Advances in Engineering and Applied Science Research, ISSN 2617-1023
2021 International Conference on Intelligent Manufacturing Technology and Information Technology
Vol. 11, 2021, pp. 90-92

Consideration on Temperature Control Technology of Circulating Water System in Industrialized Aquaculture

Maichao Sha, Ruijin Zhu*

Tibet Agricultural and Animal Husbandry University, Linzhi, Tibet, China
sushe11202@126.com
*corresponding author

ABSTRACT. The heat pump system can effectively improve the temperature of fish culture in winter, and it can also effectively improve the temperature of fish culture Energy saving potential. On this basis, this paper discusses and analyzes the temperature control technology of industrial aquaculture circulating water system, and comprehensively analyzes the feasibility of water source heat pump technology in its application.

KEYWORDS: Circulating water system, Industrialized aquaculture, Water source heat pump

1. Introduction

According to the characteristics of industrial aquaculture at this stage, it is mainly an internal circulation aquaculture system which takes environmental protection as the basic point. Temperature control technology and water quality treatment technology as the core, this mode uses the relevant technology in the circulation system to treat the biological excreta, food residues, bacteria and harmful substances in the aquaculture water body effectively, so as to make the aquaculture water quality standards. In addition, the temperature is controlled by new energy technology to achieve the goal of constant temperature in four seasons, and the temperature is controlled according to the specific production requirements. Because of the temperature control and recycling of aquaculture water, the aquaculture water quality can be effectively ensured, and even the operation cost can be reduced, the efficiency of aquaculture can be significantly improved, and the goal of minimum or zero emission can be effectively achieved. The heat pump technology for water temperature control has great economy and practicability. Therefore, it is necessary to discuss and analyze the technology, so as to provide some reference for related workers.

2. Requirements of Aquaculture and Aquatic Products on Water Temperature

As early as the end of last century, China's fishery science and technology level has been improved to a certain extent. The industrial aquaculture industry of China's marine products has been developed rapidly and has become a new pillar industry in a very short time. However, with the continuous development of this industry, its negative impact is gradually reflected. In terms of aquaculture technology, many processes almost use the traditional open aquaculture system, and its shortcomings are mainly reflected in the high cost, unstable production and backward workshop facilities and equipment, which cause serious and significant development of China's coastal aquaculture industry, and even threaten marine aquaculture Farming.[1]

There are many varieties of aquatic products, and different varieties have different requirements for water temperature. For example, the temperature of sea cucumber should be controlled at 17 ℃ ~ 24 ℃ and the temperature of sea fish should be 13 ℃ ~ 21 ℃. In addition, the temperature of shellfish and shrimp should be kept at 23 ℃ ~ 26 ℃. The sea water nursery season is generally from November to May of the next year, and the time varies according to different regions. If the temperature of freshwater is only about 2 ℃ ~ 10 ℃, then the freshwater needs to be heated. If the freshwater temperature is 25 ℃, then the freshwater should be cooled.

3. Application of Heat Pump Technology in Aquaculture Temperature Control

3.1 Advantages of Heat Pump Technology

  DOI: 10.23977/IMTIT2021021

First, high efficiency and energy saving. In traditional aquaculture system, the high-level heating energy can be effectively replaced by low-temperature regeneration through heat pump temperature regulation system. The water stored in nature can be used to heat freshwater by other energy conversion methods. In addition to making great use of air, soil and ocean energy, it is very beneficial to the recovery and utilization of waste heat in life and production. For fossil fuel boilers, only 50% ~ 90% of the fuel heat can be converted into heat to produce hot water, while for heat pump, the heat of 2KW · H ~ 6kw · h can be effectively absorbed by 1kW · h electric energy. Compared with gas-fired boiler and fuel oil, its energy can be saved by more than 40%.

Second, clean and environmental protection. When running the heat pump system, it will not consume a lot of oil, coal and gas, and then produce other pollutants and a lot of greenhouse gases. For water source heat pump units, when heating, kerosene, gas and coal-fired boiler room systems are omitted, and there is no combustion process, which can effectively avoid pollution and smoke exhaust. In the cooling process, the leading cooling water tower is omitted, which can effectively avoid water consumption, mold pollution and noise of the cooling tower.[2] Therefore, when running the water source heat pump unit, there will be no smoke exhaust, combustion, exhaust gas, waste water, waste residue and smoke, and there will be no urban heat island effect.

