EXPERIMENTAL MARINE STUDIES IN BATUMI AND ANAKLIA WATER AREAS

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Be received 27. 10.2014

The elaboration of economically effective methods of hot- and cold-water supply is one of the most important tasks on a scale of the whole country.

The objective of experimental investigations in the Black sea was to define the parameters of thermoclines in the sea areas of the cities of Batumi and Anaklia. As a result of experiments, we established the coordinates of the least distance of thermoclines from the sea coastline.

Since the recorded experimental values of seawater temperature in thermoclines are constant (8^0C) throughout a year, they indicate the justified good prospects and cost-effectiveness of hot- and cold-water supply systems when deep water layers of the Black sea are used.

Definition of the efficient as well as ecologically clean method of heat and cold supply is extremely important problem.

In selecting efficient heat and cold supply method in Georgia, it is important to consider that 90% of Georgian population lives in three climate zones (Black Sea coast, west and east lowlands) within which thecomputation temperature of air when designing heating systems in winter equals to: 1st zone (-2^0C), 2nd zone (-4^0C); 3rd zone (-7^0C). To date, the correlation of prices on natural gas and electricity in Georgia is at such alevel that utilization of air-freon-water type thermal pump for heat supply in all three zones is unprofitable compared to the natural gas within the existing methods defining the efficiency of the heat and cold supply.The concept of energy ecologic coefficient which includes both economic and ecological aspects is suggested in work [1]. In this case, the state giving the priority to the ecological aspects should pay attention to the results listed in [1]. It should also be noted, that if the heat source is of positive temperature, namely water, then the reverse thermal pumps during hot water supply as well as providing coldwhen heating the consumers have no alternative.

In permanent increase of price on natural gas the above mentioned makes utilization of both air-freon-water type thermal pumps and even more efficient water-freon-water type thermal pumps in reasonable environmentvery actual. Such a reasonable environment is very characteristic to Georgian Black Sea coast.

The Black Sea is unique all over the world due to its thermocline within which the water temperature value does not change over the year [2]. Thermocline is both tremendous heat source (for thermal pumps in heat supply) and cold source for air conditioning in summer without using air-conditioner as a device [3].

Approximately 20 million various power thermal pumps operate in the world. Under the forecast of World Energy Committee, by the year 2020 75% of the heat supply will be implementedwith the thermal pumps in the developed countries [4].

The efficiency of the thermal pump largely depends on the temperature interval it operates with. For example, in Russia when the temperature is -20^0C which is normal for Russian

latitudes, utilization of air-water type thermal pumps does not save fuel in supplying electricity through the heat electro-power station [5]. It is opposite in Sweden where the sources for the electric power are hydropower stations and nuclear power stations, 20% fuel efficiency versus boilers is achieved byt_0= 4^{O}Csea water operated water-water type thermal pumps.

The climate conditions and abnormal temperature distribution of the depth water of the Black Sea over the Georgian Black Sea coast make the utilization of the thermal pumps reasonable from both economic and ecological viewpoints. For example, in Achara because(1) environmental air computation temperature in designing the heating systemis -2^{0}C, (2) under the available data the depth sea water temperature (at 50m from sea level) is approximately t_0= 6-8^{O}C and actually of constant value all year round, the thermal pump has higher value of thermo transformationfactor than when t_0= 4^{O}Cresulting in the reduction of the prime cost of fuel.

In addition, the depth sea water with the temperature of t_0=8^{O}C is optimal for cooling air in summer by supplying it to Fan Coils or by supplying fresh water chilled in the inter-loop heat exchangers to Fan Coils.

Currently, such a method of air conditioning in form of two-loop system is implemented at Cornell university of USA [6]. Consumption of the electric power in this system is 10 times less than the consumption of the electric power when utilizing conventional method of air conditioning (with compression refrigerating).

In the 80-ies one-loop air conditioning system (ventilation with cold air) based on using the Black Sea depth water which consumes 15 times less electric power than it does with the conventional method was suggested at Georgian Scientific-Research Institute of Power Engineering [7]. But in most cases, we believe, that the priority should be given to the two-loop systems [3].

Available (some 100 year old) data about the depth water temperature and distribution of its value by depths in the Black Sea cannot serve as the basis in designing heat and cold supply of particular units, as even 1^{0}C difference significantly impacts the system efficiency. Respectively it is necessary to run marine experiments within the sections of each particular water area in order to determine the heat and cold source, i.e. minimum distance of thermocline from the shore.

