Design of Aquaponics System Based on Offshore Equipment

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Abstract. Offshore equipment is a large-scale engineering device set up in the open sea area of the deep and distant sea, which is an important way to expand the new area of aquaculture, oil and gas development and so on. In order to solve the problem of replenishment difficulty and wastewater discharge pollution existing in offshore equipment, this paper is based on the current situation of practical research and application of offshore equipment, through the literature and data calculation, systematic design of an aquaponics system based on offshore equipment, through the aquaponics system, through the automation of the data processing system, intelligent control, in the offshore equipment platform to achieve the soilless cultivation of vegetables, cultivation of fish fry in the tail water nitrification tank processing Recycling. The aquaponics system designed in this paper, in ecological, economic and social aspects, there is a positive role in promoting, especially for the future of offshore equipment independent operation to do the corresponding possibility of exploration, for the design and construction of supporting facilities for offshore equipment to provide advice and thinking.

Keywords: Aquaponics, Offshore Equipment, Sensors.

1. Introduction

Offshore equipment is an offshore production and development system that is set up in the open sea area exposed to wind and wave action, secured by facilities and equipment, and supported by supply vessels [1]. And most of them are distributed in the open and spacious sea area where the water depth should not be less than 20 meters, and the deep and distant sea area with stable current conditions [2].

Based on field research, this paper visits the front-line staff of offshore equipment and conducts research on the problems arising from offshore platforms, and at the same time summarizes the following two aspects of the problem by reviewing relevant information:

Firstly, the resident personnel of offshore equipment platform need to be stationed on the offshore platform for more than a month, and the supply ship only has limited capacity, and the problem of fresh green vegetable supply is becoming increasingly prominent.

Second, it is known from the literature that the nutrient waste pollution generated by the small-scale subsistence type of mariculture on offshore equipment itself eutrophicizes the seawater, especially the uneaten residual bait, excreta and secretions of cultured organisms, chemicals and therapeutic agents generated by the intensive bait culture system on the platforms [3], which, if discharged directly, will cause certain pollution to the ecological environment of the near-shore.

Aquaponics, an organic combination of aquaculture and hydroponic cultivation [4]. The aquaculture and vegetable production through a rational scientific design, the establishment of a composite farming system, to achieve "fish farming without water quality without water quality, planting vegetables without fertilizer and normal growth" of the ecological symbiosis effect, is the future of sustainable recycling-type zero-emission low-carbon production model [5]. Therefore, if the aquaponics system is built on the offshore equipment platform in a reasonable way, it will effectively solve the problems of the platform's supply difficulty and the difficulty of the aquaculture wastewater discharge and will have a positive effect on the environment and the economy.

This paper will be based on the two main problems on the offshore equipment, design and establish the aquaponics system adapted to the offshore equipment, without destroying the original basis of the offshore equipment platform, to realize the supply of green vegetables and the recycling of aquaculture wastewater on the platform, to solve the problem of the supply of green vegetables and recycling of aquaculture wastewater, to enhance the autonomy of the offshore equipment without the supply of the operation and the CV of the sustainable recycling type of zero-emissions. Low-carbon production mode.

2. The goal of design

Based on the problems of offshore equipment, this paper designs a systematic aquaponics system based on offshore equipment, which mainly realizes the following objectives: vegetable soilless cultivation is realized in offshore equipment platform, fish fry cultivation is realized in platform fish pond, aquaculture tail water can be recycled by nitrification tank treatment, and systematic aquaponics is realized by automation and intelligent control through data processing system.

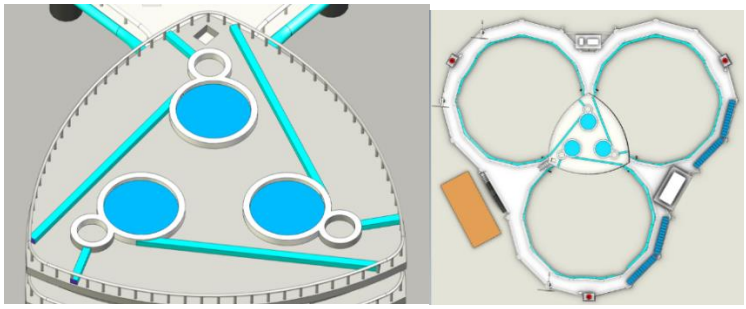
Aquaponics technology refers to the combination of aquaculture and hydroponic cultivation of two agricultural technologies, through the design of water recycling process will be transported to the aquaculture wastewater hydroponic cultivation unit, the use of microorganisms will be decomposed into nitrite and nitrate of ammonia and nitrate, as a nutrient for the plants to be absorbed and utilized, to achieve the ecological effect of water conservation, emission reduction and reuse of resources, and it is considered to be a modern agricultural production model that is highly innovative and has the potential for sustainable development. It is regarded as a modern agricultural production model with great innovation and potential for sustainable development.

