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Comparison of OTEC Power Plant Using Plate Type Heat Exchanger and One Using Double Fluted Tube Type

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ABSTRACT

The objective of this study is optimization of OTEC system using double fluted tube type heat exchanger including turbine configuration parameters and comparison of the performance of OTEC plant using plate type heat exchanger and one using double fluted tube type. The results of this study show the plate type heat exchanger has several advantages and it can be compact. The optimization parameters were the velocity of cold and warm sea water passing through the heat exchangers, the phase change temperature, and turbine configuration parameters such as specific speed, specific diameter and ratio of blade to diameter.

KEY WORDS: OTEC, plate type heat exchanger, double fluted tube type heat exchanger, optimization, Rankine cycle

INTRODUCTION

Ocean Thermal Energy Conversion (OTEC) is a system of converting heat energy into electricity by using temperature difference between the surface water and the depth. The working fluid is evaporated using warm seawater and is condensed using cold seawater. Since the temperature of warm sea water is small (about 30℃). The working fluid with a low boiling point has to be selected. Ammonia and Freon 22 have been indicated as suitable working fluids for OTEC according to the studies carried out by Uehara et al. An OTEC plant with ammonia as working fluid has several advantages in comparison with an OTEC plant with Freon 22 as working fluid by Uehara and Nakaoka (1984a) (1984b). Further, Freon 22 usage has been restricted since it cause for disruption of the Ozone layer. Therefore ammonia is selected as working fluid in this paper.

High performance heat exchanger should be used in evaporator and condenser since the utilizable temperature difference is small (about 20℃). It is generally said that the plate type heat exchanger and the double fluted tube type one are suitable for OTEC power plant. Uehara et al studied the optimization of OTEC using the plate type heat exchanger and the double fluted tube type one (Uehara and Nakaoka (1984b) and Uehara et al (1989).

The price of plate type heat exchanger has come down. It is important to keep the cost performance in mind when someone designs a power plant.

The Rankine cycle efficiency is low (about 3%～4%) since the utilizable temperature difference is small in OTEC power plants. So it needs to keep the technical examination, capital and operating cost in mind for the economical construction of the power plant and for its practical use. For this purpose we have to consider the performance of total plant apart from the performance of the individual components e.g. an evaporator, a condenser, a turbine, etc..

Using plate type heat exchanger, Uehara and Ikegami carried out a total optimization considering turbine configuration (Uehara and Ikegami1 (1990)). In this paper, optimization carried out using double fuluted tube type heat exchanger, considering turbine configuration. Ammonia is used as the working fluid. The performance of OTEC plant using plate type heat exchanger is compared with the plant using double fluted tube type heat exchanger.

NOMENCLATURE

A = heat transfer surface area
Bo = Bond number
Bo^* = corrector Bond number
c_P = constant pressure specific heat
C_{PD} = diffuser efficiency
d = diameter
D = diameter
Ds= specific diameter
g = acceleration of gravity
G = flow rate
Gr = Grashof number
h = enthalpy, height
H = sensible latent heat rate
H_{ad} = theoretical adiabatic heat drop