International Journal of Advance Research in Science and Engineering
Volume No.07, Special Issue No.03, February 2018
www.ijarse.com
IJARSE
ISSN: 2319-8354

AN OVERVIEW ON OSMOTIC POWER AND IT'S SCOPE IN INDIA

Digvijay M. Mane[1], Hrishikesh S. Gadve[2], Shailesh S. Jankar[3]

[1]*Student, Department of Mechanical Engineering,*
Dr. Daulatrao Aher College of Engineering, Karad, (India)
[2]*Student, Department of Mechanical Engineering, Associate Member of Institution of Engineers,*
The Institution of Engineers, Pune, (India)
[3]*Asst. Professor, Department of Mechanical Engineering,*
Annasheb Dange College of Engineering, and Technology, Ashta, (India)

ABSTRACT

Water, energy and environmental issues are on the top list of the world problems. Energy is needed for augmenting our water resources. During the past decade, global climate change challenges and the world's growing demand for energy have brought the need for more renewable energy to the top of the international community's agenda. We can't continue using handful of our energy sources we gain energy from today. Therefore, it is necessary to find other ways of generating energy. The need of new energy sources has led to a number of substitutes, some better than others.

It has been known for centuries that mixing freshwater and seawater releases energy. Osmotic power's excellent environmental performance and CO_2*-free power production will qualify for green certificates and other supportive policy measures for renewable energy. The estimated energy cost is commensurable and competitive with the other renewable energy sources. For the commercial power companies and technology suppliers Osmotic Power represent an agreeable new business potential.*

Present paper covers a study of Osmotic Power Generation and concludes with the best applicable methodology based on its merits, suitability and cost minimization. And briefly focuses on Osmotic Power Generation and its scope in India.

Keywords: Clean Energy. Indian Coastal Line, Osmosis, Osmotic Power, Renewable Energy,

I.INTRODUCTION

The world's seeking for cost-effective renewable energy (RE) sources is continuous and has taken many dimensions and directions. This has become more so, given the current urgency of climate change, declining world supplies of conventional fossil fuels, and elevated oil prices. Alternative energy sources, including solar, wind, tidal wave, and biomass, have been used to provide secure, sustainable and adequate energy sources.

Global energy supply for human activities is dominated by fossil fuel combustion, which 31 due to high emissions of greenhouse gases, is accelerating changes in our climate towards critical long-term effects. It is estimated that only 13% of our energy is sourced by renewable resources, mainly shared between biomass and waste (75%), hydro (17%) and solar and wind (6%) geothermal, wave and tidal energies account for the rest of the share (2%).

To reduce the dependence on fossil fuels while satisfying growing energy requirements, new alternative sources have to be explored and embraced, particularly renewable sources due to the minor impact on our environment.

However, expensive equipment and high installation costs of alternative technologies, coupled with the uneven availability distribution, have prohibited them, so far, from being used extensively. Affordable, clean, secure, and unobjectionable energy sources remain one of the world's biggest challenges.

Despite these globally shared efforts, fossil fuels will continue to remain the most important source of energy in the decades ahead, as they are the world's main source of low-cost and broadly available energy. In addition, the global consumption of energy is growing, so the need for more renewable energy will become even more pressing in addition to the need to reduce our reliance on finite and carbon-intensive fossil fuels as an energy source.

A new type of renewable and gas emission-free energy which came into spotlight is salinity-gradient energy. It is based on the liberation of energy upon mixing of waters with different salt concentrations, as between rivers and oceans. When properly constrained, this energy can be used to generate power.

Recently, osmotic energy has been introduced as a source of renewable and sustainable energy, and it shows potential for power production.

1.1 OSMOTIC POWER: The energy derived from the inequality in salinity between seawater and fresh water, converted into electricity by means of a turbine.

There are several different types of power plants using osmosis (the osmotic process); both land-based plants and plants anchored to the sea floor. The thing the plants we have studied have in common is that osmosis process is not directly used to generate power. The main purpose of osmosis is that to creates a flow through the plant and created flow forces the turbine to rotate[1].

