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The Conceptual Model of an Automated Information Processing System of Tasks Related With the Agricultere of Fish

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ABSTRACT: The paper deals with issues related to the development of a conceptual model of an automated information processing system of processes associated with fish farming. The main components of the system and the mathematical model are created.

KEYWORDS: Conceptual model, automated system, information processing, process, production volume. mathematical model.

I.INTRODUCTION

The creation of an automated system for processing the feeding process using a computer makes it possible to increase the volume of production of marketable trout, increase the efficiency of its cultivation and reduce the proportion of manual labor. In addition, the creation of an automatic measurement and control system makes it possible to improve the conduct of the technological process.

The automatic fish feeding system must be reliable to avoid significant economic losses. It should also provide for the occurrence of various hazardous situations for fish.

With an automated feeding system, the programs in the computer must be coordinated with the specific conditions for growing trout. When automating feeding, the daily growth of fish is taken into account. Feeding intensity can be either constant throughout the day or variable. The operator should be able to set the maximum or minimum feeding rate for the first or second half of the day.

The introduction of fish feeding automation makes it possible to involve the farm staff in performing other operations, which increases the farm's efficiency, to increase the fish growth rate by 40%, but the feed coefficient is higher than with manual feeding [1].

A. External installation parameters.

The developed design of the feed supply unit will be designed for tanks (pools) with a diameter of 6 to 12 meters. It is a metal frame, in the center of which, with the help of fastening structures in the form of bridges, a feed device (feed dispenser) is installed (Fig. 1).
Subsequently, fish feed will be filled manually (manually) into the hopper of the feed device.

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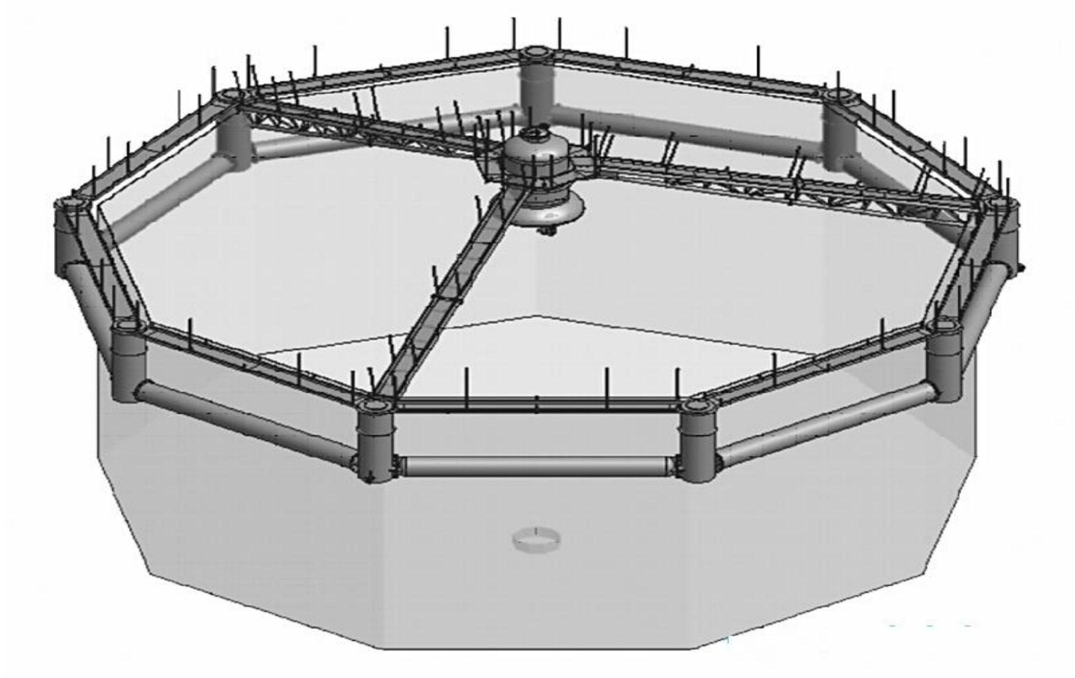

Fig. 1. Sketch of the appearance of the feed unit.

