(RO) Water Purification by Cycling Action meets the needs of people without requiring any electrical energy. RO is a physical process that uses the osmosis phenomenon, that is, the osmotic pressure difference between the salt water and the pure water to remove the salts from water. Water will pass through the membrane, when the applied pressure is higher than the osmotic pressure, while salt is retained. As a result, a low salt concentration permeate stream is obtained and a concentrated brine remains at the feed side. A typical RO system consists of four major sub-system : pre-treatment system, high-pressure pump, membrane module and post treatment system. In operation by pedaling the cycle, man power is converted into mechanical energy which is further converted into hydraulic energy in RO pump.*

Keywords: *Cycling Action, Membrane, Osmotic Pressure, Reverse Osmosis*

1. Introduction

Pure water is very much essential to survive but nowadays the water is getting contaminated due to industrialization which leads to many water related diseases.In many developing countries, people walk many miles to reach a source of water that is not necessarily potable.Water can contain dirt, minerals, chemicals and other impurities that make it smell and taste bad. Some of these contaminants can endanger health, especially when they include microscopic organisms and bacteria that can cause serious illness. Filtering water can help purify water, removing these impurities and making it safe to drink, while often improving its taste.A study conducted by various sources compared different modern methods of water purification- distillation, ultra-violet light, reverse osmosis, solid block activated carbon, granular activated carbon, water softeners, sediment filters, boiling, bottled water, ozonation, chlorination, ion exchange etc. Among all the above methods mentioned Reverse Osmosis is best suited for issues which were originally designed for mainly two things, they are: desalination of brackish water or sea water and reducing very specific chemical contaminants. Reverse Osmosis is needed to remove Fluoride, sodium, total dissolved salts, or chemicals like arsenic, radium and nitrates. In response to such a need, Reverse Osmosis Water Purification by Cycling Action is proposed to produce clean drinking water which uses human power to get pure form of water for drinking.The term water purification refers to a process, which selectively extracts pure water from an impure solution, leaving all kinds of impurities behind, regardless of their source or their nature. This is quite different than water treatment described above. There are only three scientifically recognized methods of water purification. These are: Distillation, freeze-thawing, and reverse osmosis (RO). Of these, reverse osmosis offers the most practical and economical approach to water purification. The equipment is compact, easy to operate, and it is highly energy-efficient, in comparison with distillation and freeze-thawing equipment. RO is an effective method of reducing the concentration of total dissolved solids and many impurities found in water.

2. LiteratureSurvey

Dustin [1], proposed a paper,which discovered whether human powered reverse osmosis is a viable option for producing potable water for developing countries. A device was designed to test the practicality of this idea through a numerical analysis. The device uses a bicycle to harness human motion to convert it into usable power to run a reverse osmosis filtration system. The flow rate was determined according to given information from the reverse osmosis manufacturer. It indicated that a human could easily provide enough power to run a reverse osmosis system such as this. The flow rate was then used to determine how useful this power was by considering how fast it could produce clean drinking water and how much water a person needs to drink daily. Ultimately from all of the research and results, it was determined that human powered reverse osmosis is not only a viable option, but an incredibly economical and effective means for providing potable water for developing countries.

Anusha and Yash [2], have discussed this paper which analyzes the design of a pedal operated water filtration system to be used by local dwellers. It works on the principle of compression and suddenrelease of a tube by creating negative pressure in the tube and this vacuum created draws water from the sump into the pump while rollers push the water through to the filter where adsorption takes place to purify the water. The design comprises of a peristaltic pump powered by pedaling, a filter and hose or flexible tube. As the operator sits on the seat and pedals, the pedal crank transfers the motion to the rotor thus the rollers and the tube is squeezed by the set of rollers to move the fluid. This design will reduce the labor, cost and weariness caused by transporting and sanitizing drinkable water for use.

Anand and Ramprasad [3],had presented a seminar report, which involved reviewing the literature regarding a variety of portable water purification techniques like boiling, solar water disinfection, sedimentation and ceramic filters coagulation, adsorption (activated carbon), chlorination, UV irradiation, ultra filtration, reverse osmosis and other combined methods that have been predominantly used at the household level. The information on performance of these purifiers with respect to parameters like cost, availability, ease of use, dependence on utilities, and microbial efficacy was also mostly obtainable in the literature. The outlook of this report was to study, describe and contrast different portable water purifiers. The drinking water quality standards were described and the issues related to the water quality in India were discussed. Subsequently, a suitable classification mechanism and a comprehensive description of a wide spectrum of purifiers were covered. A review based on multiple attributes was carried out to ascertain the appropriate choice for specific situations.

