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EXPERIMENTAL STUDY OF CAVITATION HEAT GENERATOR FOR HEATING WATER

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ЭКСПЕРИМЕНТАЛЬНОЕ ИССЛЕДОВАНИЕ КАВИТАЦИОННОГО ТЕПЛОГЕНЕРАТОРА ДЛЯ НАГРЕВА ВОДЫ

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Abstract. The energy released by cavitation is a new method to make full use of energy. Based on this, a new type of cavitation heat generator for heating water is designed. A conical core is used instead of the traditional throttling element to build a set. Closed circulation system device, the performance of the cavitation heat generator when the cone core with different cone angles was tested in the test. The temperature difference and pressure difference before and after the three groups of liquid medium flow through the cavitation heat generator were measured experimentally. The results show that the cavitation heat generator with a 30-degree tapered core has the best performance and improves the heating efficiency of the feed water, which has a great reference value for the further study of cavitation heat transfer.

Аннотация. Энергия, выделяемая кавитацией, является новым методом для полного использования энергии. Исходя из этого, разработан новый тип кавитационного теплогенератора для нагрева воды. Для создания набора вместо традиционного дросселирующего элемента используется коническое ядро. Устройство закрытого циркуляционного устройства, производительность кавитационного теплогенератора при проверке конусного сердечника с различными углами конуса в тесте. Экспериментально измерены разность температур и разность давлений до и после трех групп потока жидкой среды через кавитационный теплогенератор. Результаты показывают, что кавитационный теплогенератор с 30-градусным коническим сердечником имеет лучшую производительность и улучшает эффективность нагрева питательной воды, которая имеет большое опорное значение для дальнейшего изучения переноса тепла кавитации.

Keywords: cavitation heat generator, tapered core, experimental, enhanced heat transfer.

Ключевые слова: авитационный теплогенератор, коническая сердцевина, экспериментальный, повышенная теплопередача.

Introduction

Cavitation refers to the process of formation, development and collapse of vapor or gas voids (cavitations) at the internal or liquid–solid interface of a liquid when the local pressure in the liquid is reduced [1]. At present, the cavitation used is mainly divided into two categories, one is vibration cavitation, the vibration induced by the vibration of the object in the liquid, and the liquid generates pressure pulsation with the vibration of the object. When the low pressure of the internal pulsating pressure of the liquid is lower than the vaporization pressure Cavitation will form. The other type is hydrodynamic cavitation caused by throttling devices such as orifice plates and venturi tubes. Both types of technology are researched and utilized in their respective fields in their respective fields. In industrial applications, the additional energy consumption of the orifice plate is high, and the cavitation intensity of the venturi tube is low. The cavitation effects of the two conventional throttling elements cannot meet the actual needs, so effective measures need to be taken. The device has been improved to enhance the cavitation effect.

In fact, cavitation was first discovered through its negative effects (cavitation). With the deepening of cavitation research, its positive effects are gradually recognized and increasingly attract the attention of researchers. According to chemical action, cavitation will degrade wastewater [2], disinfect drinking water [3], and aggravate chemical reactions. In addition, it has been found that heat transfer can be enhanced by its mechanical effect. Bergles et al. studied the effect of ultrasonic vibration on heat transfer [4], and concluded that ultrasonic vibration can enhance the heat transfer of liquid. However, these studies use acoustic vibration to enhance heat transfer and do not involve true cavitation to enhance heat transfer. It was not until the beginning of this century that foreign scholars really began to pay attention to the study of cavitation–enhanced heat transfer, combined with the classical reinforcement theory [5–7]. These explorations revealed the internal causes and mechanisms of cavitation to enhance heat transfer to a certain extent. The generation of cavitation causes the flow pattern of the fluid to transition from a single–phase flow to a two–phase flow, thereby destroying the macroscopic continuity of the liquid. When the liquid flows through the area where the downstream pressure is high, the bubbles will collapse. Due to the mass transfer between gas and liquid phases and the two–phase turbulence phenomenon in the cavitation process, the flow characteristics are very complicated, and many scholars at home and abroad have studied it [8]. In 2015, Zhu Jiakai team team of Zhejiang University took the lead in setting up a set of venturi tube cryofluidation visualization experimental device in China, and obtained a series of clear cavitation shedding process pictures and analyzed the process [9].