3.2 Heat Pump Temperature Regulating System in Recirculating Aquaculture System

3.2.1 Sedimentation Tank

In order to remove P and N in water, a large amount of residual feed and feces should be removed first, and then biological purification should be carried out. The sedimentation tank is an important facility in the treatment of solid pollutants in water. It mainly uses the way of sedimentation to separate the larger suspended particles, and generally can remove 60% ~ 90% of the suspended solids.

3.2.2 Microfiltration Machine

The effect of biological purification, fish growth and system configuration will be affected by the removal of suspended solids. If TSS stays in the aquaculture system for a long time, it will seriously affect the quality of aquaculture production, and even damage the gills, and cause the blockage of biofilter. The removal effect of TSS directly determines the stability of the system operation and the quality of water quality. In this project, the micro filter is an important equipment, which can intercept and remove the small particles by using the filtration effect of the microporous screen, so as to further reduce the organic load of the biofilter.[3]

3.3 Water Source Heat Pump Temperature Regulating System

For water source heat pump, freshwater is filtered by circulating water pump and heated in the heat pump until the required temperature is reached, and then it is supplemented in the aquaculture pond. In addition, the circulating water that has been treated by water is heated by heat pump, and then sent to the aquaculture pond.

3.4 Calculation of Heat Load in Winter

Heating circulating water load is

$Q_1=C\cdot M_1(t_1-t_2)$

Where C is the specific heat capacity of freshwater, M1 is the circulating horizontal flow, T1 is the water temperature required by the aquaculture pond, and T2 is the effluent temperature of the aquaculture pond.

The heating load of fresh water is

$Q_2=C\cdot M_2(t_1-t_3)$

M2 is the fresh water flow, while T3 is the specific temperature of the replenished freshwater.

Building heat consumption

$Q_3=S\cdot q$

Where s is the specific building area of the breeding workshop, and Q is the load per unit building area.

3.5 Economic Analysis

When the initial investment cost is estimated, the general initial investment mainly includes the boiler equipment and auxiliary equipment postposition cost and civil engineering cost. For water source heat pump, it mainly includes the cost of circulating water pump, heat pump unit and pipeline valve, and the specific cost should be determined according to the local market price.

Because freshwater has a certain degree of corrosion, so the heat exchanger is generally made of pure titanium, and the shell is made of high-strength engineering PVC particles, which has strong corrosion resistance. PVC and titanium can effectively resist the corrosion of freshwater, alkali and acid, and the specific cost should be determined according to the market price.[4]

4. Conclusion

In aquaculture, heat pump technology as a new form of cold and heat sources, its advantages and applicability have been highly recognized by the industry. In order to better meet the temperature requirements of aquatic products, it is necessary to control the constant temperature of aquaculture water. Through the water source heat pump unit, the heat load of aquaculture workshop in winter can be effectively met. [5]In the economic benefit analysis of water source heat pump and coal-fired boiler, we can know that water source heat pump has good economic advantages. If the time value of investment is not considered, the investment of heat pump system can be recovered after 6.25 years. Compared with coal-fired boiler, water source heat pump has more advantages. From the perspective of environmental protection, the use of heat pump can effectively reduce emissions of SO2 and CO2, which is very beneficial to environmental protection, and even can effectively save sewage charges, fully reflecting the advantages of economy and energy saving.

Acknowledgement

Natural Science Foundation of Xizang (No. : 2019ZRG69) : Research on precision feeding and efficient clean water Treatment technology of industrial circulating water facility breeding in plateau

References

[1] Jiang Yanli, Dong Xinlin, Cui Congming, et al. Discussion on temperature control technology of circulating water system in industrialized aquaculture. Aquaculture, No.3, 2017.

[2] Wu Yuguo, Jiang Yake, Zhang Weizhong, et al. Application of heat pump technology in industrialized aquaculture system. Fisheries Science and technology information, Vol.46, No.1, pp.38-42, 2019.

[3] Zhang Jiguang, Shi Ziqiang, Yang Wansheng, et al. Application of heat pump in mariculture. Acta refrigeration Sinica, No.3, pp.48-51, 2002.

[4] Qu Keming, Du shouen.No.1. Engineering technology for construction of high efficiency aquaculture system of seawater engineering. Ocean Press, 2010, pp.1-23.

[5] Liu Guodan, Liu Keke, Hu Songtao, et al. Application of heat pump system in sea cucumber breeding. HVAC, Vol.44, No.9, pp.56-61, 2014.