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An innovative Desalination process by application of alternate techniques

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Abstract— Desalination involves large amount of energy consumption because which the process is found to be uneconomical and is not being widely used in practice. In this paper a different technique of using natural resources is suggested. Using this process, the desalination process will be effective and energy conserving.

Index Terms— Conservation, Desalination, Economy, Renewable Energy . Marine technique, Hydro electricity, eco friendly.

1 INTRODUCTION

DDESALINATION is a process that is used to purify the water by removing salt and minerals from them so as to extract water that is suitable for drinking or agriculture purposes.

Over 97.5 % of the earth's water contains salt. More than 16 billion gallons of desalinated water are produced daily, with much of it designated for drinking water in the Persian Gulf countries. It is a challenge to find a desalination process that is cheap enough to bring desalinated water to the poor and remote regions of the earth. Currently there are several techniques used for the desalinating water in large quantities, including carbon nanotubes, and biomimetics. Evaporation desalination, however, is still the most commonly used. All desalination processes produce dangerous by-products, such as concentrated brine, that pose environmental hazards to fresh water and animals.

Evaporation is the simplest process in which the water is boiled to the gaseous state so that the water is separated from the salts and the vapours are cooled again to obtain pure water. Since the boiling temperature of water is less than that of salts, the salts are left as residue.

Though adoption of desalination process saves the depleting ground water resources, it has both ecological and economical problems. The salt produced as a byproduct of desalination process is of high concentration and cannot be used. Also, the process involves large amount of energy consumption. This paper addresses these problems and alternate methods of desalination are suggested.

The minimum energy consumption for sea water desalination is around 1 kWh. Desalination is most useful for dry countries such as Australia, Arab Emirates, Israel etc. According to the International Desalination Association, in June 2011, 15,988 desalination plants operated worldwide, producing 66.5 million cubic meters per day, providing water for 300 million people [1].

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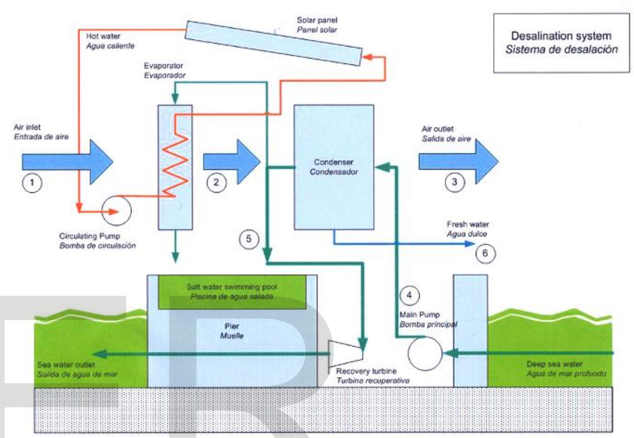

Fig 1. Desalination process (Courtesy [3])

Desalination is generally divided into two primary categories: Distillation Processes and Membrane Processes

2 THERMAL DISTILLATION

Over 60 percent of the world's desalted ocean water is produced by boiling seawater to produce water vapor that is then condensed to form fresh water. The processes often recover and reuse waste heat from electrical power generating plants to decrease overall energy requirements. Boiling in successive stages each operated at a lower temperature and pressure can also significantly reduce the amount of energy needed. Evaporative processes are used primarily for seawater conversion, and consist of the following well established methods:

- Multistage flash evaporation (MSF)
- Multieffect distillation (MED)
- Vapor compression (VC)

MSF and MED require thermal input in addition to electric power, and because they handle hot seawater, materials selection becomes a critical factor in design. VC uses only electric power, with the thermal input coming from heat of compression. VC is generally the most economical evaporative process, but the fan compressors that are used limit the output capacity of the equipment.

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3 Membrane Process

Reverse Osmosis

When two solutions with different concentrations of a solute are mixed, the total amount of solutes (i.e. salts) in the two solutions will be equally distributed in the total amount of solvent (i.e. water) from the two solutions.

In Reverse Osmosis, salt water on one side of a semi-permeable plastic membrane is subjected to pressure, causing fresh water to diffuse through the membrane and leaving behind a more concentrated solution than the source supply containing the majority of the dissolved minerals and other contaminants. The major energy requirement for reverse osmosis is for pressurizing the source, or "feed" water.

Depending on the characteristics of the feed water, different types of membranes may be used. Because the feed water must pass through very narrow passages as a result of the way the membrane packaged, fine particulates or suspended solids must be removed during an initial treatment phase (pretreatment).

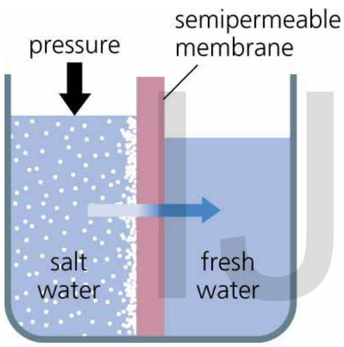


Fig 2. Reverse OsmosisProcesss [4]

Electrodialysis

Electrodialysis is an electrochemical process in which the salts pass through the cation and anion membranes, leaving the water behind. It is a process typically used for brackish water Because most dissolved salts are ionic (either positively or negatively charged) and the ions are attracted to electrodes with an opposite electric charge, membranes that allow selective passage of either positively or negatively charged ions accomplish the desalting.