3. The design of system

3.1. Stockbreeding model

This device selects largemouth black bass as the main fish in the culture of fish, with a small amount of rainbow trout mixed culture mode. In terms of growing vegetable species, the traditional hydroponic crop water spinach was chosen to be used.

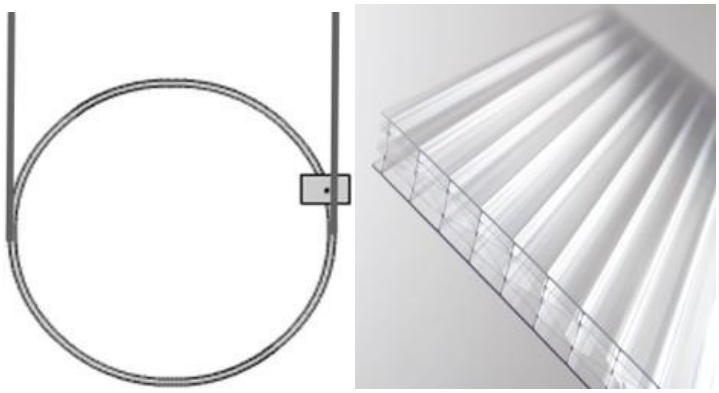
The fry of largemouth bass and rainbow trout are put into the fish pond of the aquaponics system for cultivation (Figure 1(a,b)), and through the operation of the aquaponics system, it has the advantages of being able to efficiently collect culture residues (excreta and residual bait), reduce the pollution of the water body, reduce the cost of production, and be easy to manage, etc. [6], and it can minimize the artificial feeding.



(a) (b)

Figure 1. Overhead view of top fish(a) and nitrification tanks(b)

In terms of other infrastructures of the aquaponics system, two-layer rectangular sunlight panels of transparent color (shown in Figure 2(a,b)) were selected. The sunshine board integrates light, heat preservation and sound insulation, which can block the sun and rain, as well as heat preservation and light transmission, and it can block most of the sea winds, so that the water yongcai is affected by the sea winds as little as possible.



(a) (b)

Figure 2. Schematic of sunlight panel position setting(a) and Sunshine board style (b)

3.2. Pipeline cultivation

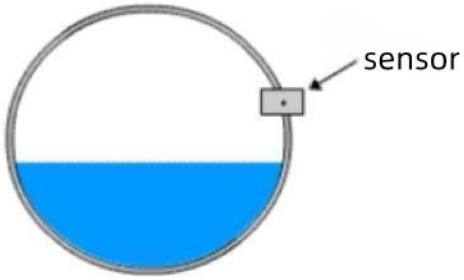


Figure 3. Simulation of water level sensor in pipe

In the aquaponics cultivation pipeline system designed in this paper, a water level sensor is installed in the pipeline as shown in Figure 3, which can transform the water level parameter of the measured point into the corresponding electric signal in real time. The working principle is: the water level sensor in the pipeline, the feeling of the water level signal transmitted to the controller, the controller computer will be measured water level signal and set the signal for comparison, resulting in deviation, and then according to the nature of the deviation, to the water supply motorized valve to send the "on" and "off" instructions to ensure that the pipeline to reach the set levelof water (as shown in Figure 4). Water level sensors and control systems to ensure that the water level in the pipeline with the water spinach different growth period changes, as well as the water level in the pipeline constant, so as to ensure that the water in the pipeline always meet the water spinach growth requirements.

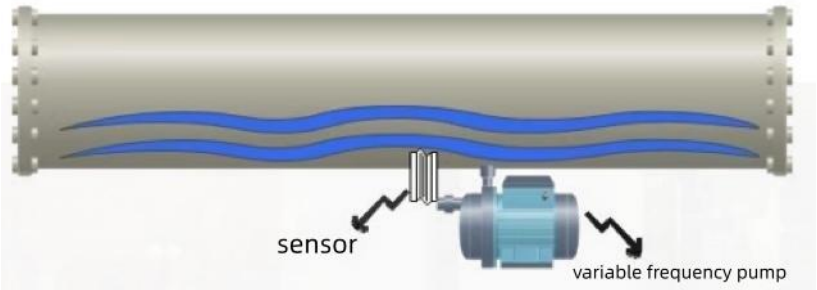


Figure 4. Flow sensor position simulation

In order to enable water spinach to fully absorb the nutrients in the water and not to interfere with the normal growth of water spinach, this system adopts a glass-backed micro-nano thermal distributed flow rate sensor based on the working principle of dielectric heat transfer and micro-electro-mechanical system (MEMS) processing technology for the measurement of low flow rate of liquid applications [7].