Jayant et al. [4],have presented their paper about fabrication of PPWP. And experimentally investigates the working of Pedal Powered Water Pump (PPWP) along with its purification which has been used for pure drinking water supply and garden irrigation. PPWP will consist of a centrifugal pump operated by pedal power. The centrifugal pump is positioned on its stand in such a way that driven shaft of the centrifugal pump was butted to the bicycle wheel. By pedaling the bicycle, the bicycle wheel rotates, thereby rotating the centrifugal pump which in turns discharges water from the sump. PPWP provides drinking water and irrigation in remote areas where electricity is not available. PPWP is not only free from pollution but also provide healthy exercise. PPWP reduces the rising energy costs. PPWP will design as a portable one which can be used for irrigation in various places. The experimental investigation was executed and performance of the PPWP had carried out at different rpm. The PPWP requires only manual power thereby reducing the utility bill considerably.

Garud and Kulkarni [5], discussed and presented a paper in which Reverse Osmosis (RO) is a membrane based process technology to purify water by separating the dissolved solids from feed stream resulting in permeate and reject stream for a wide range of applications in domestic as well as industrial applications. It is seen from literature review that RO technology is used to remove dissolved solids, color, organic contaminants, and nitrate from feed stream. Hence RO technology used in the treatment of water and hazardous waste, separation processes in the food, beverage and paper industry, as well as recovery of organic and inorganic materials from chemical processes as an alternative method . This paper intends to provide an overall vision of RO technology as an alternative method for treating waste water in different Industrial applications. The present short review shows applicability of RO system for treating effluents from beverage industry, distillery spent wash, ground water treatment, recovery of phenol compounds, and reclamation of wastewater and sea water reverse osmosis (SWRO) treatment indicating efficiency and applicability of RO technology.

3. Working Principle

The entire process of the design begins by adding salt water into the tank. All the heavy sediment is immediately removed as the water passes through several layered mesh micro filters. The initial filtering step is crucial because the RO filter would quickly clog if it had to filter heavier sediments.To set the purification system in motion we need to begin peddling the pedal. Since the pump mechanism is geared to minimize the effort needed to operate it, the user feels little to no difference in having to power the pump system compared to pedal a bicycle.The water then enters the four stages of the filters in RO system. Fig.1 Working Model.

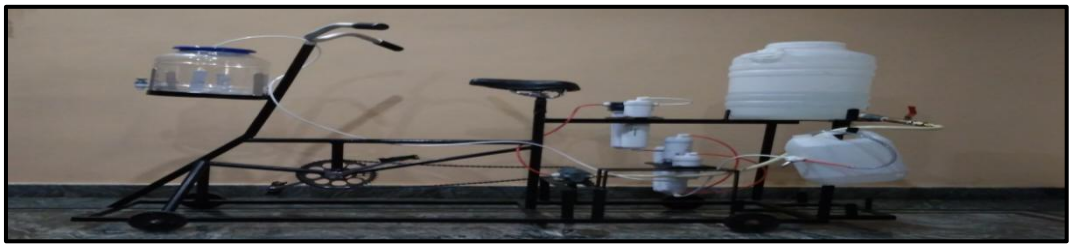

Fig. 1 working model

The first stageremoves any very heavy sediment down to fine microns still left in the water that the first set of filters did not catch.
The second stage removes any unwanted color, taste and odor. These two stages prepare the water for the most crucial step Reverse Osmosis. Without these previous two filters, the RO membrane could easily be destroyed by certain chemicals that may be in the dirty water. The more filtered the water in before passing through the RO membrane, the longer the membrane will last.
The third stageis the heart of the system as it removes all particles down to 0.0001 micron in size.
The fourth and final stage is a repeat of the second stage, purely to optimize water quality. From here, the water exits the system as potable water and rinse water. The purest water is used for drinking and the rinse water can be used in many ways other than drinking such as irrigation, cleaning etc. so that water can never get wasted.

3.1 Main Components

The main components used to fabricate the model are:

- Filters
- Chain Drive with Sprocket
- Rotary Gear Pump

3.1.1 Filters

A filter removes impurities from water by means of a fine physical barrier, a chemical process or a biological process. Filters cleanse water to different extents for purposes such as providing agricultural irrigation, accessible drinking water, public and private aquaria, and the safe use of ponds and swimming pools. Filters use sieving, adsorption, ion exchanges, biological metabolite transfer, and other processes to remove unwanted substances from a quantity of water. And unlike a sieve or screen, a filter can potentially remove particles much smaller than the holes through which its water passes.