The trend is even more popular in Norway which not only supplies the country's power demands from the hydroelectric plants; it is also exporting electricity to the neighboring countries.

Very recently, Norway has recently started a new power plant called the Statkraft Power Plant that utilizes osmotic pressure to generate electricity. In this paper, we give an overview of this state-of-the-art method of power generation and relate it with the opportunities of osmotic power generation in India[2].

India ranks sixth in world so far as total energy. As concerned, but still much more energy is needed to keep pace with our economic development objectives. Most of our energy requirements are met through fossil fuel that leads to dependence on imports and energy insecurity.

It is very important to apply renewable energy for a wide variety of applications and provide energy solutions by modifying the energy proportion, improving energy stability, increasing energy sustainability, conversion reduction and hence enhance the system efficiency.

Apart from this, the Government of India has introduced numerous schemes and projects for creating job opportunities through rural development and employment guarantee schemes, poverty assuagement programs, Bharat Nirman, Rajeev Yuva Shakti programs, Make in India etc. These schemes have been effectively implemented at the village level by government agencies, NGOs and also by small enterprises, SHGs etc. This will also put a positive impact on the osmotic power energy utilization in India[3].

The present work aimed to study the osmotic power concept and utilization in India.

II. LITERATURE SURVEY

2.1 Adel O. Sharif, Ali. A. Merdaw, Mohammed. I. Sanduk, Sami. M. Al-Aibi, ZenaRahal:

A detailed study on the potential of osmotic energy for power production. The study includes both pilot plant testing and theoretical modeling including cost estimation. In this study both theoretical and experimental investigations of the potential of the osmotic energy (salinity gradient) for power generation have been carried out. The results indicate a high potential of the osmotic energy for power generation using the Hydro Osmotic Process.

He conclude that a clean electricity could be produced using the HOP process at a projected cost of 30 $/MWh, if a suitable membrane is used, and the osmotic potential difference between the two solutions is greater than 25 bar; a condition that can be readily achieved in many sites around the world[4].

2.2 Dineshkumar U. Adokar, Dhanesh S. Patil, Amrita Gupta.:

An Analysis focuses on one of those alternatives; osmotic energy. The estimated energy cost is comparable and competitive with the other renewable energy sources. For both the commercial power companies and technology suppliers. Osmotic Power represents an attractive new business potential. The possibility to use osmotic power from our oceans lies within the technology that needs to be developed. There are many possible ways to exploit energy from salinity gradients. It seems, as osmotic pressure will be crucial with each of the possibilities. The need of new energy sources has led to a number of alternatives. However in the future if the technology is further developed and the costs will decrease, osmotic energy might be an alternative to the energy sources we use today[1].

2.3 Avinash Mishra:

The need for renewable energy resources has never been bigger then today. A relative unknown, renewable energy resource is osmosis. It's based on the materials striving after equality. Osmotic energy is not something we can use in the nearest future. The disadvantages, the obstacles, are too big to be overcome at the moment. The cleaning of the membranes and the cost are good examples of such obstacles. However in the future if the technology is further developed and the costs will decrease, osmotic energy might be an alternative to the energy sources we use today[5].

IJARSE
ISSN: 2319-8354

2.4 Syed Waqar Hasan, Syed Faraz Hasan:

In this paper, there is detailed analysis of an in-depth look into the technical details of the osmotic power generation. They identified some of the geographical locations alongside the country's coast that can be ideal for setting up an osmotic power station. They evaluated the osmotic potential in the sea water on the coast of Karachi with the help of laboratory tests and mathematical estimation. According to estimation, the osmotic potential in Karachi's sea water is comparable to that available in the first commercial osmotic power plant. It has been discussed that the ideal location of setting up an osmotic plant is where the river water falls into an ocean or a sea[2].

III.OSMOTIC POWER WORKING

The newly emerging solar food processing technology is an important Socio-economic activity in the country especially in rural areas. It has become an interdisciplinary technology with a multiphase character in rural set up.

Limited fossil resources and environmental problems associated with them have emphasized the need for new sustainable energy supply options that use renewable energies. A salinity Gradient power generation system is a newly emerging system also known as Osmotic Power generating system.

