Year-round fish breeding on energy saving principles of industrial aquaculture

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Abstract. With a view to year-round valuable fish farming a control system terming their breeding and growth, protected by USSR inventor's certificates and Russian inventor's patents, was developed. The management principle is fish contents in "critical" salinity along with the simultaneous thresholds "signal" factors (temperature and light) and subsequently obtaining offspring and juveniles in complex of optimal ecological conditions.

For the implementation of the proposed industrial biotechnology and year-round fish farming a new installation of water recycling system (WRS) hatcheries and farms was developed by means of the underground conditioning of fish cultivation medium. Their essence is that fish farm water supply systems are additionally provided by underground, or in a half in ground large volume tank-sump tanks. Such WRC, being isolated from climate conditions, allow to conserve and use natural seasonal water resources and first consensually resolve earlier alternative volume-dependent energy problem (requiring lower volumes of water) and water purification (requiring its increasing) in septic tank-sump tanks. The basic principle of their operation is filling one tank-conditioner by "cold" water and the other by "warm" at the appropriate seasons and by additional water supply fish farm systems water circulation. Techno-economic calculation shows, that with the increasing volume of such water air conditioning heat transfer will be proportionally reduced, but productivity increases and reduces its system specific cost while maximizing reliability.

Introduction

On the basis of constructive working schemes of fish neurosecretory brain centres participation in reproduction by means of their maintenance in material-energetic body homeostasis the control system terming breeding and growth of valuable fish was developed with a view to year-round fish aquaculture [3]. Specifically to stimulate breeders maturity preparations of isolated anterior and posterior lobes of the pituitary gland were developed and introduced in sturgeon culture. It allows to enhance breeders industrial usage to an average of 15% (inventor's certificates ## 719671, 1163817). To delay breeders maturity, to reserve their brood stocks and to accelerate growth of juveniles the method of their industrial reservation and growing in critical salinity medium 4-8‰ was produced (inventor's certificates ## 965409, 682197, Russian inventor's patent # 2582347). This external nature medium, close to the inner body medium, provides energy-efficient osmotic equilibrium between them and therefore optimizes fish reproduction, growth and survival [3]. Ecological-physiological principle of management is The management principle is fish contents in "critical" salinity along with the
simultaneous thresholds "signal" factors (temperature and light) and subsequently receipt offspring and cultivation juveniles in complex of optimal ecological conditions (figure 1).

![Diagram showing principle of fish breeding and accelerate growth management](image)

**Figure 1** Principle of fish breeding and accelerate growth management by the triad of leading environmental factors: signal (T°, L) and phylogenetic (‰) values, providing metabolic (material and energic) body homeostasis on the example of fish migrations basic mechanism [by: 3]

**Results**

For the implementation of the proposed industrial biotechnology and year-round fish farming a new installation of water recycling system (WRS) hatcheries and farms was developed by means of the underground conditioning of fish cultivation medium (inventor's certificates #982614, figure 2A.; Russian inventor’s patent # 2400975, figure 2B.).

![Diagram showing water supply system](image)

**Figure 2 A.** Water supply system of combined type farms for fish species spring- and autumn-spawning reproduction. The system contains 2 underground tanks (1, 2) located below the layer of seasonal frost penetration (zone a.), each of which is connected with fish pools (5, 6), with means of aeration and water purification (7).

**Figure 2 B.** Water supply system of the fish hatcheries, which includes sediment tanks, partially buried in the ground (1, 2), fish ponds (4, 5), auxiliary water treatment (6).
Systems are based on natural and industrial principles of environmental engineering [1] and the new energy-saving principle of subterranean hydro-conditioning of fully managed medium for fish cultivation [3].

They also are operated on the basis of a new principle of fish cultivation management biotech by the triad of environmental factors (see figure 1) and therefore, are fundamentally different from all the WRS developed, that now using in fish farms and considered the most perspective [2, 4, 5].

The essence of new technological solutions is that fish hatcheries and farms water supply systems systems are provided additional by large volume underground tanks buried either in the ground or in a half undergrounds (figure 2). Such in fact fundamentally new motherland WRS, isolated from climate conditions, allows to maintain and use the natural seasonal water-energetic resources (instead of reproducing the seasonally lost) and firstly to resolve consensually earlier alternative volume-dependent energy problem (requiring lower volumes of water) and water purification (requiring increasing amounts of water) in tank-sump tanks.

Storage tanks (figure 2a) may be equipped with heat exchangers that provide long-term seasonal water term stabilization in the system, which consists of 2 different tanks placed below ground layer below seasonal frost soils (zone a: 1, 2) and communicating with the ground mines (3, 4). 1 reservoir associated with fish pools (5, 6), with means of aeration and water purification (7) through a system of pipelines (8, 9) and pumps (10), and the tank 2-through piping system (11-13)-with pumps (14). Return water from fish basins, aeration and cleanup tools is realized through pipelines (15-17) running spray aeration nozzle (18, 19). At the bottom of the tanks placed water intake tube (20, 21), connected to the piping. 1 tank is equipped with an internal heat exchanger (22), United with artesian water supply system (zone c: 24). Heat exchanger (22) connected through the control valve with a nebulizer (18). The outside of the tank 2 installed heat exchanger (29), housed in the groundwater zone (zone b) and connected in parallel to the reservoir and pipeline 2 13. Regulating valves (30, 31) allow you to skip the water from the tank through a heat exchanger 2 (29), or bypassing it. The basic principle of operation systems is filling one tank-air conditioners «cold» water (e.g. with 3-7°C) and the other "warm" (9-15°C) in the appropriate seasons and water them further land-based hatcheries pools closed water circulation systems. Reviewed and management options composition of water and prolonged heat sunk its system of interseasonal heat exchangers in the relevant ground zones (figure 2A).

