Power Supply of Mariculture Complexes

V V Loshchenkov¹, V V Knyazhev¹

¹Institute of Marine Technology Problems FEB RAS, Sukhanov st., 5A, Vladivostok, 690091, Russia

E-mail: lab_07@marine.febras.ru

Abstract. The authors have developed a complex for the cultivation of marine aquatic organisms, including a coastal fry breeding plant and marine plantations in the water column on the deep-sea shelf, installed with a bottom anchor. The autonomy of the plant and marine plantations is ensured by the automation of technological processes with energy supply from renewable sources. The development is based on the task to expand the capabilities of mariculture by creating autonomous automatic installations for growing marine aquatic organisms with remote dispatch control and management. This solution provides the possibility of placement away from the coast and automatic program selection of the optimal immersion depth of cultivated aquatic organisms to intensify the growth of aquatic organisms and escape from the storm, and service by standard methods of the fishing fleet without diving operations. Solving this problem will increase the efficiency and scale of mariculture in food production and introduce into practice autonomous biotechnical systems for biological treatment of sea areas exposed to anthropogenic impact.

1. Introduction

The climatic conditions on the coast in the North-Western part of the Sea of Japan determine a number of problems in the development of mariculture in the Primorsky Krai, and the most important is the energy supply of modern technologies for the cultivation of marine organisms in hydraulic structures located on island territories and on remote coasts that are not connected to a single energy system. New industrial methods of breeding mariculture require high energy costs [1]. Currently, for the autonomous supply of production facilities, electric power generators and heating and heating installations using fossil fuel are used, which have a harmful effect on the environment and are not economical. One of the promising ways to solve this problem is the use of systems for generating heat and electricity based on renewable energy sources from the environment, such as geothermal, thermal and wave energy of the ocean, solar and wind energy [2].

2. Relevance

Currently existing coastal marine farms use the coastal waters of bays, bays, river mouths. At the same time, the recreation area of people is rejected, the exchange of water in the coastal zone is hampered, and the litter of the coastal water area occurs. The farms themselves are susceptible to storm damage and freshening. One of the ways to solve the problem of increasing the production of mariculture is the use of hydraulic structures with an anchor on the deep-water shelf.

In solving the problem of coastal water purification, marine aquaculture farms can also contribute, which will not only produce biomass of plants and animals, but also biological water purification.
Hydrobiological methods of combating water pollution using mariculture have been proposed and are being developed [3,4,5,6].

3. Statement of the problem

It is necessary to resolve the issues of power supply for the coastal plant, autonomous automatic plantations in the aquatic environment and an auxiliary semi-submersible platform vessel in the Peter

Figure 1. Figure 1. Scheme of an autonomous plant for breeding aquatic organisms: 1- control valve; 2- circulating pump; 3- heat exchanger; 4- heating sector probes; 5- cooling sector probes; 6- heat exchanger.

A - thermostatically controlled circulation circuit, replenishment of pools, filling, heating and water exchange of the reserve tank;
B - heating-cooling circuit of pools, reserve tank and make-up, thermostated (protection against overheating-overcooling of circuit A);
C - solar heating and night cooling circuit, thermostated in direct solar heating mode;
D - heat and cold extraction circuit from the surface waters of the adjacent water area;
E - fresh water circulation - pool water exchange, waste water dilution;
K - purification, normalization of water in pools;
M - heating, cooling of premises;

the Great Bay. The technology is considered with surface maintenance of sea plantations using standard methods of the fishing fleet, without diving operations, with devices for autonomous automatic growing of aquatic organisms in the water column. In the considered method of mariculture, it is proposed to carry out underwater plantations to the shelf of the open sea. The placement of mariculture plantations in the water column above the shelf of the open sea, in addition to its scale, involves the use of artificial mini-upwelling of huge stocks of bottom detritus with living matter, this
significantly expands the entire production spectrum, allows you to choose the type of hydrobiont, the stage of growth, the degree of growth intensification, the degree of biological purification of bottom sediments and waters of the adjacent water area. In their natural habitat, the viability of grown aquatic organisms will increase, and help to the Ocean in clearing the waste of civilization will become significant. The main task is to supply power to instruments and subsea technological processes. Surface wind waves serve as an environmentally friendly renewable energy source for this technology. Consider a wave power plant for autonomous power supply of devices and devices for underwater mariculture plantations.

4. Plant for growing juvenile aquatic organisms
The coastal breeding plant, due to its location in remote, inaccessible ecologically clean areas of the coast, with valuable local species, is made semi-automatic, in a modular design. The plant is located, after studying local geological, meteorological, hydrological and hydrobiological parameters in places of maximum energy flows [6] Pool modules and energy modules are made depending on the type of hydrobiont and local natural renewable energy sources. Figure 1 shows a diagram of a plant for breeding aquatic organisms on Popov Island in the Peter the Great Bay, developed for a mariculture enterprise, with the development of modular solutions. Automation of technological parameters of water exchange and climate, minimum rotational service personnel and remote dispatch control by narrow specialists will create conditions for the development of production in remote areas with minimal environmental damage.