Osmotic Power can be developed and deeply implemented as viable source and option for electricity generation in future.

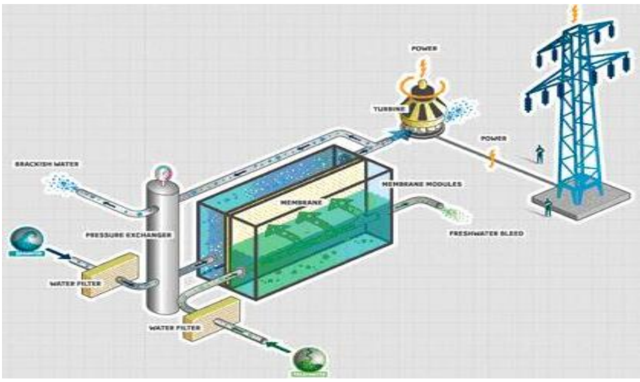

Fig. 1 : Osmotic Power Generation System[5]

Filtered freshwater is fed into the plant. It enters the membrane modules containing spiral wound or hollow fiber Membranes. 80 – 90% of the fresh water is transferred by osmosis across the membrane into the pressurized seawater into membrane modules.

The osmotic process increases the volumetric flow of high pressure water and is the key energy transfer in the plant. This requires a membrane that has a high water flux and high salt holding. Typical membrane performance should be in the range of 4 – 6 W/m^2. The brackish water is split into two flows coming from the membrane module. About 1/3 of the water goes to the turbine for generation of power. 2/3 return to the pressure exchanger to pressurize the feed incoming of seawater.

IJARSE
ISSN: 2319-8354

To optimize the power plant the typical operating pressure is in the range of 11 – 15 bars. This is equivalent to a water head of 100 – 145 meters in a hydropower plant, generating about 1 MW/m^3s freshwater. The freshwater feed operates at atmospheric pressure. Some pre-treatment of the water is necessary. Experience from Norwegian water treatment plants indicates that mechanical filtration down to 50 µm in combination with a standard cleaning and maintenance cycle is enough to sustain the membrane performance for 7 – 10 years. Similar lifetime data are assumed for osmotic power plants[6].

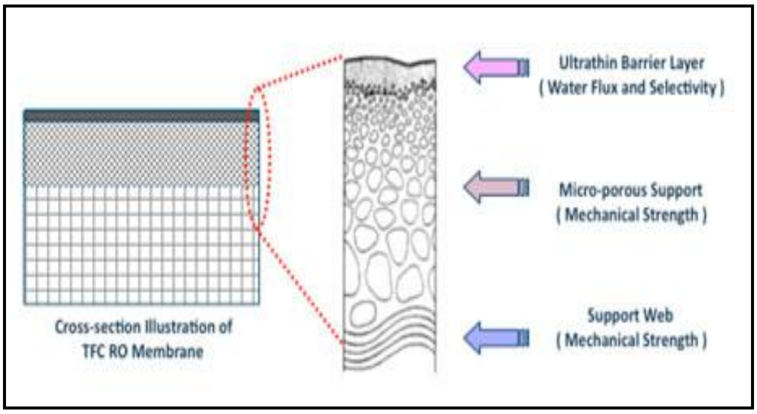

Fig. 2: TFC or TFM Membrane used in Osmosis Process[5]

3.1 Principles of Osmotic Power

In a setup where a semi-permeable membrane separates the solution and solute, the pressure exerted by the solution on the membrane is known as the Osmotic pressure.

Figure 3(a) and 3(b) show the solution and solute separated by a semi permeable membrane (permeable to solute) inside a container. Initially, as shown in Figure 3(a), same quantities of the solvent and solution are present in the container.

The solute on one side tends to drift across the membrane to dilute the solution on the other side and hence increases the level of the solution inside the container. Consequently, a pressure difference is generated on one side of the container.

The membrane typically allows fresh water to pass through it and hence the fresh water is normally used as a solute in commercial installations.

The pressure difference P_{diff}, shown in Figure 3(b), is referred to as the Osmotic Pressure and can be used for generating electricity. This pressure is later imparted against the turbine blades to get renewable electricity[7].