As can be seen in the draft design, the structure does not contain difficult-to-implement elements and details. A distinctive feature of this unit is its ease of assembly and operation.

B.Feeding devices. Selection of the optimal feed dispenser option.

A feeder is a device that dispenses food to fish according to a strictly defined program drawn up by a fish farmer.

Feeders can be driven mechanically, electrically, pneumatically or hydraulically. Therefore, for automatic feeding of fish, a whole system is used, which consists of an AC step-down transformer, an operating and a pause timer, i.e. a control unit that allows you to connect a certain number of feeders to it.

For the project under development, the electric type of the feed dispenser was chosen, since the use of a pneumatic feeder implies the presence of a compressor, which greatly complicates our design and increases project implementation costs.

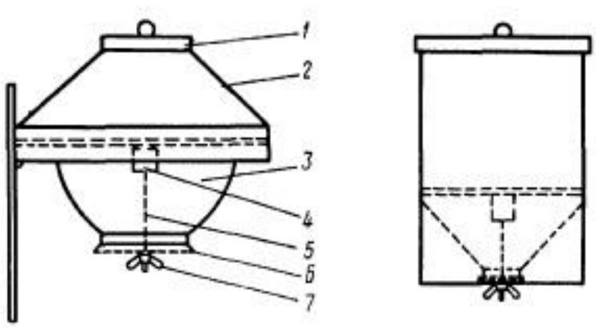

Fig. 2. Electric feeder;
Elements of the feed dispenser: 1 - cover, 2 - hopper, 3 - power supply, 4 - electric motor, 5 - shaft, 6 - distributor disc, 7 - adjusting nut.

The selection of the type of feed dispenser is made taking into account the individual weight of fish, the amount and weight of all fish being raised and the size of the pool.

When installing the feeder, the distribution device is located near the water surface. Feeders should be mounted on a stable base and at the same time not interfere with the fish breeding operations in the pool. The feeder should be easily accessible for adjusting and filling the hopper with feed.

When using feeders and feeders, control over the fish being raised is reduced. On farms with variable habitat conditions, the use of feeders can be negative. In farms with relatively constant living conditions, labor costs are reduced due to the use of automatic feed dispensers.

Consequently, in each specific case, it is necessary to analyze what possibilities are available for the automation of feeding an individual in the conditions of a given economy and what economic effect this can give.

C. Selection of a sensor for indication and regulation of the water level in the tank.

This paper eals with 3 main tasks:

Feeding fish;

Control of the liquid level in the tank;

Water temperature regulation;

At this stage, we will briefly consider the concept and types of level gauges and choose the best option for the design being developed.

Level Gauge - is a device for continuous measurement on an industrial scale of the levels of liquid and bulk materials in various containers, tanks, technological storages, and apparatus. Also the widely used name for level gauges is level sensors or level transmitters.

Level gauges for measuring liquid level are divided into the following types:

Mechanical type;

Hydrostatic type;

Electric (capacitive) type;

Acoustic type;

Radar type;

Reflex microwave (wave) type;

Radiation type;

To measure the water level in the pool, it is more rational to use the mechanical (float) type of the level sensor. Level gauges of this type have a number of advantages, including low cost, high accuracy class and ease of use. Today there are many companies producing this kind of device. One of them is the Hungarian company Nivelco, whose products are of the highest quality.

After reviewing the model range of float level transmitters produced by this company, I settled on the Nivofloat NWP-100 model (Fig. 3). In terms of parameters, this level gauge fully meets our requirements.

Fig. 3. External view of the float level transmitter Nivofloat NWP-100.

This level sensor switches a load of 16 Amperes 250 Volts, which allows you to control the pump without additional devices. The special float shape and high buoyancy ensure reliable control of the water level in the pool. If necessary, NW-100 can be used not only as a level switch, but also to control the drain / filling of clean or service water. The electrical system of the NW-100 level sensor is designed for 107 switching operations. The drainage level sensor cable with a cross-section of copper conductors 3x1 mm2 has an external PVC insulation (Nivofloat NWP 110) or neoprene (Nivofloat NWN 110). The special shape of the float does not require any additional weight or counterbalance.