Experimental studies were run in Batumi and Anaklia waters in 2009-2010 and 2013 as the requirement of the marine experiments is minimum 2 year cycle due to the varying nature of the sea water wave and near bottom and upper layer flow.

The depth water temperature distribution by depths has been experimentally studied by us, at the same time we surveyed electric conductivity of water(to identify salinity) and pressure (to accurately measure the depth from the sea level). Modern the so called CTD sensors functioning online have been used for the mentioned parameter surveys. The parameters have been measured with various time step-intervals. Maximum interval made 15 minutes. The experiments were run in summer (June-September).

Within the scope of the studies run, the parameters were measured from four platforms located at various isobaths, at various depths from the seal level, obviously including the bottom of the sea and at 3.5-5 m distance from the bottom (see principal chart on figure 1.). Principal chart of the long-term continuous measurement system is given on figure 2.

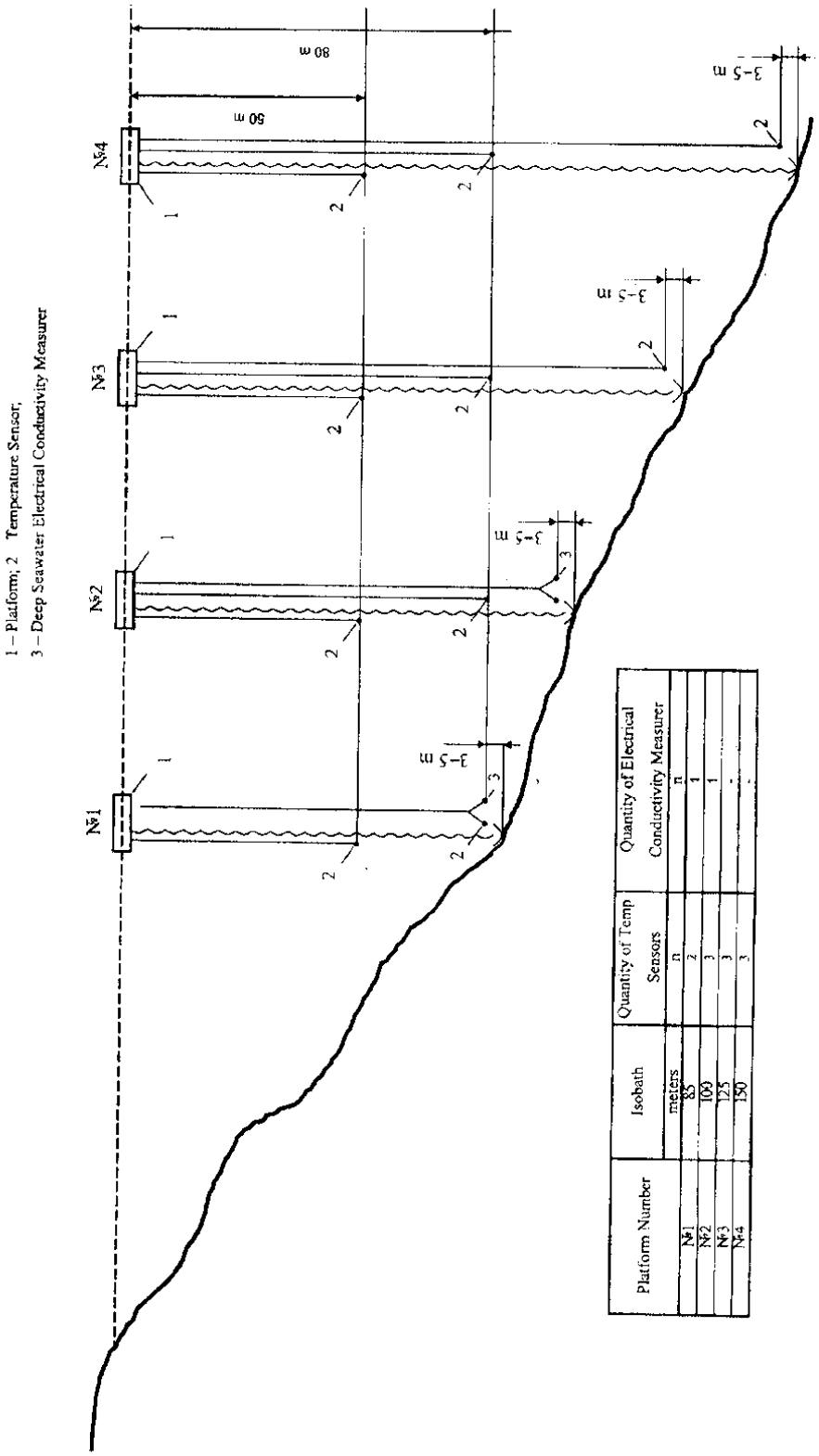

Figure 1. Principal Chart of Measuring Water Parameters at Various Depths of the Black Sea Besides, chemical and biological tests of water sample taken from 80m depth have been run

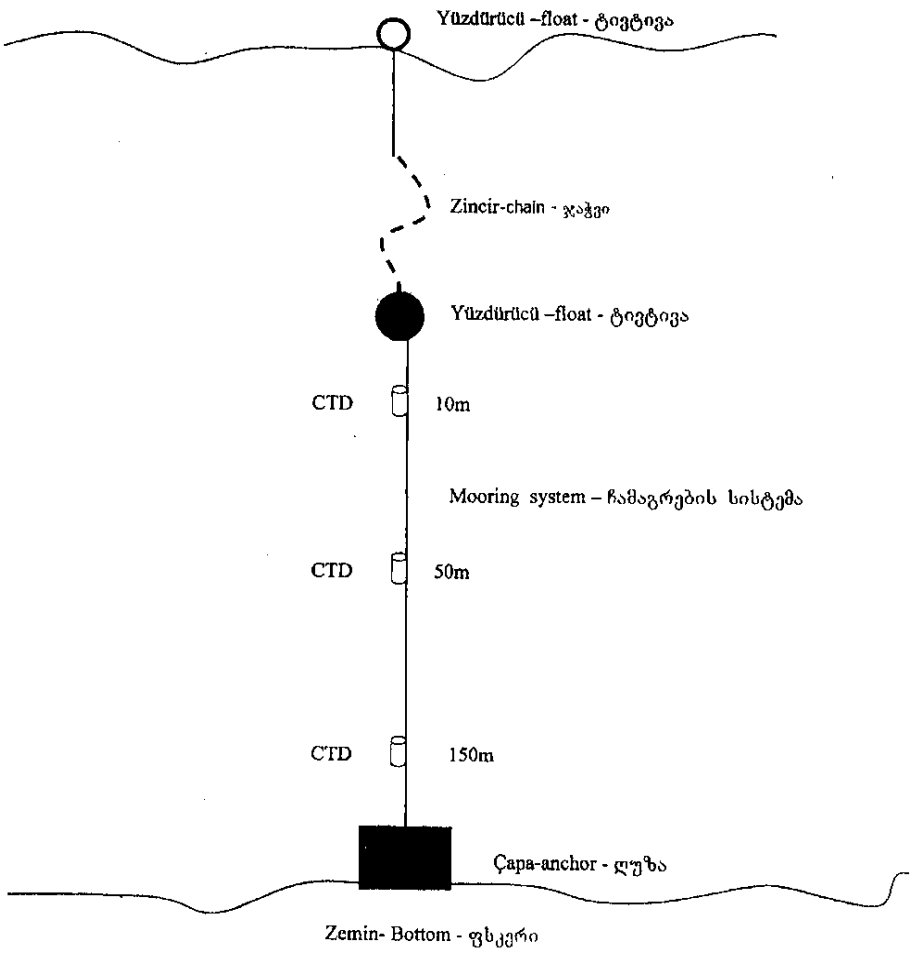

Figure 2. Long-term – continuous measurement system

Results of the experimental studies run at all four platforms showed the presence of thermocline both in Batumi and Anaklia water areas (see figure 3). Minimal depth sea water temperature values have been identified within 60-80 m depth.

Dependence of the water temperature value on the isobaths value close to the bottom within the water intake area for the heat and cold supply in Batumi water areais given on figure 4. The results of Anaklia surveys are shown in Table 1. The water temperature values in the identified thermocline satisfies the requirements of cold generation for air conditioning in summer providing also efficient operation of the thermal pump in Autumn-Winter period for heating purposes and ensures hot water supply all year round.

