SCHEMES AND CYCLES OF AIR/WATER TEMPERATURE DIFFERENCES UTILIZATION

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Summary

This Article describes practical opportunities for realization of projects using thermal energy resources available in arctic regions, describes proposed methods of utilization of natural temperature differences between cold polar air and relatively warm water, indicates important theoretical information, and discusses the problems relevant to different technical decisions.

1. Introduction

Arctic coastal region's infrastructure development and their further economical progress dictate the search for an optimum mix of various energy sources to supply the polar industrial enterprises and cities of the future. Certainly, it is possible to extend electricity transmission lines from regions well provided with electrical power, to build gas and oil pipelines, to install nuclear reactors or thermal power stations using imported or local fuel. However, it can be advantageous to use local renewable sources of energy, one of them being the thermal energy of natural temperature differences between polar air and river or ocean water (conception AWTEC). Development of those commercial scale energy resources promises to decrease expenses for imported fuel and its transportation, to decrease the transportation losses of energy and to decrease the potential danger of adverse effect on rather vulnerable natural complexes of polar territories owing to the pollution of the environment by waste products from fossil fuels combustion including thermal pollution. A potential consequence of such pollution in the polar region can be an ecological calamity of planetary scale, whereas utilization of renewable energy is the way to partially reduce such adverse effects.

2. Classification of Converters

The main part of an AWTEC power plant is the converter, which transforms the thermal energy into useful mechanical work or electricity. To simplify the description of possible variants it is useful to introduce some classification of converters. As a base for classification it is expedient to use an important feature - presence or absence of a turbine (steam-driven or hydraulic). Two large classes can easily subdivide all propositions in this case. The subsequent splitting permits to conduct further detailed elaboration.

Other approaches are also possible, for example, those based on the presence or absence of the working fluid phase transitions in a working cycle. The approach chosen here was accepted to simplify the allocation of groups with mixed features (for example, phase transition and direct conversion).

The following options are considered:

1. Converters with turbines

1.1. Steam-driven turbines (with a working fluid, heated up in a special evaporator; by mixing the working fluid with water);
1.2. Hydraulic transformation of energy;
1.3. Mixed transformation of energy;
1.4. Natural draught and gas turbine

2. Converters without turbines

2.1. Use of mechanical equipment (effects of buoyancy, effects of replacement with external plunger, effects of material form memory and so on);
2.2. Direct conversion of energy (use of heat pipes with a thermoelectric generator etc.).

In order to give preference to particular converters, it is important to indicate their corresponding optional power. Two options can be considered: large scale (hundreds of megawatts) power units, and rather small ones (tens of kilowatts) stand alone power sources to supply small remote settlements and individual consumers.

For large-scale power converters, the type 1.1 seems to be the most suitable. All other converters can be used as sources for local networks or single consumers. It is interesting to note an opportunity of type 2.1 converters is its application for auxiliary purposes: (start-up of the equipment with the help of thermoelectric devices) and for intensification of mass and heat transfer processes (high-voltage electrostatic generators).

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Biographical Sketches

Viacheslav Korobkov (1939), PhD. Scientific employee of Baltic State Technical University (St.-Petersburg, Russia), expert in the field of applied hydrodynamics and until recently, head, sector of appropriate laboratory of institute. More than 20 years he is involved in problems of ocean energy conversion, ocean ecology. Author of 100 scientific work, 5 books and 25 inventions including the works on indicated problems.

Albert Ilyin (1935), Professor, faculty of heat-and-power engineering, Astrakhan State Technical University (Astrakhan, Russia). Many years he has worked in research institutes in Vladivostok and has built up a reputation as expert in the field of general, ship and industrial power engineering on traditional and on renewable sources of energy including energy of the ocean. Prof. Ilyin supervised several projects in the large Russian power programs. As a result he published more than 300 scientific works and inventions. He is an active member of Russian Academy of Engineering Sciences and of International Academy of Ecology and Safety of Ability to Live.