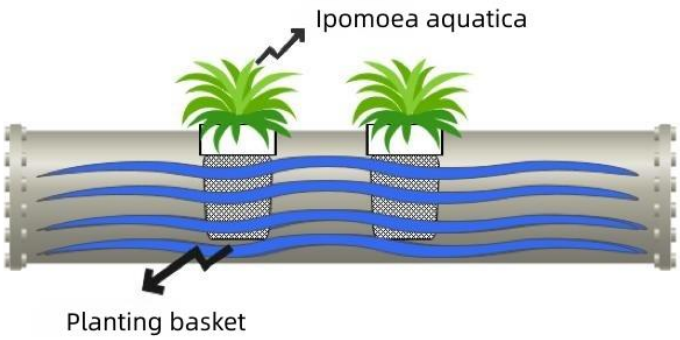


Figure 5. Planting basket with water spinach simulation

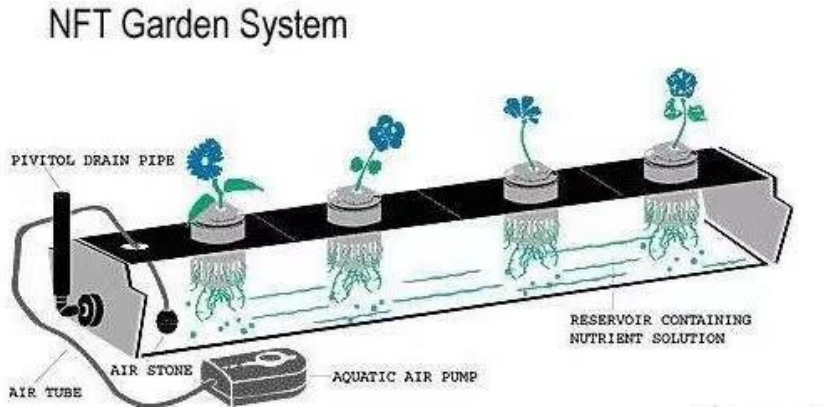


Figure 6. NFT hydroponic system

The fixing basket is an object used in soilless culture production(as shown in Figure 5), which can prevent the plant from growing without support, the root system is immersed in the circulating water, which is prone to anaerobic respiration and produce rotting roots, and it can help the plant's root system to grow better. This device adds a planting basket to the system, which is used to fix the water spinach to ensure the normal growth of water spinach(as shown in Figure 6). Through the fixed role of the planting basket, the water spinach is fixed in the pipeline to maximize the protection of water spinach from the impact of the sea breeze.

3.3. Water quality monitoring

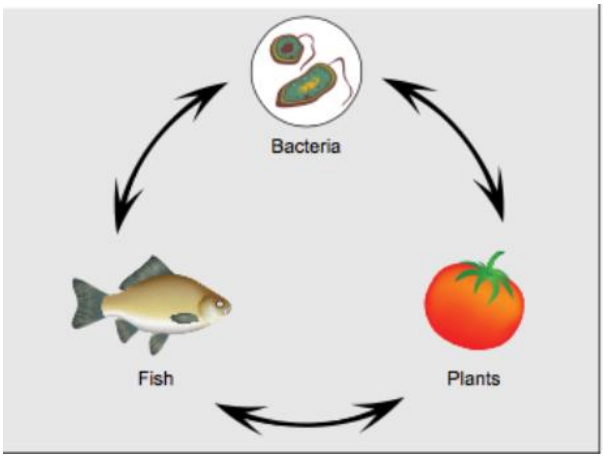


Figure 7. Aquaponics cycle

Essentially, an aquaponics system is an organic system formed by fish, vegetables, and bacteria, so each organism in the aquaponics system has a specific tolerance range for each parameter of water quality(as shown in Figure 7). As can be seen in Table 1, the tolerance ranges for all three organisms

are relatively similar, but compromises are needed so that some organisms cannot function at their optimal levels.