4 A Marine Technique

Marine current power is a form of energy, obtained from the kinetic energy of marine currents .Unlike other forms of renewable energy, marine currents are a consistent source of kinetic energy caused by regular tidal cycles influenced by the phases of the moon. Intermittency is a problem for wind, wave and solar power as the sun doesn't always shine and the wind doesn't always blow, which makes marine currents more predictable than wind and solar power. These sources of renewable energy often require backup from traditional forms of power generation. There are several factors that make electricity generation from marine currents very appealing when compared to other renewables:

- The predictability of the resource, unlike most of other renewables is easy and accurate.
- The potentially large resource that can be exploited with little environmental impact, thereby offering one of the least damaging methods for large-scale electricity generation.
- The sun acts as the primary driving force, causing winds and temperature differences. Because there are only small fluctuations in current speed and stream location with no changes in direction, ocean currents may be suitable locations for deploying energy extraction devices such as turbines.
- The potential of electric power generation from marine tidal currents is enormous.
- Tidal turbines are installed on the seabed at locations with high tidal current velocities, or strong continuous ocean currents where they extract energy from the flowing water. Tidal turbines are very much like underwater windmills except the rotors are driven by consistent, fast-moving currents. The submerged rotors harness the power of the marine currents to drive generators, which in turn produce electricity.
- This energy is used to pump sea water into the plant's reservoir apart from satisfying the electrical demand of the plant. This water from the reservoir is used for the generation of hydro electric power.

Fig 3. Marine Current Turbines [5], [6]

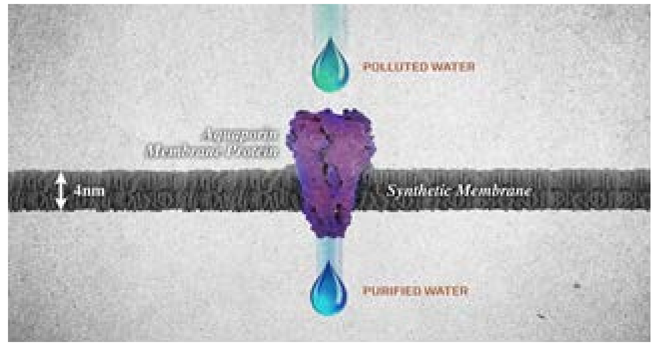
5 Hydro Electricity

Hydroelectricity is the term referring to electricity generated by hydropower ie. the production of electrical power through the use of the gravitational force of falling or flowing water. It

is the most widely used form of renewable energy.
Hydroelectric power comes from the potential energy of dammed water driving a water turbine and generator. The power extracted from the water depends on the volume and on the difference in height between the source and the water's outflow. The cost of hydroelectricity is relatively low and it is also a flexible source of electricity since the amount produced can be changed up or down very quickly to adapt to changing energy demands.
This hydroelectric power generated is an additional source of energy to facilitate the osmotic process used in desalination.
Currently there are several techniques used for the desalinating water in large quantities, including forward and reverse osmosis, carbon nanotubes, and biomimetics. Evaporation desalination, however, is still the most commonly used. All desalination processes produce dangerous by-products, such as concentrated brine, that pose environmental hazards to fresh water and animals

6 AQUAPORIN-EMBEDDEDBIOMIMETIC MEMBRANE

Aquaporins are water-transport proteins that play an important role in regulating asmotic level in living organisms. These proteins have exceptionally high water permeability, high selectivity for pure water molecules, and a low energy cost, which make aquaporin-embedded membrane well suited as an alternative to conventional RO membranes.
Unlike synthetic polymeric membranes, which are driven by the high pressure-induced diffusion of water through size selective pores, this technology utilizes the biological osmosis mechanism to control the flow of water in cellular systems at low energy. In nature, the direction of osmotic water flow is determined by the osmotic pressure difference between compartments, i.e. water flows toward higher osmotic pressure compartment (salty solution or contaminated water). This direction can however be reversed by applying a pressure to the salty solution (i.e., RO).
The principle of RO is based on the semipermeable characteristics of the separating membrane, which allows the transport of only water molecules depending on the direction of osmotic gradient. Aquaporin channels can be used to control the direction of water flow through a minimum level of pressure. Hence aquaporin-embedded biomimetic membranes can be used as an alternative to conventional RO membranes.
Since aquaporin-incorporated membranes are the key component to attaining higher levels of salt rejection and water flux,imporatnce is given to improve the quality and properties of the materials used to produce aquaporin-based membranes. Both the production yield and the stability of the aquaporin is being improved through genetic modification. This water purification membrane is applied to treat wastewater and seawater at a much lower pressure than current membranes. The low-energy requirement and high water flow rate of aquaporins are essential components to the realization of cost-effective water purification membranes. In addition to enhanced energy efficiency, it is also found to be cost-effective.



7 CONCLUSION

The desalination process is a very useful process for dry countries where there is shortage of fresh water sources. However, the present system has certain disadvantages, which can be overcome by adopting the alternate Techniques. The innovative processes described in the paper solves many of the problems and proves to be eco-friendly and energy conserving.

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