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Characteristics of the NWP-100 level sensor:

Selecting a sensor for indicating and regulating the temperature of the water in the tank.

Working temperature range of liquids:	0°C to +50°C
Float mechanical protection:	IP-68
Maximum pressure in tanks:	no more than 2 bar
Maximum number of sensor switchings:	At least 10 million
Float rope length:	1 to 25m
Cable section size:	3x1 мм^2
Digital interface:	-
Maximum passive load on the built-in relay output:	250В / 16А

As mentioned above, one of the main objectives of this project is to control the temperature of the water in the tank. There are many instruments for indicating the temperature of liquids. The most common type of such devices are capacitive sensors. They have proven themselves the best in this market. The advantage of these sensors is their relatively low cost, high indication accuracy and long life cycle. The capacitive thermal sensor QAE2111.015 from Siemens was chosen for the developed installation (Fig. 5).

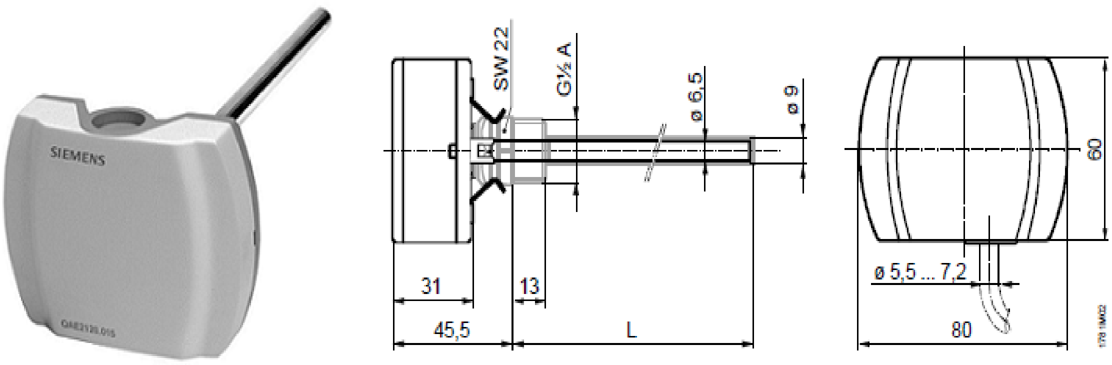

Fig. 5. Immersion temperature sensor.

Immersion temperature sensor SIEMENS QAE2111.015 is used in heating, ventilation, air conditioning and water supply systems to indicate water temperature using a Pt-100 sensor. It has an immersion rod length of 150 mm. In the course of temperature measurement, the signal from the sensor is transmitted to the controller for further processing.

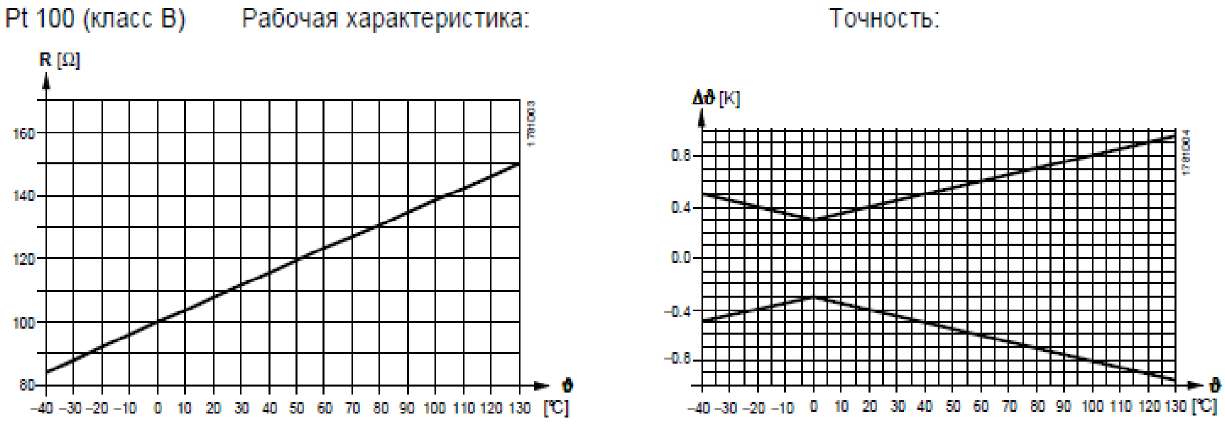

Fig. 6. The working characteristic of the device.