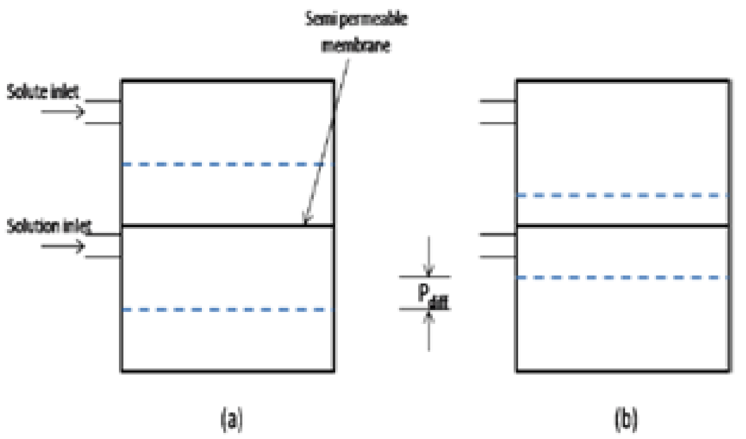

Fig. 3: The Principle of Osmotic Power[6]

A schematic diagram of the Osmotic power plant is given in Figure 4. The plant requires abundant supplies of fresh and sea water to follow the principle of osmosis. In Figure 3, the sea water is fed to Tank A after modestly pressurizing it using the pressure exchanger.

Similarly, tank B is filled with the fresh water, which is separated from Tank A via a semi permeable membrane. Due to osmosis, the fresh water from Tank B diffuses into Tank A and further increases the fluid pressure inside Tank A. This pressure is imparted against the turbine which eventually produces mechanical power at its terminals. Some of the pressure from Tank A is fed back to the pressure exchanger, which is utilized in pressurizing the incoming sea water.

Therefore, the energy required for pressurizing the sea water does not come from any external source. The turbine coupled with a generator eventually converts this mechanical power into electricity[8].

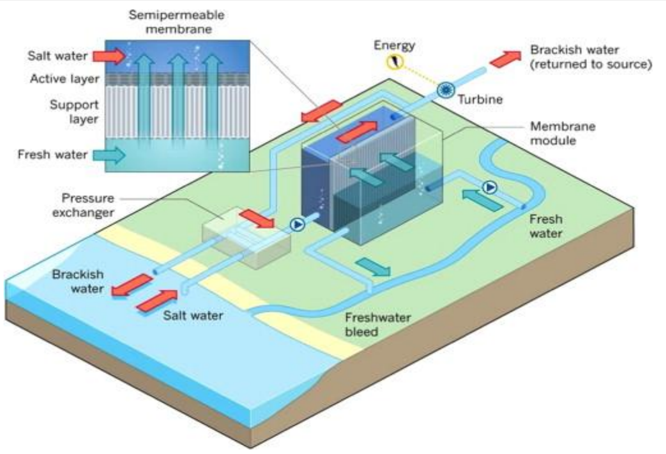

Fig. 4: Schematic Diagram of Osmotic Power Plant[9]

In India the plant at Charanka in Gujarat is the largest solar plant of capacity 221 MW commissioned on April, 2014 and after complete installation the capacity will be raised upto 500 MW. Generally this method is used for generation of electricity in India[3].

International Journal of Advance Research in Science and Engineering
Volume No.07, Special Issue No.03, February 2018
www.ijarse.com
IJARSE
ISSN: 2319-8354

IV. CURRENT STATE OF KNOWLEDGE

Osmotic power is in the prototype and demonstration stage. Statkraft, the world leader in the field, tested a prototype osmotic power plant in Norway's Oslo Fjord from 2009 to 2013.

From February 2012 to December 2013, Statkraft and Hydro-Québec carried out a joint osmotic power R&D project. Their primary goal was to develop techniques for pretreating water, assess the impact of water quality on membrane performance, and evaluate the process's repercussions for sustainable development.

The world's first osmosis driven prototype for power generation has now been put into operation. In the southern part of Norway, approximately 1 hour drive from Oslo, a complete prototype of an Osmotic Power plant has been built. The prototype represents a major milestone towards the commercialization of Osmotic Power and creates a unique test site for future technology development of Osmotic Power.