Table 1. Comparison of organism types and environmental differences

Type of organism	Temperature (℃)	pH	Spandex (mg/L)	Nitrite (mg/L)	Nitrate (mg/L)	Dissolved oxygen (mg/L)
Warm water fish	22-32	5-8.5	<3	<1	<400	4-6
Cold water fish	10-18	5-8.5	<1	<0.1	<400	6-8
Plants	16-30	5.5-7.5	<30	<1	-	>3
Fungus	14-34	5-8.5	<3	<1	-	4-8

Considering the actual aquaculture environment as well as the selected fish and vegetable species, the idealized compromises of the aquaponics system required by this device for the key water quality parameters are shown in Table 2 below.

Table 2. Key water quality parameters

Type of organism	Temperature (℃)	pH	Spandex (mg/L)	Nitrite (mg/L)	Nitrate (mg/L)	Dissolved oxygen (mg/L)
Aquaponics	18-30	5-7	<1	<1	5-150	>5

The overall goal is to maintain a healthy ecosystem with water quality parameters that meet the requirements for growing fish, vegetables and bacteria simultaneously. Therefore, water quality monitors were installed at the fish tank inlet, nitrification tank inlet, and nitrification tank outlet of the installation to facilitate active control of the water quality to meet these standards and to keep the system functioning properly.

3.4. Data Acquisition and Processing

3.4.1 information collection

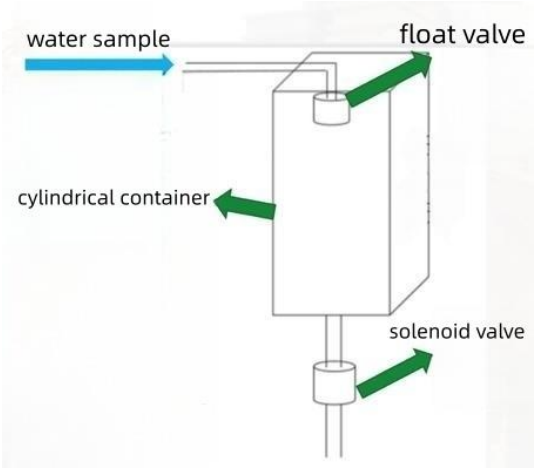


Figure 8. Column container analysis

In this paper, the information acquisition device is shown in Figure 8, the column container is used in the U.S. YSI multi-parameter water quality analyzer and Hash Instruments to determine, for the measurement of PH, ammonia nitrogen, nitrite, nitrate, dissolved oxygen and other content.

Column container of the inlet pipe through the branch of the water pipe and two pumps connected to the two pumps were connected to the sample cell and the blank control. There is a float valve in the water inlet pipe above the column container, which will automatically stop filling when the sample to be tested is injected up to a certain height. There is a solenoid valve at the outlet below the columnar container, which is connected to the PLC controller. At the end of the measurement, the solenoid valve will be opened to discharge the measured water sample.

3.4.2 Data processing

In the two systems of water quality monitoring and pipeline cultivation, the sensor transmits the data to the data processing system, compares and analyzes the range of values with the ideal situation, and then outputs them through the control system, using water pumps and oxygenation pumps, etc., for the regulation and control of the nutrient composition and the water flow situation, and the control system for data processing and analysis is shown in Figure 9.