At present, research on the use of cavitation mechanism to enhance heat transfer has yielded relatively mature research results in countries such as Russia and the United States. The cavitation heat generator in this paper is different from the traditional cavitation. The conical core in the device replaces the traditional throttling element to provide a cavitation surface for the liquid medium, enhance the cavitation strength, and then increase the heating of the feed water. Efficiency, more to meet the actual needs of industrialization. Among them, it can be used as a heat source, that is, for centralized or separate heating [10]. Since the cavitation heat generator works by utilizing the energy released by cavitation, it is a new method to make full use of energy, so There is a lot of research space and potential value in this field.

Material and research methods

According to the experimental study content, a test bench was built in Figure 1. The experimental device is a closed system of circulation. A comparative assessment of the cavitation effect with three different cone inserts was carried out. Results when using tapered inserts with different taper angle*s*.

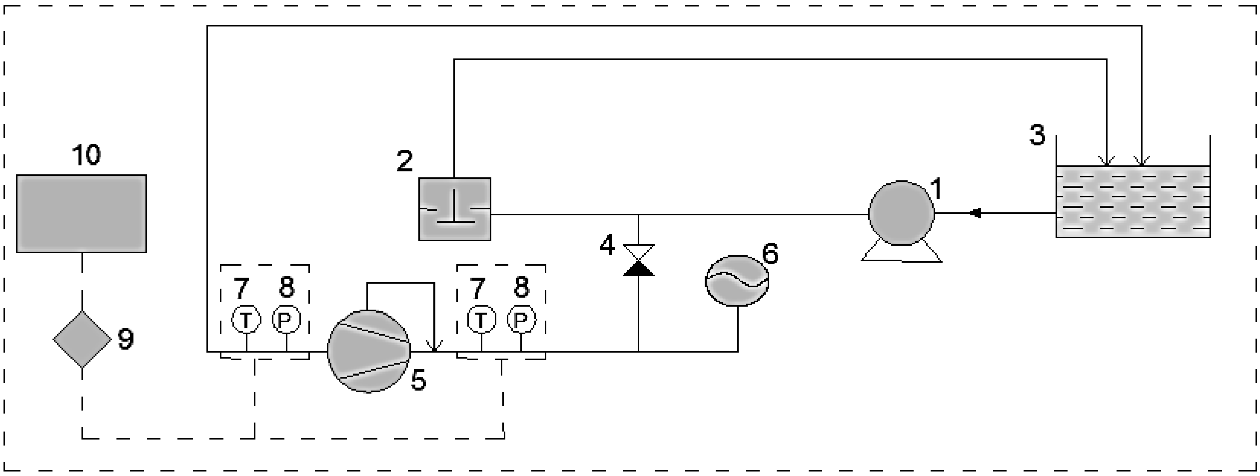

Figure 1. Schematic diagram of the experimental system: 1 — Circulating pump; 2 — Shock valve; 3 — Water tank; 4 — Check value; 5 — Jet cavitator; 6 — Hydraulic accumulator; 7 — Temperature sensor; 8 — Pressure sensor; 9 — Sensor; 10 — Data storage computer

Figure 2. Schematic diagram of the experimental device

Experimental results

(1) The result of the data obtained with a 30-degree conical nozzle.