The plant did generate the first small kWh of electricity from osmosis in November 2009, and the first proof of the concept of producing power by osmosis has been recorded.

The prototype is designed to be used as a laboratory for the ongoing development of the technology. In this respect, it will contribute to technology enhancements in order to reach the objective of producing power at a competitive cost, and creating the basis for up-scaling the various components to commercial scale.

Fig. 5: Pelton Turbine used for Power Generation in Osmotic Power Plant.

A turbine with a generator is installed to generate electricity from the pressurized water. With continues flow of water at approximately 12 bar, a Pelton turbine was chosen. To be able to generate as much electricity as possible from the membranes installed, the turbine must be optimized for the correct flow of water at the given pressure. In a full scale installation, the combined efficiency of the turbine and generator is expected to exceed 85%[9].

The overall objectives of the prototype are twofold. Firstly, confirming that the designed system can produce power on a reliable 24-hour/day production.

Secondly, the plant will be used for further testing of technology achieved from parallel research activities to substantially increase the efficiency. The performance and efficiency of the individual component, as well as the system efficiency as a whole, will be directed towards the targets for commercial production of Osmotic Power.

4.1 Advantages

- It is renewable.
- There's no risk of running out of salt because of osmotic power produced.
- Power produced has minimal environmental impact.
- It is very clean process.
- If there's a salt gradient then power will be available no matter what the topography is.
- The amount of heat occurring is not harmful for the marine organisms.

4.2 Disadvantages

- Osmotic energy is expensive than diesel power plants but less expensive than hydro power plants.
- The osmotic chamber must be mechanically very sturdy.
- Protection of marine organisms from turbine and other machinery must be ensured.

  But our focus point is that **'Can we use Osmotic Power in India?'**

  The answer is, Yes! It is possible.

4.3 Osmotic Power options in India

India has a land frontier of 15,200 km (9,445 mi) and a coastline of 7,516.6 km (4,671 mi).

India has a reasonably large coastal belt spread across the north of Gujarat to Kerala touching Arabian Sea, north of West Bengal to South of Tamil Nadu touching Bay of Bengal and some part of Kerala and Tamil Nadu touching The Indian Ocean. Since an osmotic plant requires abundant supply of fresh and sea water, the ideal locations for setting up these plants are spots where the rivers fall into the seas and oceans.

Figure 5 shows India's coastal belt at the Arabian Sea, Bay of Bengal and The Indian Ocean the rivers which fall into the sea. It is evident from the figure that several places provide an appropriate opportunity to set up an osmotic plant and reap the low-cost low-carbon benefits for generating electricity.

Table II details India's rivers falling into the Arabian Sea. These locations for setting up an osmotic plant can be fruitful for increasing the overall installed capacity of the nation[2].

4.4 Required aspects for Establishing Osmotic Power Plant.

- Abundant source of salt water.
- Abundant source of fresh water.
- Location suitable for establishing power plant.
- Plenty of Man power.
- Necessary equipment's for power generation.

As we know this all necessities are available in plenty in India[10].

Fig. 5: Indian Coastal Belt showing several rivers falling into sea[10].

Table 1. List of major rivers falling into the Sea

RIVERS	DELIVERS TO	LOCATION
Narmada	Arabian Sea	Gujarat
Tapi	Arabian Sea	Gujarat
Mahanadi	Bay Of Bengal	Orissa
Godavari	Bay Of Bengal	Andhra Pradesh
Krishna	Bay Of Bengal	Andhra Pradesh
Kaveri	Bay Of Bengal	Tamil Nadu

An accurate way of calculating the osmotic pressure is by using osmometers that are commercially available. However, in order to avoid the financial issues, the theoretical value is also preferred.

V. CONCLUSION

In this paper, we have examined the osmotic energy. Moreover, the research also assessed the various strategies and methods, which should be practiced by the firms in India to reduce their electricity bills by encouraging use of osmotic power. However, introduction of modern technology is necessary if the rate at which energy is consumed by industries in India is to be reduced.