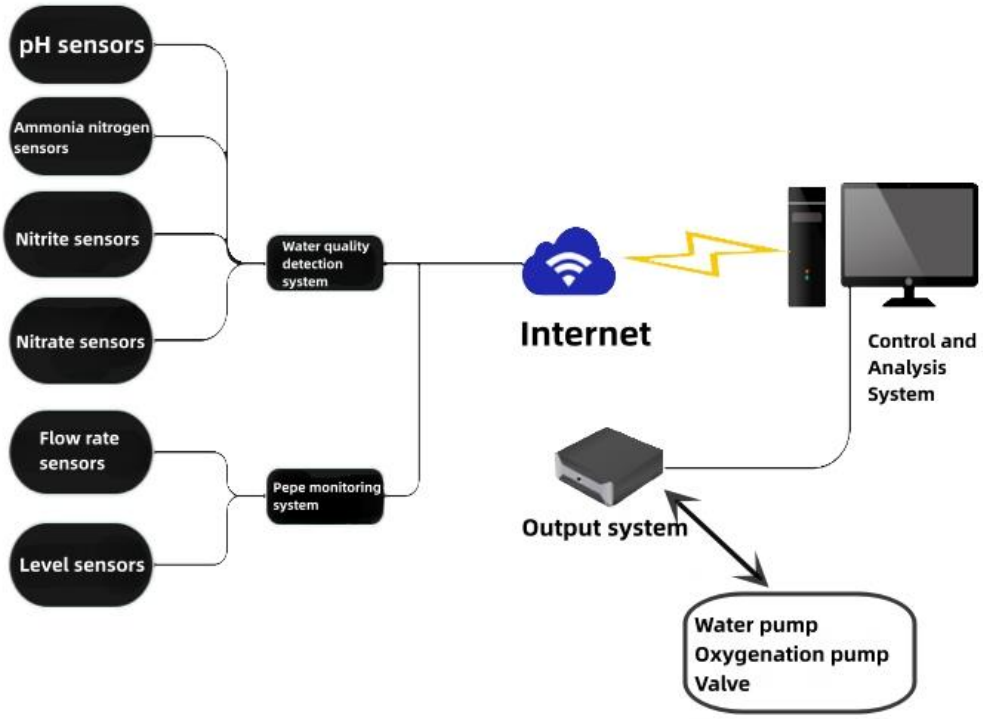


Figure 9. Data processing system workflow

Using automated monitoring equipment, collect and analyze data about aquaculture water quality and environmental parameters, such as dissolved oxygen (DO), pH, temperature (T), total ammonia nitrogen (TAN), nitrate, nitrite content, etc., combined with the processing system, the water quality and aquaculture environment for effective real-time monitoring, so as to make the closed-circulation water aquaculture water quality and environmental stability and reliability [8].

According to the water quality standards, the data processing terminal every 24 hours for statistical analysis of data, and as a standard, control the input of nitrifying bacteria, nitrite bacteria, as well as the switch of the oxygen pump(as shown in Figure 10).

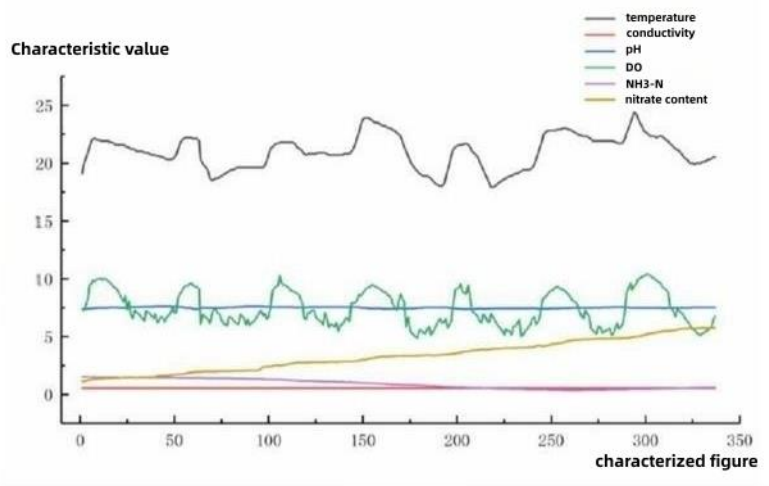
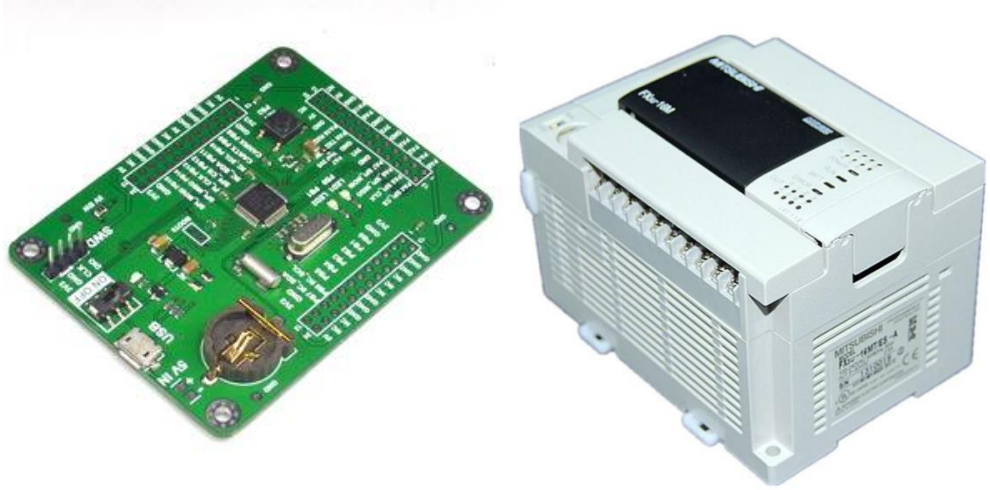


Figure 10. Numerical monitoring of water quality characteristics

Through the water level sensor and flow rate sensor, the real-time monitoring of the cultivation pipeline about the water flow, through the monitoring of the water level and flow rate in the pipeline, the system control to change the pump switch to control the flow rate, as well as the switch of the gate valve to control the water level .

