A Review on various ocean thermal energy conversion systems (OTEC)

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Abstract

Ocean Thermal Energy Conversion (OTEC) systems is used to produce electricity by the use of the temperature difference which is there between deep cold ocean water and warm surface water. Ocean Thermal Energy Conversion plants generally pumps a very high quantity of cold and surface seawater which is used to run a power plant for the production of electricity. This paper presents the work done by various researches up-to now in this particular field and will be a review of different OTEC systems and methods present up-to now with their advantages and disadvantages.

Keywords: OTEC, electricity, thermal energy.

Introduction

Energy is one of the most useful measure of all the work done nowadays. For every work which we do needs energy. One of the most important form of energy is electrical energy which everybody needs. Up-to now for the electricity generation, we only depend upon fossil fuels like coal or oil. But as these resources are exhausting at a faster rate and with exponential increase in the world's population, there is a need to look for some other resources which are in abundance and proper harnessing of these resources has not been yet to its full extent. There are various such resources like solar energy, wind energy, Ocean energy etc. Among this ocean energy is the type of resource which nowadays are being used for electricity generations in different countries but till now it has not been used extensively around the globe due to its various factors.

Among ocean energy sources, OTEC is one of the available renewable energy resources which is used for the power supply. The resource potential for OTEC is considered to be much higher than for other ocean energy forms. There are two types of systems of OTEC.

It can be either closed-cycle or open-cycle. Closed-cycle OTEC uses working fluids like refrigerants such as ammonia or R-134a as they have low boiling points which makes them suitable for electricity generation. It generally uses the Rankine cycle, using a low-pressure turbine. On the other hand, Open-cycle engines use vapor from the seawater as the working fluid. This paper presents the contribution and research done by various researchers in this field showing the merits and de-merits of using this energy for electricity generation.

Contribution of various researchers in chronological order:

S.no	year	Researcher	Work/Parameters	Findings
1.	1978	J. G. McGowan et al. [1]	This paper presents and focuses on the material needs for OTEC power plants.	They concluded that the material problem caused due to the OTEC systems are to be accounted for and must be given considerations in the favourable geographic conditions.
2.	2006	G. Buigues et al. [2]	This paper presents the problems and possibilities in Sea Energy Conversion systems	This paper shows about the advantages and disadvantages of using the sea conversion energy systems
3.	2007	Lasantha Meegahapola et al. [3]	This paper presents varied roots of Ocean Thermal Energy Conversion (OTEC) strategies and Challenges which are faced in terms of efficiency and economy.	The conclusion they gave is in terms of the future OTEC design in terms of technology and economy.
4.	2008	Karen Anne Finney [4]	This paper presents the idea behind ocean thermal energy conversion system	He concluded that actual mini OTEC plants shows that OTEC systems will become a feasible, efficient and renewable source of energy in coming years.
5.	2013	Prasant Kumar Sahu et al. [5]	This paper presents the scenario of ocean thermal energy in India	They conclude that cost of production of energy is in significant when it gets compared to the other types of sources and also the cost of electricity is getting low there is an increase in power output.
6.	2016	Jaswar Koto [6]	This paper presents the potential of ocean thermal energy in Indonesia	It is concluded that locations in Indonesia have a temperature gradient of more than 20 degree Celsius and are suitable to install OTEC.
7.	2017	Grishma Shedge. [7]	This paper presents the review of various aspects of OTEC systems.	It is concluded that the OTEC works efficiently when there is a significant temperature difference in the ocean water is there. Also, this power plant can be used simultaneously for other purposes too.
8	2017	Abdullah Mohammed Aldale [8]	OTEC Environmental effects, advantages, disadvantages and future prospects.	He concludes that OTEC effectiveness in the production of electricity is still hypothetical and has not been calculated well as these types of systems are not that efficient and its effectiveness can only be measured when it gets connected with some power grid.

9	2018	Yasuyuki Ikegami et al. [9]	Single Rankine, double-stage Rankine and Kalina cycles were studied	They concluded that the double-stage Rankine cycle power is greater than that of the single Rankine cycle when the temperature of sea water distribution ratio ranges from 0.3 to 0.7. They also concluded that double-stage Rankine cycle highest power output rises nearly with the Kalina cycle.
10	2018	Yanli Jia et al. [10]	Boundary conditions were modified/ adjusted for the best results	They concluded that a straight implementation of the modified conditions at first resulted in a simulated ocean that is less closely matched, to counter this situation, the monthly heat flux input across the ocean-atmosphere interface were adjusted by the use of more satisfactory results.
11	2018	Gérard Nihous [11]	Previously used algorithm was used for the evaluation of steady state global OTEC is used which is further extended to probe the effect of various methodologies	. He concluded that if separate evaporator and condenser discharges, a 60% increase in the power was recorded than the conventional one.
12	2018	Clark C.K.Liu [12]	This paper shows the review on the technological advancements on various OTEC systems and open ocean mariculture	He concluded that a collaborative research park of OTEC-DOWA could be located offshore from the strategic location of Taiping Island which consists of the construction and testing of an open-cycle OTEC plant for electricity and the construction and testing of wave-driven artificial upwelling facilities
13	2018	Xiuyu He et al. [13]	This paper shows the effectiveness of the proposed control is with the help of simulation.	In this paper research was done for the vibration controls and various numerical experiments were done.

