In the concluding address we pointed out that the readiness of TPS projects for their realization can be stated with certainty. The most important aspects of design, equipment, structural elements, construction technology, have been solved, and what really matters is, there are no contraindications in the area of ecology for their realization.

It is now necessary to prove to governments, companies, and the public the need for constructing TPSs, which make a high contribution to saving people living in the region of these stations from the harmful effect of emissions of thermal power stations. This position is reflected in the declaration and appeal. It should be noted that the symposium, the decision on conducting which was made several years ago, showed the enormous significance of comparing various decisions for the quality of the projects. The extensive spectrum of designs presented and discussed, especially personal contacts, enrich the creative mind and enable finding and realizing new ideas.

It is impossible also not to mention the original culture program which, in addition to traditional excursions in Moscow and St. Petersburg and sightseeing in Murmansk, included also a tour of the "White House" region, attended by accompanied by guards, by Artem Kolesnikov, co-worker of Gidroproekt, and meeting with defenders of the Arctic region, attended by Britains and Americans, which excited the foreign participants of the symposium.

The words of Dr. Wilson that St. Petersburg is a most beautiful city and other specialists that the complex of structures for flood control, which Yu. K. Sevenard showed to them and which made an unforgettable impression on them by its grandly designed plan and perfection of execution, were dear to us, the Soviet participants of the symposium.

NEW APPROACH TO THE USE OF WAVE POWER PLANTS

A. L. Zuikov, V. A. Linyuchev, V. I. Lubanovskii, and B. E. Monakhov

The energy of tides and wind waves stand out among marine renewable energy sources with respect to the degree of study. In the world there are several operating tidal power stations (PPSs) and wave power plants (WPPs) having an insignificant capacity. In the USSR the PPS in the Tugur Bay in the southwestern part of the Sea of Okhotsk in the region of the Shaniarskie Islands is among the largest being planned. The Tugur PPS will have a maximum capacity of 6800 MW (420 units each with a capacity of 16.2 MW). The retaining structures of the PPS will be the powerhouse and bank dams. The total length of the retaining front is 17.6 km, including 10.1 km of the powerhouse of the PPS and two stretches of the earth dam with a length of 2.4 and 5.1 km. The powerhouse of the PPS is constructed from floated-in blocks, the hollows of which are filled with soil after installing in place. The thickness of the walls and partitions of the floated-in blocks is 35 cm, which determines the inadmissibility of a considerable dynamic effect of wind waves and the effect from moving ice floes. The inadmissibility of sea waves overtopping the crest of the dam leads to an increase of its elevation, which increases capital investments.

Furthermore, the wave effect creates certain difficulties when operating the PPS owing to the fact that the acting heads are commensurate with the height of large waves.

In principle it is possible to reduce the effect of wind waves on PPS structures in two waves: the first is the construction of breakwaters of traditional designs used for protecting ports and coastal structures; the second is the installation of wave power plants.

The existing breakwater structures are divided mainly into three classes: stationary with support on the ground, floating, and pneumatic. With consideration of the considerable length of the upstream face requiring protection from waves and the considerable (up to 25 m) depth at places of installing breakwaters, it can be assumed that the cost of stationary breakwater structures will comprise a considerable part of the cost of the main structures. Therefore, with consideration of the rather large capital investments, the use of stationary breakwaters is not expedient. Floating breakwaters do not differ in operating principle

Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 2, pp. 7-10, February, 1992.
Fig. 1. Rocking wave power plant according to Skarney's patent: 1) hull; 2) pontoon; 3) partition; 4) hydraulic turbine; 5) generator; 6) anchor cable; 7) working fluid.

Fig. 2. Scheme of OWC and pneumatic breakwater: 1) conical reinforced-concrete structure of the OWC; 2) air chamber; 3) air collector with check valve; 4) pressure booster; 5) pressurized header; 6) compressed-air pipeline; 7) perforated pipe; 8) air curtain; 9) structure being protected.

from the majority of the structures of wave power plants, since the energy of waves is absorbed by the floating operating elements. The cost of a WPP can exceed the cost of floating breakwaters due to the presence of one or two energy conversion loops, but the useful energy being removed by the WPP considerably exceeds their cost effectiveness.

Pneumatic breakwaters, creating a curtain of air bubbles, have a good wave-suppressing capacity, but they have a substantial shortcoming consisting in the consumption of a considerable amount of electrical energy for driving the compressors. Therefore, the use of pneumatic breakwaters in regions experiencing difficulties with electrical energy is not expedient. But in the case of using wave power plants for producing compressed air, this method of protection from waves, as will be shown below, is economically rather effective.

Wind waves in the region of sitting of the PPS are characterized by the following characteristics:

Large waves with a height of more than 1 m can be observed on average from July through October, when the sea surface is free from ice;

The wave height of 50% probability is 2.2 m with a period of 7.2 sec. Storm waves of 1% probability can reach a height of 6 m with a period of 8.8 sec, and during passage of cyclones (lows) the maximum wave height can reach 8-9 m.

When selecting protective wave power plants it was required that the waves acting on structures of the PPS be limited to a height of 3 m under any storm conditions.

It is understandable that the calculation and design of a WPP to absorb waves with a height of 6-9 m will lead, first, to an extreme increase of their cost (commensurate with additional investments in protecting the TPS) and, second, to a decrease of the energy efficiency from the viewpoint of tapping the wave energy owing to the large inertia of the structure of the WPP.

Therefore, a new approach to controlling the effect of storm waves on the WPP was selected: the use of the excess wave energy for its dissipation. This approach provides also the principle of self-regulation, i.e., the greater the wave energy, the greater the part of it which can be used for its dissipation.