For breeding spring-spawning fish and reservation autumn-spawning water supply is carried out from the tank 2 (9-15°C); for breeding autumn-spawning and reservation spring-spawning fish – 1 tank (3-7°C). In summer, the heat setting of cold water in the water tank 1 is carried out by artesian water through a heat exchanger (22) and heat setting (additional insulation) "warm" water through the heat exchanger in winter (29) in the zone all year round warm (with 10-15°C) groundwater. There are a variety of options for use of tanks-in isolation, with a mix of warm, cold river and artesian waters, use of geothermal waters in the lines, etc.

Technical-economic calculations shows that already in the volume of water in the tank from 10,000. m³ speed heat transfer in soil decreases to 0, 1°C per month and below, and the degree of water purification progressively increases due to the sumption effect. With the increasing volume of reservoirs-hydro-conditioners proportional increases productivity and reduces its system specific cost while maximizing reliability, available for any culture.

Principle of this system operation is based on the following common biological and bio-geo-coenological patterns, proven us reference and estimates (if protection of inventions, scientific discussions, research reports):

1) match temperature ranges spring-spawning fish breeding with temperatures reservation autumn-spawning (9-15°C) and vice versa (with 3-7°C), that allows to use 2 temperature modes in two autonomous circulating systems;

2) groundwater and soil temperatures (below freezing) coincide with the seasonal spawning fish bred for local climatic zone (South: sturgeon, carp – 9-15°C; North: whitefish, salmon – 2-7°C with year-round);
3) most common of artesian water temperature (with 5-9°C) close to the essential (3-7°C) tank system 1,
4) any geothermal waters are suitable for additional insulation (with 9-15°C), as well as for different use cases in any system of tanks. ROI application system must grow in regions with short or generally unfavorable growing season.

However, the disadvantage of such a system are the high costs for the construction and operation of underground tanks with mines and heat exchangers, reducing its reliability, as well as large energy consumption for water supply in land-breeding facilities that reduces the effectiveness of the work as a whole.

Therefore, to reduce the cost of building and operating the system, increasing the reliability and efficiency of its work, we developed a new simplified (modernized) device (figure 2B). This task is solved by the construction of a special device the water system tanks households of which fish are recessed into the ground and have calculated the amount of taper and providing heat gradient from inner medium, unlike the previous one, no more than 0,1°C per month. It differs from the previous one so that the water tanks buried in the ground in the upper part and its part, being above the earth's surface, isolated from climatic influences various insulating materials. Their filling with water heat gradient not exceeding 0,1°C per month, they have a conical bottom corner not less than the 45° that provides maximum water circulation for the spillway. On pipelines for water are a means of its aeration and physico-chemical treatment, but for the first time their water pipes are equipped with devices for automatic vertical movement, managed water quality sensors. The latter are designed for water intake of pure water higher than defending the beleaguered mist and its complete removal from the bottom when water outlet. It is important to emphasize that if the gradient of heat transfer to the surrounding (outer) medium 0,1°C per month, the tank volume provided securely 10,000 m³ increased, this ratio decreases even more.

| The cost of non-coastal underground tanks, thousands rub. in prices 2007 year | Volume of tanks m³ | # the model draft (SNIP) | Type of plant forming main indicators date design | Regulatory and estimates | Additional indicators for the calculation |
|---|---|---|---|---|---|
| | | | | | |
| 2.70 | 1000 | 4-18-400 | Smargen farm (project No. 1577) power: 30 million, PCs: the main production of freshwater government; funds: 11.9 million, rub. Water consumption: 31 million, m³/year | Water supply for tank, at water speed recycling | Specific water supply for tank, at limited conditions, estimated calculated under the new scheme |
| | | | | | |
| 3.56 | 2000 | 4-18-500 | Smargen farm (project No. 1523) power: 6.5 million, PCs: the main production of freshwater government; funds: 13.3 million, rub. Water consumption by 50 million, m³/year | Water supply for tank, at water speed recycling | Specific water supply for tank, at limited conditions, estimated calculated under the new scheme |
| 4.70 | 6000 | 4-18-850 | Smargen farm (project No. 1523) power: 6.5 million, PCs: the main production of freshwater government; funds: 13.3 million, rub. Water consumption by 50 million, m³/year | Water supply for tank, at water speed recycling | Specific water supply for tank, at limited conditions, estimated calculated under the new scheme |
| 5.80 | 10000 | - | Whitefish farm (object No. 1361) power: 1.5 million, PCs: yearlings. The main production funds 344,5 thousand, rub. Water consumption: 3.73 million, m³/year | Water supply for tank, at water speed recycling | Specific water supply for tank, at limited conditions, estimated calculated under the new scheme |

Figure 3. Table estimated and estimates for construction and operation of underground tanks for fish farms.
This solution provides lower costs to build and operate the system, increasing its reliability and efficiency through optimizing placement, design and volume tanks. This means the availability of equipment for maintenance and repair, as well as a single level of water filling throughout the system. You do not need the buried heat exchangers and mines and with the increasing volume of tanks and additional means of thermoregulation and water purification. Main technical and economic indices calculation possible exploitation of the system are given in the table. For the effective valuable fish species growth in such WRS it appears appropriate to continue the search, development and testing of such energy-saving critical salinity medium, but already artificial (retrofit) similar tested for effective breeders reserve migratory and local forms of sturgeon and bony fish (inventor's certificate # 965409).

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