Conclusion

By looking at the contributions done by various researchers it can be concluded that if the present trends of increase in population continues, the fossil fuels may get extinct in the near future. So, we have to look for some other sources of energy which are in abundance. One such method is using OTEC for the electricity generation. **It** holds promise in a sustainable way to meet the energy needs globally. It is good as it is pollution free. So, it is concluded that, by using this OTEC energy for the electricity generation, it decrease its dependability over the fossil fuels and will be a very good prospect in the near future.

References

[1] J. G. McGowan & W. E. Heronemus, "Ocean thermal energy conversion material requirements for large-Scale systems", Metall Mater Trans A 9, 207–214 (1978). https://doi.org/10.1007/BF02646702

[2] G. Buigues, I. Zamora, A. J. Mazón, V. Valverde and F.J. Pérez, "Sea Energy Conversion: Problems and Possibilities", https://doi.org/10.24084/repqj04.242 RE&PQJ, Vol. 1, No.4, April 2006

[3] Lasantha Meegahapola, Lanka Udawatta and Sanjeeva Witharana, "The Ocean Thermal Energy Conversion Strategies and Analysis of Current Challenges", Second International Conference on Industrial and Information Systems, ICIIS 2007, 8 – 11 August 2007, Sri Lanka

[4] Karen Anne Finney, "Ocean Thermal Energy Conversion", Ocean Thermal Energy Conversion. Guelph Engineering Journal, (1), 17 - 23. ISSN: 1916-1107. ©2008.

[5] Er. Prasant Kumar Sahu and Er. Chinmaya Prasad Nanda, "Indian Ocean Thermal Energy", International Journal of Engineering Research & Technology (IJERT) Vol. 2 Issue 10, October – 2013 IJERT ISSN: 2278-0181

[6] Jaswar Koto, "Potential of Ocean Thermal Energy Conversion in Indonesia", International Journal of Environmental Research & Clean Energy 30nd October 2016. Vol.4 No.1

[7] Grishma Shedge, "Ocean thermal energy conversion – a review", 2nd international conference on emerging trends in engineering and management research, IETE Pune, India (ICETEMR-17) ISBN: 978-93-86171-46-7

[8] Abdullah Mohammed Aldale, "Ocean Thermal Energy Conversion (OTEC)", American Journal of Engineering Research (AJER) e-ISSN: 2320-0847 p-ISSN: 2320-0936 Volume-6, Issue-4, pp-164-167.

[9] Yasuyuki Ikegami, Takeshi Yasunaga and Takafumi Morisaki, "Ocean Thermal Energy Conversion Using Double-Stage Rankine Cycle", J. Mar. Sci. Eng. 2018, 6, 21; doi:10.3390/jmse6010021

[10] Yanli Jia, Gérard C. Nihous and Krishnakumar Rajagopalan, "An Evaluation of the Large-Scale Implementation of Ocean Thermal Energy Conversion (OTEC) Using an Ocean General Circulation Model with Low-Complexity Atmospheric Feedback Effects, J. Mar. Sci. Eng. 2018, 6, 12; doi:10.3390/jmse6010012

[11] Gérard Nihous, "A Preliminary Investigation of the Effect of Ocean Thermal Energy Conversion (OTEC) Effluent Discharge Options on Global OTEC Resources", J. Mar. Sci. Eng. 2018, 6, 25; doi:10.3390/jmse6010025

[12] Clark C.K.Liu, "Ocean thermal energy conversion and open ocean mariculture: The prospect of Mainland-Taiwan collaborative research and development" Sustainable Environment Research Volume 28, Issue 6, November 2018, Pages 267-273

[13] Xiuyu He, Wei He, Yingru Liu, Yiheng Wang, Guang Li,Yu Wang, "Robust Adaptive Control of an Offshore Ocean Thermal Energy Conversion System", IEEE transactions on systems, man and cybernetics: systems, VOL. , NO. , 2018