To effectively reduce the hardness/TDS from water supplied in locality, the technology that would suit best is RO. Reverse Osmosis is the reversal of the natural flow of Osmosis. In water Purification system, Reverse Osmosis is used to separate the salts and other heavy metals from water. The RO technology uses Reverse Osmosis for water purification, where in the water is passed at a high pressure through a thin film composite membrane which reduces the dissolved salts and removes chemical and biological impurities and also reduces the high levels of TDS to the permissible drinking water limits. It makes water free from physical, chemical and disease-causing microbial contaminants, while it also improves the taste of water making it sweet. Fig.2 shows 4 stage filters.
RO, 4 Stage = Sediment + Pre-Carbon + RO Membrane + Post-Carbon

Fig. 2 4 stage filters

3.1.2 Chain Drive with Sprocket

Chain drive is a way of transmitting mechanical power from one place to another. It is oftenused to convey power to the wheels of a vehicle, particularly bicycles and motorcycles. It is also used in a wide variety of machines besides vehicles. Most often, the power is conveyed by a roller chain, known as the drive chain or transmission chain, passing over a sprocket gear, with the teeth of the gear meshing with the holes in

the links of the chain. The gear is turned, and this pulls the chain putting mechanical force into the system as shown in Fig. 3 Chain Drive with Sprocket.

A sprocket is a profiled wheel with teeth that meshes with a chain, track or other perforated or indented material. It is distinguished from a gear in that sprockets are never meshed together directly, and differs from a pulley in that sprockets have teeth and pulleys are smooth.Sprockets are used in bicycles, motorcycles, cars, tracked vehicles, and other machinery to transmit rotary motion between two shafts where gears are unsuitable or to impart linear motion to a track, tape. Fig. 3 shows Chain drive with Sprocket.

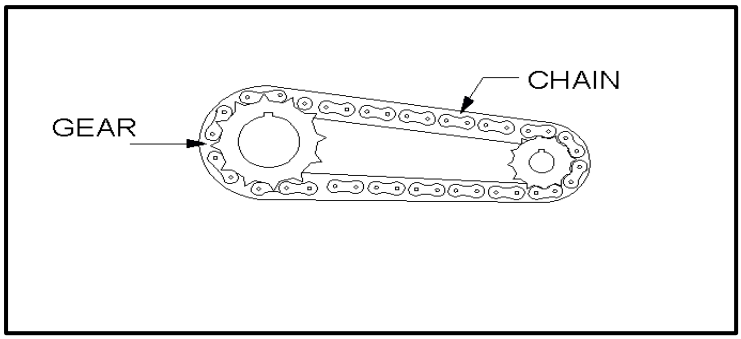

Fig. 3chain drive with sprocket

3.1.3 Rotary Gear pump

A gear pump uses the meshing of gears to pump fluid by displacement. They are one of the most common types of pumps for hydraulic fluid power applications.

External gear pumps are similar in pumping action to internal gear pumps in that two gears come into and out of mesh to produce flow. However, the external gear pump uses two identical gears rotating against each other one gear is driven by a motor and it in turn drives the other gear. Each gear is supported by a shaft with bearings on both sides of the gear as shown in Fig.4.

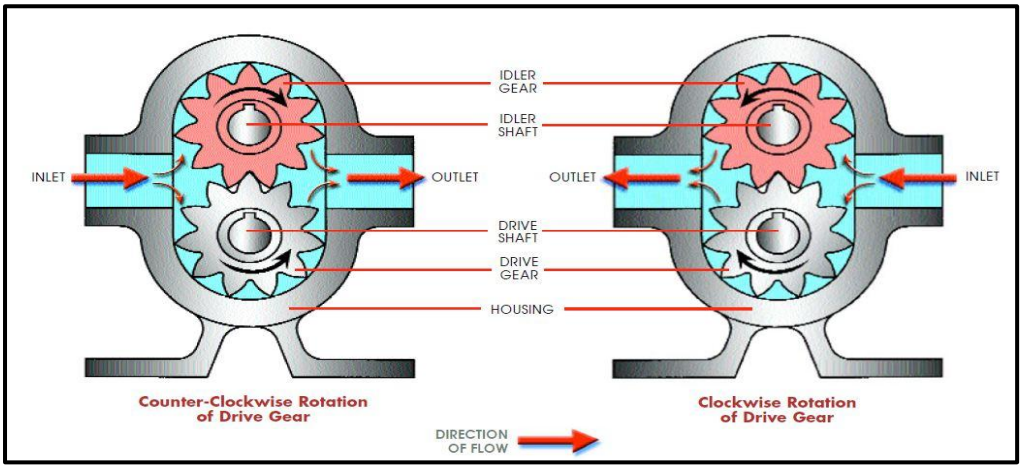

Fig. 4 working of pump

Specification of pump used:

Type	Rotary Gear Pump
Model	EG-050
Capacity	20lpm
Inlet and Outlet size	0.5x0.5 inch
Motor Required	0.5HP
Weight	2.3 kg

4. Results

The trials are carried out using Reverse Osmosis Water Purification by Cycling Action for three different samples of water. The below table shows the trials for different water samples:

Trial 1:-
Sample water: Tank water
Capacity: 1440 ml/hr

Table 1: Trial 1

Water Type	TDS value (ppm)	Quantity (liter)
Water to be filtered from tank	998	-
Water coming out of RO membrane	874	1.44
Water which is filtered through Post Carbon filter	119	4.56

Trial 2:-
Sample water: Bore well water
Capacity: 2220 ml/hr

Table 2: Trial 2

Water Type	TDS value (ppm)	Quantity (liter)
Water to be filtered from tank	875	-
Water coming out of RO membrane	716	2.22
Water which is filtered through Post Carbon filter	114	4.8

Trial 3:-
Sample water: Bore well water
Capacity: 2220 ml/hr

Table 3: Trial 3

Water Type	TDS value (ppm)	Quantity (liter)
Water to be filtered from tank	743	-
Water coming out of RO membrane	516	2.22
Water which is filtered through Post Carbon filter	48	5.4

5. Advantages And Disadvantages

The advantages, disadvantages, applications and future scope of this project are:

5.1 Advantages

The advantages are as follows:

- Its operation and maintenance is very simple
- It is compact and portable.
- It is simple in process.
- Power saved and good exercise for human beings.

5.2 Disadvantages

The disadvantages are as follows:

- Slow production rate.
- Requires lots of water to produce pure water.

6. Conclusion

The pedal operated water filtration system is a new system that is useful in developing countries like India to have daily access to safe drinking water all by harnessing the energy of pedal power.Reverse osmosis is a relatively new, but very effective application of an established scientific process. Whether it is used to meet the needs of a typical family of four, or the needs of an industrial operation requiring thousands of gallons per day, it can be a cost effective to provide the required quantity of highly treated water. With continual advances in system and membrane design that boost efficiency and reliability, RO can be expected to play a major role in water treatment for years to come.In Reverse Osmosis Water purification by Cycling Action

- Simple in design.
- Portable.
- Economical.
- Effective way for providing potable water.
- Less maintenance.

6.1 Future Scope

The future scope includes redesigning the structure of the model and the type of pump to get higher pressure. The RO filters can be made combinations with UV filters to get high quality of pure water. By increasing the speed of cycling action higher rate of water flow can be created. The model can be redesigned in to movable model from stationary model by using bicycle in which pump and filters can be attached using suitable mechanism, and it can be even used as a travelling device from one place to another place and hence pure water can be collected in separate container by the time the person reaches his destination.

References

[1] Drake, Human Powered Reverse Osmosis for Producing Potable Water for Developing Countries, *Ninth LACCEI Latin American and Caribbean Conference(LACCEI'2011), Engineering for a Smart Planet, Innovation, Information Technology and Computational Tools for Sustainable Development, Medellin, Colombia*, 1(9), August 3-5, 2011, 1-6.

[2] Anusha Pikle and Yash Siriah, Pedal Operated Water Filtration System (Mobifilt), *International Journal of Current Engineering and Technology* , Department of Mechanical Engineering, Shri Savitribai Phule Pune University, Pune, India, 2(4),March 2016,254-258.

[3] Anand B. Rao and Ramprasad V, Seminar Report on Portable Water Purifiers, *Centre for Technology Alternatives for Rural Areas (CTARA)*, Indian Institute of Technology Bombay, Powai, Mumbai, November, 2014, 36-37.

[4] Jayant Gidwani, Amit Kesheorey and Nitesh Lowanshi, *"*Pedal Powered Water Pumping and *Purification",ijsart.*Department of Mechanical Engineering, Swami Vivekananda College Of Engineering Indore, Madhya Pradesh, 1(2), 5 May2016, 10-13.

[5] Garud R. M. and Kulkarni G. S ''A Short Review on Process and Applications of Reverse Osmosis'' *Universal Journal of Environmental Research and Technology Shivaji University*, Kolhapur, Maharashtra, 1(1), 2011, 233-238.