Figure 2. Modular autonomous automated biotechnical construction for cultivation of various types of marine aquatic organisms. 1-bottom anchor; 2 - electric cable winch; 3 - platform; 4 - anchor cable; 5 - automatic mechanical spring rod air valve; 6 - wave energy device; 7 - cable-rod with an air pipeline; 8 - automatic software monitoring and control unit with dispatching satellite communication; 9 - a set of sensors: battery charge, air pressure in the pontoon and the height of surface waves; 10 - a set of sensors for depth, illumination, temperature, salinity, oxygen content and water flow rate; 11 - rigid loop; 12 - rigid lattice; 13 - elastic floats; 14 - collector cables with aquatic organisms; 15 - rigid lattice of hollow pipes; 16 - flexible guys; 17 - cable-rod with an air pipeline; 18 - airlift intake; 19 - cable-rod with air duct and airlift pipe of bottom detritus.
5. Marine aquatic farm

Industrial cultivation of aquatic organisms, as close as possible to natural conditions, without rejection of the coastal strip, with the preservation of ecological parameters and local species, possibly in the marine pelagial on autonomous plantations, in the deep-sea shelf zone. Figure 2 shows a schematic diagram of the subsea farm-plantation segment.

The energy needs of the Farm are provided by a wave power plant through an electric accumulator and a tank with a supply of compressed air, fed by an electric generator and a piston pump [7, 8]. For example, a Farm with a Platform with a size of 20x20x10m for growing filter feeder organisms (bivalve molluscs), having 1000 collectors, with an initial mass of cultivated marine organisms on collectors of 2 kg / 1m² until the marketable mass on the collectors reaches 200 kg / 1m², it will consume electricity per shift during the year. depth, operation of sensors and a control unit with satellite communication 28 kWh on average per day. For a mechanical air pump, when changing the Platform depth with a drop of 20 meters and a capacity reserve with a multiplicity of 2, an electrical equivalent with a power of 0.25 kW is required. A total of 12,410 kWh is needed for a growing period of 1 year. A wave power plant with an average actual electrical power of 0.4 kW is required. The parameters (dimensions) of the wave power plant, at a given electrical power, are also determined by the size of the compressed air accumulator, which is dependent on the hydrographic forecast. For the open part of the Peter the Great Gulf (Sea of Japan), taking into account long-term data on the duration and magnitude of the wave flow, with a coverage of 80%, a wave power plant with a pontoon diameter of 1.5 m and a weight of up to 1000 kg will be required.

There is no diving work on the farms. Surface work is performed by a specialized semi-submersible dock ship. The semi-submersible dock is used for, settling larvae on cages, assembling farms, arranging farms in the offshore zone of the open sea for growing aquatic organisms and removing farms for harvesting and processing crops. In order to save energy costs, the supply vessel is provided with a wave energy device, the main elements of which are the ship's hull and floating anchors lowered to a depth with flexible communication. The wave device works during periods of plantation maintenance as a generator of electricity and a vibration damper.

Autonomous automatic installation for growing marine aquatic organisms works as follows. In the Installation, after manufacturing and assembly, the operability of all systems is checked and the programs are configured, and then the Installation is disassembled and brought into transport state. At sea, in transport condition, the Installation is delivered to the place of setting by a supporting semi-submersible dock. The resettlement of cultivated aquatic organisms on collector cables is carried out on a supply vessel in the basins before being placed in the reservoir. Upon arrival at the place of setting, the truss is assembled on the deck without connecting the collector cables 15 (Figure 2) and the operability of all systems is checked. After checking in the compressed air system, the pressure is released, then the supply vessel is submerged, the lattice of pipes 14 with floats 17 floats above the deck and collector cables with attached hydrobionts are attached to the lattice. The truss is installed in the workplace with ship lifting equipment. First, a bottom anchor 1 with a winch 2 and a cable-cable 4 is installed, then platform 3 is brought out into clear water. At a distance from platform 3, a wave device 6 with a cable-cable 7 is lowered into the water. At the direction of the dispatcher, the control unit 8 slowly plunges winch 6 platform 3 to a predetermined depth, and the farm goes into autonomous program mode. In the initial period of growing, platform 3 has positive buoyancy due to the volume of the cavity of the lattice of pipes 14, which gives the wave unit 6 time to fill the compressed air system. Further, there is a long-term automatic process of growing aquatic organisms to the specified characteristics with regulation of the tension of the cable-rope with increasing weight of aquatic organisms, with the possibility of changing the depth in daily, seasonal periods and when a storm approaches. Changing the depth of platform 3 in automatic mode is as follows: the program of the control and management unit 8 using sensors 9 determines the depth (in the permissible depth horizon) with optimal characteristics for aquatic organisms and, in the case of permissible wave height on the surface, the winch 6 sets the platform 3 to the calculated depth; the depth change occurs slowly with stops to return the tension value of the cable-rope 3. When lifting platform 3, the water pressure
decreases, the volume of elastic floats 17 increases, the tension of the piston 28 (Figure 3) is increased by the truss, the spring 35 is compressed, the hole 30 is displaced to alignment with the hole 34, the air from the buoyancy of the truss is released into the water, the volume of the floats decreases, the tension is restored and further rise is possible. When the truss is submerged, the water pressure increases, the volume of the floats 17 decreases, the tension of the piston 28 (Figure 3) by the truss decreases, the spring 35 expands, the hole 30 is displaced until it aligns with the hole 33, the compressed air from the wave installation enters the buoyancy, the volume of the floats increases, the amount of tension is restored, hole 30 is located between holes 33, 34 and the next immersion cycle becomes possible. The change in the depth of the platform can also be set to the control unit 8 (Figure 2) via satellite communication by the dispatcher. At the end of the growing process and the approach of the serving vessel, the dispatcher gives the command to the control unit 8 via satellite communication to raise the platform to the surface. First, the wave device 6 is lifted aboard. After the floats 17 emerge on the surface, the service vessel is submerged and the farm is displaced to a place above the submerged deck, the service vessel floats, the harvest is harvested on the deck. The wave set is also lifted aboard and after maintenance work, the farm is returned with a new batch of aquatic organisms for cultivation and the wave device in place for the next cultivation cycle. If necessary, a complete removal of the farm or a complete replacement is possible.