Temperature sensor characteristics:

Temperature measuring range :	-30°C to +130°C
Protection class:	IP42
Immersion sleeve material:	Stainless steel
Immersion depth:	150мм
Instrument dimensions:	80 x 60 x 31 мм
Cable section size:	3x1 мм^2
Accuracy of measurements:	In the working range $\pm 0{,}95\ K$

1.5. Model. Consider the following hypothesized mathematical model of a food-fish system in an artificial reservoir where fish are grown for one season. [2]

$$\begin{cases} \dfrac{dN_0}{dt} = Q - \upsilon_1(N_0)N_1, \\ \dfrac{dN_1}{dt} = k_1\upsilon_1(N_0)N_1 - \varepsilon N_1 H\left(N_1^\tau - N_1^p\right), 0 < t < t_k, \end{cases}$$

Where N_0 – the mass of "food" arriving at a speed Q, N_1- biomass of fish, $\upsilon\ (\cdot)$ – trophic function, k – the share of food used for the growth of fish biomass, ε – coefficient of competition of fish for food at $N_1 \geq N_1^p$, N_1^p- fish thresholds, $H\ (\cdot)$ – Heaviside function, $N_1^\tau = \frac{1}{\tau}\int_0^\tau N_1\ (t)dt$ for any $\tau > 0$, $u\ \tau < t_k, t_k$ – end of the season. For theoretical purposes, instead of the original model, consider the system

$$\begin{cases} \dfrac{dN_0}{dt} = Q - \tilde{\upsilon}\ (N_0)N_0N_1, \\ \dfrac{dN_1}{dt} = k\tilde{\upsilon}(N_0)N_1 - \varepsilon N_1^2 H\left(N_1^\tau - N_1^p\right). \end{cases}$$

Theorem. Let be $N(0) \leq \frac{\bar{Q}}{N_1^p}, \bar{Q} = maxQ$, then $N_0(t) \leq \frac{Q}{N_1^p}$,

for all t and $\frac{1}{\tau}\int_0^\tau N_1(t)dt \geq N_1^p$, Where

$$N_1^p = \frac{1}{\varepsilon\tau} ln\left[1 + \frac{N_0\varepsilon}{k\bar{\upsilon}}\left(e^{k\bar{\upsilon}\tau} - 1\right)\right], \bar{\upsilon}\ (\xi) \leq \bar{\upsilon}, \xi > 0.$$

Note that the mathematical issues of bringing the model taking into account age and spatial factors were studied in [3,4].

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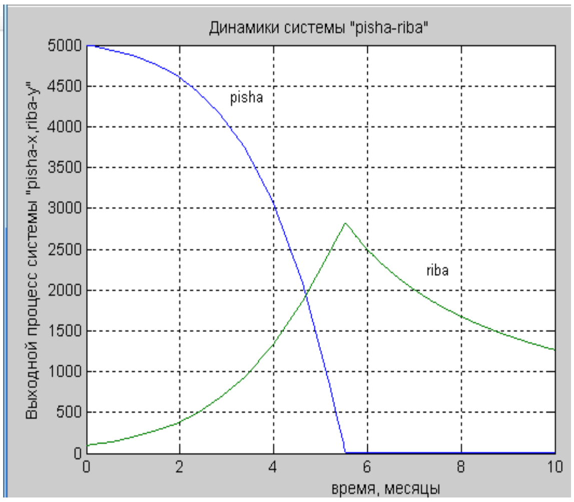
ame	Value	Min	Max
a	1	1	1
a0	10	10	10
eps	0.0001	0.0001	0.0001
k	0.7	0.7	0.7
m	1	1	1
q	10	10	10
t	<359x1 double>	0	10
t0	0	0	0
tk	10	10	10
y	<359x2 double>	0.036	5000
y0	[5000 100]	100	5000



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