The results obtainedmake us conclude that utilization of thermocline water for heat and cold supply of the large units (hotels, health care and sanitation units, port facilities, logistic centers, etc.) located on the Black Sea coast of Georgia has no alternative as according to [3], when the depth water temperature is 8-10^{0}C, in air conditioning in summer, 11 times less electric power is consumed with the innovative technology than with conventional method and the operation costs of the heat supply are 3 times less than in case of heat supply with natural gas.

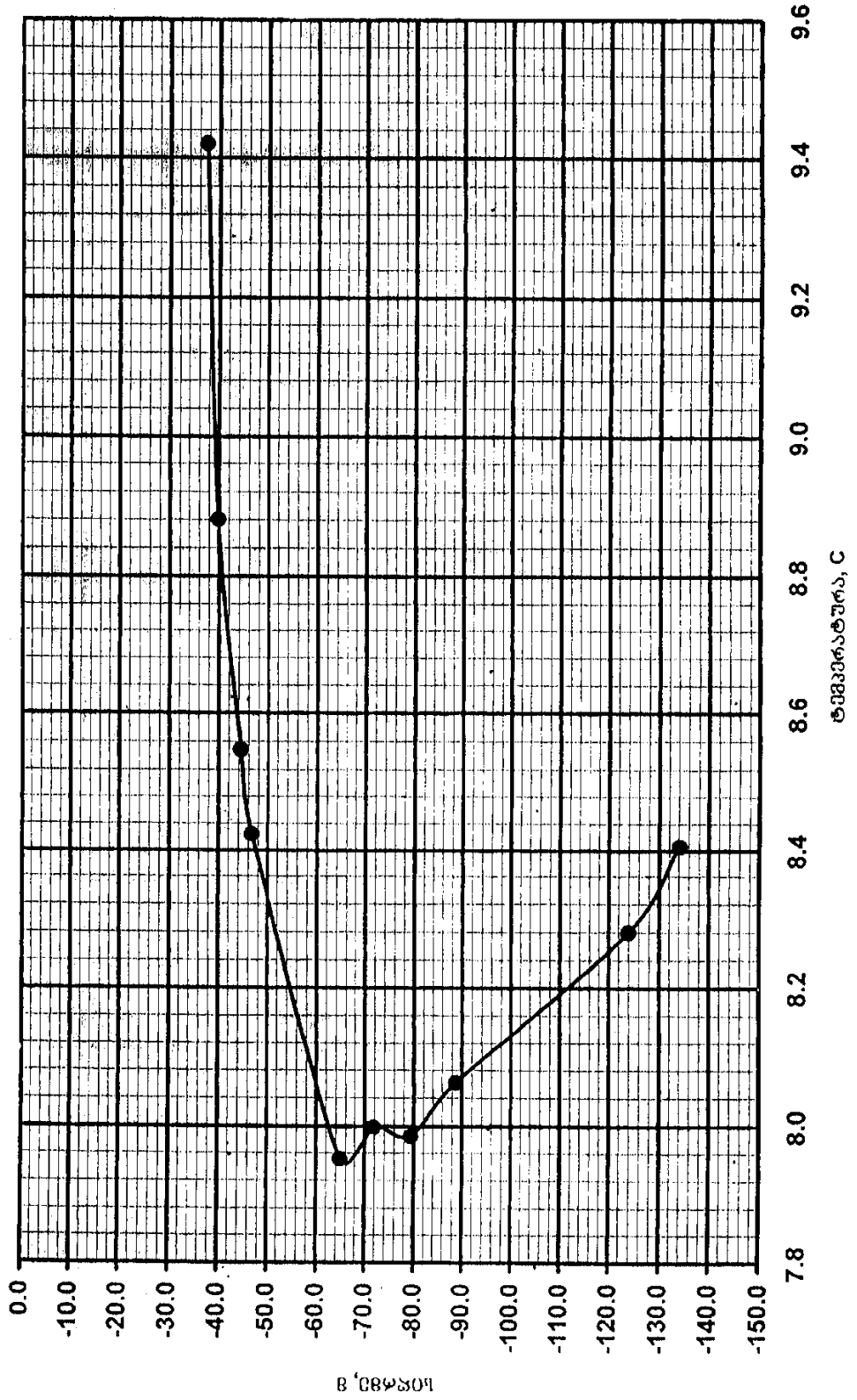

Figure 3. Dependence of Depth Water Temperature on the Depth from the Seal Level in Batumi Waters