Figure 3. The automatic mechanical spring-loaded rod air valve in the operating position contains: a piston 26; eye 27; hollow sliding rod 28; hole 29 connected by pipeline with the buoyancy of the farm; hole 30 for inlet to buoyancy of compressed air from the wave installation or release of air from the buoyancy of the farm into the water when the rod 28 is displaced; cylinder 31; eye 32; hole 33 for supplying compressed air from the wave installation; hole 34 release of air from the buoyancy in the water; compression spring 35.

6. Conclusion
This development will increase the efficiency and scale of mariculture in the production of food products and introduce into practice autonomous biotechnical systems for biological treatment of marine areas exposed to anthropogenic impact. Automation of technological processes, power supply from a renewable source and remote dispatch control and management of a marine farm will allow access to areas of water areas remote from the coast. Alignment of mathematics

The preferred style for displayed mathematics in *Journal of Physics: Conference Series* is to centre equations; however, long equations that will not fit on one line, or need to be continued on subsequent lines, should start flush left. Any continuation lines in such equations should be indented by 25 mm.

Equations should be split at mathematically sound points, often immediately before =, + or – signs or between terms multiplied together. The connecting signs are not repeated and appear only at the beginning of the turned-over line. A multiplication sign should be added to the start of turned-over
lines where the break is between two multiplied terms, is factorized; do not use abbreviations such as ‘eqn.’ or ‘eq.’.

7. References

[1] Molotkov V E, Volkov A V 2008 Renewable energy sources in hydrotechnical systems for cultivation of marine hydrobionts Vestnik FEB RAS 3 (Vladivostok) pp 105-11
[2] Knyazhev V V, Loshchenkov V V 2018 Energy Supply of Marine Autonomous Objects from Renewable Energy Sources Offshore, Arctic and Renewable Energy Technologies, 13th ISOPE PACOMS Symposium (Jeju Island, Korea)
[3] Alemov S V 1987 On the creation of artificial colonies of mussels for the purpose of hydrobiological treatment of oily sea waters Arts. reefs for fish. households abstracts. report Vses. Conf (Moscow, December 2-4) pp 69-71
[4] Mironov O G 1997 Hydrobiological method of combating pollution of marine water area Patent UA 21460 IPC A 01K 61. Bul. 16.12.1997
[5] Polyakov A S, Grintsov V A, Gubanov V I, Subotin A A, Ivanov V N 2006 Method melioration of coastal ecosystems Patent UA 7735, IPC A 01K 61/00, Bul. 15.11.2006 11
[6] Molotkov V E 2013 Biotechnical complexes of mariculture in the system environmental safety of seaport waters Anniversary. int. scientific. practical confer. "White-Nights-2013” 3-5 June 2013 St. Petersburg Part II (St. Petersburg. SP. Pavlushkin V.I.) pp 164-66
[7] Loschenkov V V, Knyazhev V V, Kopylov V V, Kirik N S 2014 Marine wave power plant Utility model patent RU 145688 F03B13 / 12 Bul. 27
[8] Loschenkov V V, Knyazhev V V 2014 Power supply of perspective complexes mariculture 2nd Asian Wave and Tidal Energy Conference (AWTEC-2014) (Tokyo) p 44