Comparison between Kalina Cycle and Conventional OTEC System using Ammonia-Water Mixtures as Working Fluid.

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ABSTRACT

Ocean Thermal Energy Conversion (OTEC) plant generates electricity by using 20\(^\circ\)C temperature difference between warm surface seawater at surface and cold deep seawater. OTEC is environment-friendly and semi-permanent energy sources because its heat source is seawater warmed by the sun and no incineration, and no \(\text{CO}_2\) emission can be achieved.

In this paper, it is focused on the cycle that is removed the regenerator, the absorber, and the diffuser from conventional Kalina cycle, and is returned the liquid working fluid separated with the separator to the inlet of the evaporator. The cycle was called R-cycle. It is compared N-cycle with a conventional Karina cycle by the numerical simulation. Two computational methods are used the program that is not treated the heat transfer performance of each heat exchanger, and other program that is treat the heat transfer performance of each heat exchanger and the condition of heat source. As a result, a past Kalina cycle was more efficient even though which calculation was used.

KEY WORDS

OTEC, Kalina cycle, R-Cycle, ammonia – water mixture

NOMENCLATURE

\(h\) : specific enthalpy  
\(P\) : pressure  
\(Q\) : heat transfer rate  
\(T\) : temperature  
\(W\) : mass flow rate  
\(W_t\) : power of turbine  
\(W_p\) : power of pump  
\(Y\) : mass fraction of ammonia – water mixture  
\(\eta_k\) : Kalina cycle thermal efficiency  
\(\eta_r\) : R-cycle thermal efficiency  
\(\xi\) : ratio of vapor mass flow rate  

Subscripts  
\(C\) : condenser  
\(CS\) : cold sea water  
\(E\) : evaporator  
\(i\) : inlet  
\(o\) : outlet  
\(RG\) : regenerator  
\(WS\) : warm surface seawater

INTRODUCTION

Ocean Thermal Energy Conversion (OTEC) plant generates electricity by using 20\(^\circ\)C temperature difference between warm surface seawater at surface and cold deep seawater. As for OTEC, the research has been done for about 120 years or more as effective use of environment-friendly natural energy. At first, the research is done at an open cycle by seawater evaporates directly. Afterwards, a closed cycle that had used the working fluid was designed because of the improvement of efficiency. Various researches are done, and freon and ammonia, etc. have come to be used for the working fluid widely. And, the Kalina cycle that Kalina had proposed was paid to attention by efficiency's having greatly improved than Rankine cycle. As a result, it has been proven that efficiency or more improves by using not only a current pure medium but also ammonia/water mixture. And, in recent years, Uehara Cycle having been proposed by Uehara et al. attracted attention worldwide in efficiency more than the Kalina Cycle cycle. But, as you know, Uehara Cycle becomes a very complex cycle when a lot of equipment is necessary. Therefore, the equipment mechanical loss which includes the deterioration is not able to be disregarded in respect of the cost. Then, we decided to examine whether there is a simple, efficient system again. Then, we remove the regenerator, diffuser, and the absorber at a past Kalina cycle, and after a working fluid had gone out of the evaporation machine, it thought the cycle when the working fluid of the liquid phase separated with the separator was returned to the inlet of evaporator. We decided to call this cycle R-Cycle. An almost similar cycle has already been proposed by Kenneth C.Starling for about 30 years ago at this cycle. However, the influence of the mass fraction of ammonia - water mixture was not described, and judged for the reexamined value to exist enough. Therefore, it calculated at the cycle using ammonia/water mixture as working fluid, and we compared a past Kalina cycle and this R-Cycle and examined it.