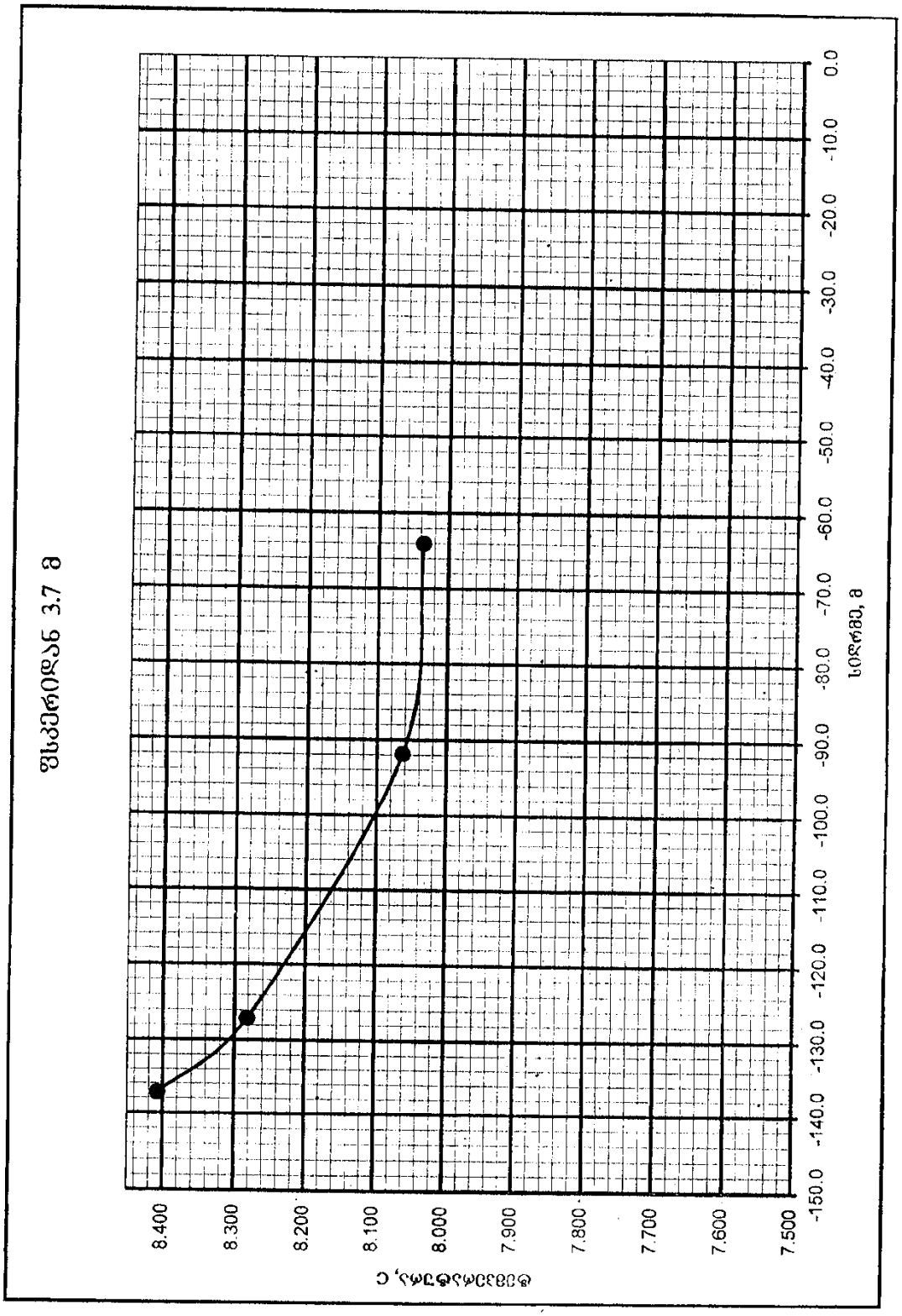

Figure 4. Dependence of the Depth Water Temperature on Isobath Value at 3.7 m distance from the Bottom in Batumi Waters

Table

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It should also be noted that in case of the above discussed method there will be no greenhouse gas - carbon dioxide generation hence its emission into the atmosphere.

Finally, we, the authors, would like to thank Georgian Rustaveli Foundation and Mr. Ioseb Orjonikidze, Georgian businessman working in Moscow,for funding our experimental studies.

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