The fuzzy controller of this design is a two-dimensional fuzzy controller, which has different input variables and outputs in different situations. In the pipeline cultivation system, its input variables are water level and flow rate in the pipeline, and its outputs are pump switch and sensor switch. In the water quality detection system, the input variables are dissolved oxygen (DO), pH, temperature (T), total ammonia nitrogen (TAN), nitrate, and nitrite content in the fish pond, and the outputs are inputs of nitrifying bacteria, nitrite bacteria, and the on/off switch of the oxygenation pump.

When designing the fuzzy control decision-making algorithm in this paper, the relevant data values and corresponding outputs measured in the previous experiments are firstly input into the fuzzy controller for self-learning, so that when the working parameters of the system are input, the fuzzy controller will get the fuzzy outputs according to the decision-making algorithm, and the fuzzy quantities are transformed into the outputs that need to be regulated in this time. The output calculated by the fuzzy controller is passed to the PLC controller(as shown in Figure 11(a,b)), which controls the opening and closing of each pump and solenoid valve according to the expected situation to realize the control.



(a) (b)

Figure 11. Data processing system: Fuzzy controller(a) and PLC controller(b)

4. Discovery

The aquaponics system designed in this article, combined with offshore equipment, innovatively combines the aquaponics system with offshore equipment to explore its feasibility and development mode.

The aquaponics system is designed in the article, which innovatively combines factory water recycling with aquaponics system. Factory water recycling aquaculture is through physical, biological, chemical and other means and equipment, the harmful solids, suspended solids, soluble substances and gases in the aquaculture water will be discharged from the water or converted into harmless substances, and replenishment of dissolved oxygen, so that the water quality to meet the needs of the normal growth of fish, to achieve the recycling of water under high-density aquaculture conditions of high-efficiency aquaculture mode, can effectively reduce the ammonia nitrogen and nitrosative nitrogen and other water quality indexes content, purification of aquaponics system. It can effectively reduce the content of ammonia nitrogen and nitrite nitrogen in aquaculture water, purify the water quality, and has the advantages of high aquaculture density, water and land saving, environmental

friendliness, product traceability, etc. It is an important mode of aquaculture development in the future [9].

In addition, the aquaponics system is equipped with a nitrification biological treatment tank, the aquaculture fish tank and the waste liquid silo are connected to the pipeline of the planting tank through a pump, and the aquaculture fish tank is equipped with a PH value sensor, a temperature sensor, an Ec value sensor, and a liquid level sensor.

5. Conclusions

In this paper, based on the actual research and application status of offshore equipment, through literature and data calculation, a systematic aquaponics system based on offshore equipment is designed, consisting of pipeline cultivation system and fish pond, nitrification tank and other parts, and through the data acquisition and processing system, to complete the automation and intelligent control and operation of the system, and to realize the soilless cultivation of vegetables on the offshore equipment platform, in the cultivation of fish fry, and the treatment of the tail water nitrification tank. Recycling.

This aquaponics system has positive promotion effects in ecological, economic and social aspects.

In terms of ecological environment, it adopts the concept of offshore aquaponics, utilizes the aquaponics technology on the offshore platform, realizes the primary production of marine agriculture, and builds a sustainable and zero-emission aquaponics system. At the same time, the aquaponics system has a decorative and aesthetic role on the offshore equipment.

In the economic aspect, the existing research shows that the aquaponics system is profitable, increasing the types of agricultural products, and achieving the effect of "seed - cultivation" double harvest to increase production [10]. Transforming the traditional economy, changing the linear economy into a circular economy, promoting the development of ecological circular economy, creating a new industrialized ecological civilization of the fishery culture.

In the social aspect, the establishment of aquaponics system of offshore equipment is a modern marine agricultural production model full of development potential, and promotes the establishment of the cyclic "seed-cultivation" model of offshore equipment.

In terms of strategic reserve, offshore equipment is placed in the ocean, and the establishment of aquaponics system can realize partial self-sufficiency of offshore equipment in terms of supply, and reduce the dependence on land.

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