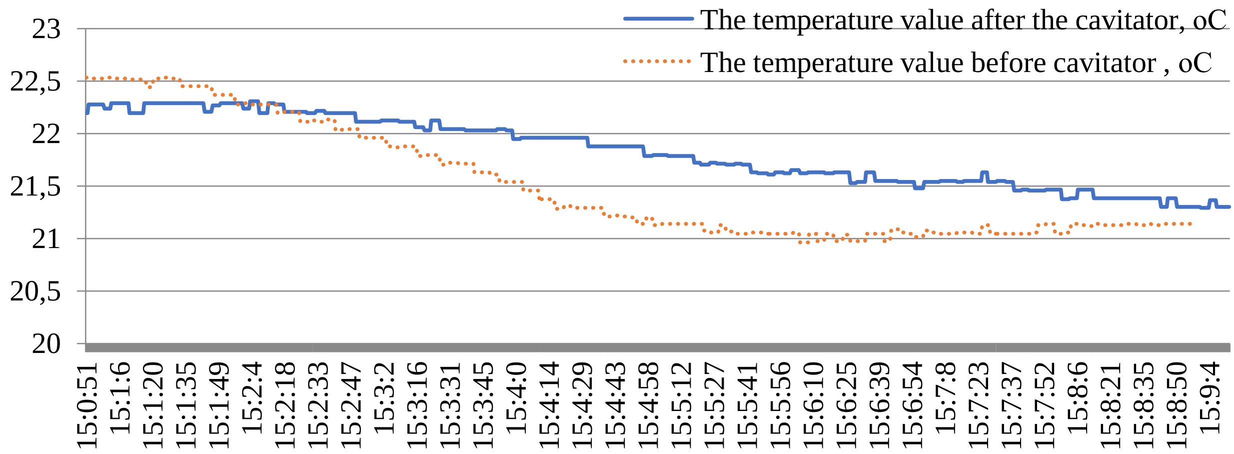

Figure 3. Temperature values before and after the cavitator

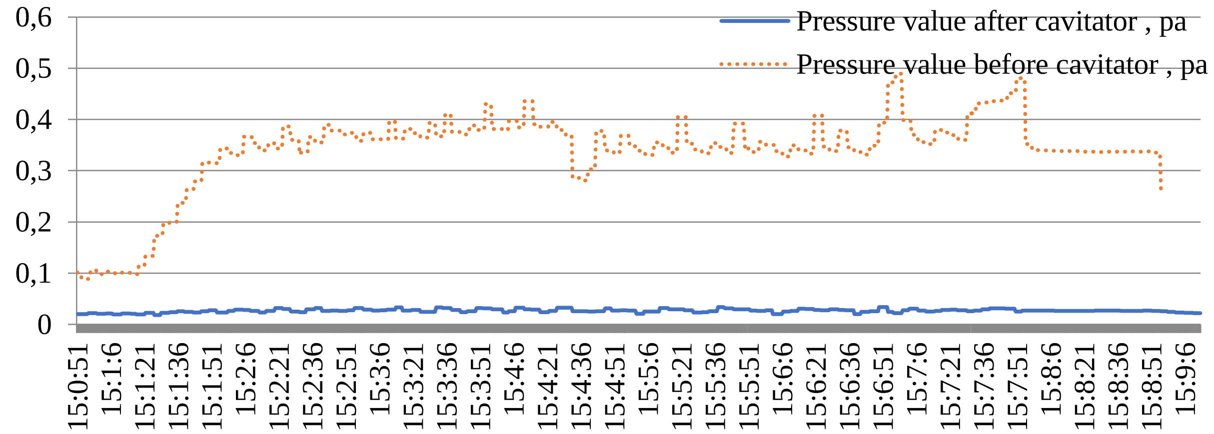

Figure 4. Pressure values before and after the cavitator (2) The result of the data obtained with a 45-degree conical nozzle