Through its adaptable technology and relatively low maintenance requirements, osmotic energy can replace or extend existing infrastructure and solve unique problems in powering entire country.

Osmotic energy is not something we can use in the nearest future. The disadvantages, the obstacles, are too big to be overcome at the moment. The cleaning of the membranes and the cost are good examples of such challenges. However in the future if the technology is further developed and the costs will decrease, osmotic energy might be an alternative to the energy sources we use today.

The salinity gradient energy is a most promising energy source for generation electricity with the high potential available in comparison to anther sources of renewable energy. There are many places in the world which the salinity gradient energy is available, so installation the plants in rivers mouth can be produced and supported the huge amount of global electricity demands in future. For increasing the technical potential of salinity gradient energy the plant is constructed in the river moth, because of decreasing the energy losses for pumping or transferring.

There are many attractive features about using salt for power. A big advantage is that it is renewable.

Designers, engineers, architectures, service engineers and material providers must consider osmotic energy installations as a sustainable energy development. Besides, policies by governments and communities may play a greater role to encourage domestic and industrial sector to apply the new technologies.

REFERENCES

[1] Dineshkumar U. Adokar, Dhanesh S. Patil, Amrita Gupta. Generation of Electricity by OSMOSIS *International Journal of Emerging Technology and Advanced Engineering* www.ijetae.com (ISSN 2250-2459, ISO 9001:2008 Certified Journal, *Volume 3, Issue 3*, March 2013) Head of department, Lecturer, Final Year Student, Electrical, SSBT's COET, Bambhori, Jalgaon.

[2] Syed Waqar Hasan, Syed Faraz Hasan. National Refinery Limited, Pakistan. *JPMS Conference Issue Materials 2011*. Department of Electrical Engineering, NED University of Engineering and Technology, Karachi.

[3] Digvijay M. Mane, Hrishikesh S. Gadve. A STUDY ON USE OF SOLAR POWER IN FOOD INDUSTRY. *Sanskruti International Multidisciplinary Research Journal*. SIMRJ ISSN: 2455-1511 *Vol. II Issue-II* Oct-Nov-Dec 2016. Student, Department of Mechanical Engineering, Shree Santkrupa Institute of Engineering and Technology (Polytechnic), Ghogaon, Karad-415111, Satara (M. S.).

[4] Adel O. Sharif, Ali. A. Merdaw, Mohammed. I. Sanduk, Sami. M. Al-Aibi, Zena Rahal. The potential of chemical-osmotic energy for renewable power generation. *World Renewable Energy Congress 2011 Sweden, 8-13 May*. Centre for Osmosis Research & Applications, Chemical & Process Engineering Department, University of Surrey, UK.

[5] Avinash Mishra. Osmotic Power Huge Source of Renewable Energy. *International Journal of Scientific & Engineering Research, Volume 4, Issue3,* March-2013 ISSN 2229-5518.

[6] Yunus Emami, Sajjad Mehrangiz, Ahmad Etemadi, Asgar Mostafazadeh, Saeid Darvishi. A Brief Review about Salinity Gradient Energy. *International Journal of Smart Grid and Clean Energy Vol. 2 Issue-2 May 2013*. Urmia University of Technology, Urmia, Iran.

[7] Reproduction authorized with acknowledgement of source Legal deposit – 1st quarter 2015 Bibliothèque et *Archives nationales du Québec ISBN: 978-2-550-72233-5 2015G033-3.*

[8] Drisya U., Sreelakshmi C. S. Osmotic Power from Solar Pond Power Plant: A New Suggestion towards Co Generation. *International Journal of Innovative Research in Science, Engineering and Technology*.An ISO 3297: 2007 Certified Organization *Volume 5, Special Issue 5*, April 2016. International Conference on Emerging Trends in Smart Grid Technology - INCETS'16.

[9] Stein Erik Skilhagen. OSMOTIC POWER – A New, Renewable Energy Source. Head of Osmotic Power, Statkraft AS, Lilleakerveien 60216 OSLO, NORWAY.

[10] Vishnu.P., OSMOTIC POWER Power production based on the pressure difference between waters of different salt concentration.