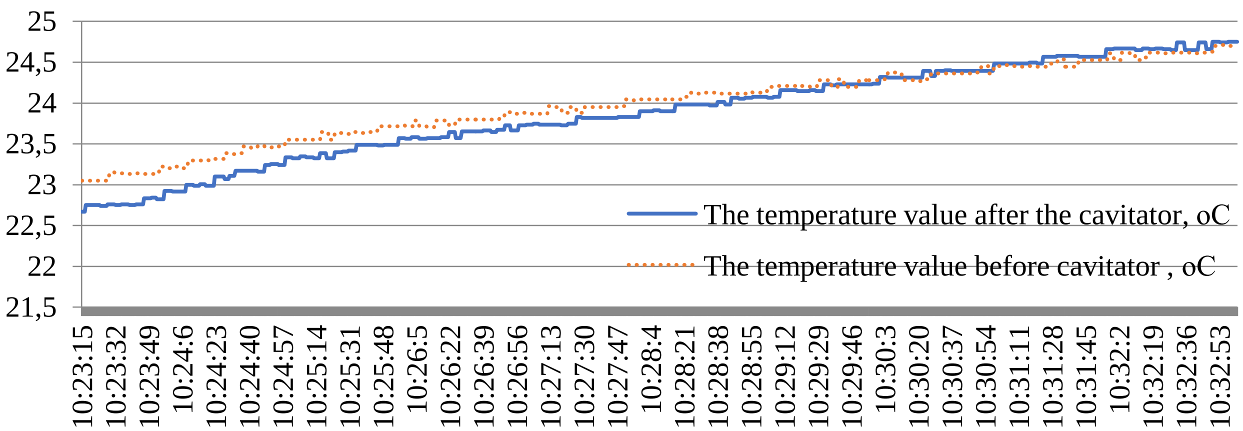

Figure 5. Temperature values before and after the cavitator

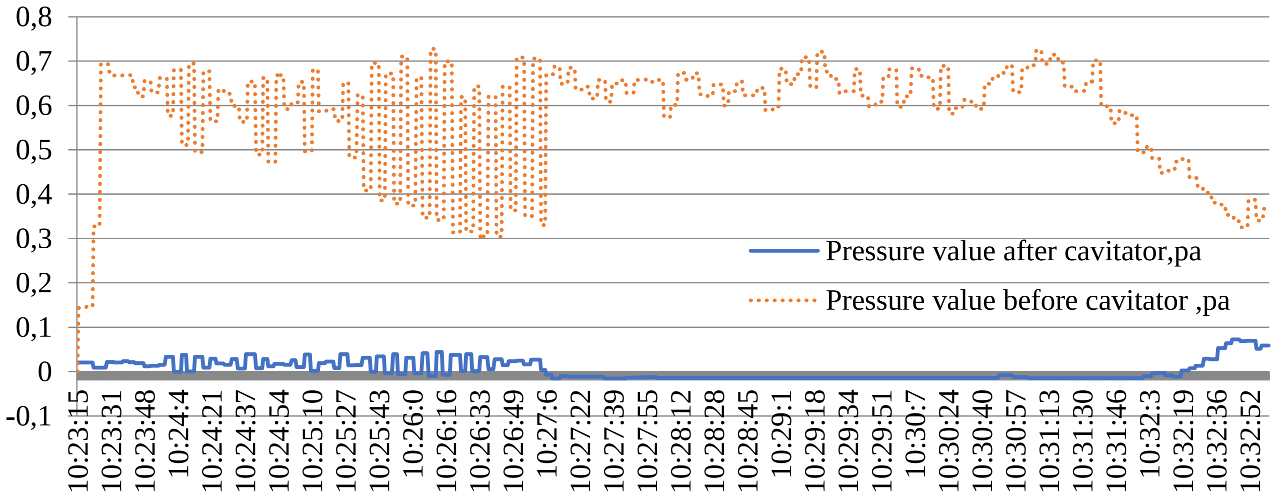

Figure 6. Pressure values before and after the cavitator (3)The result of the data obtained with a 90-degree conical nozzle

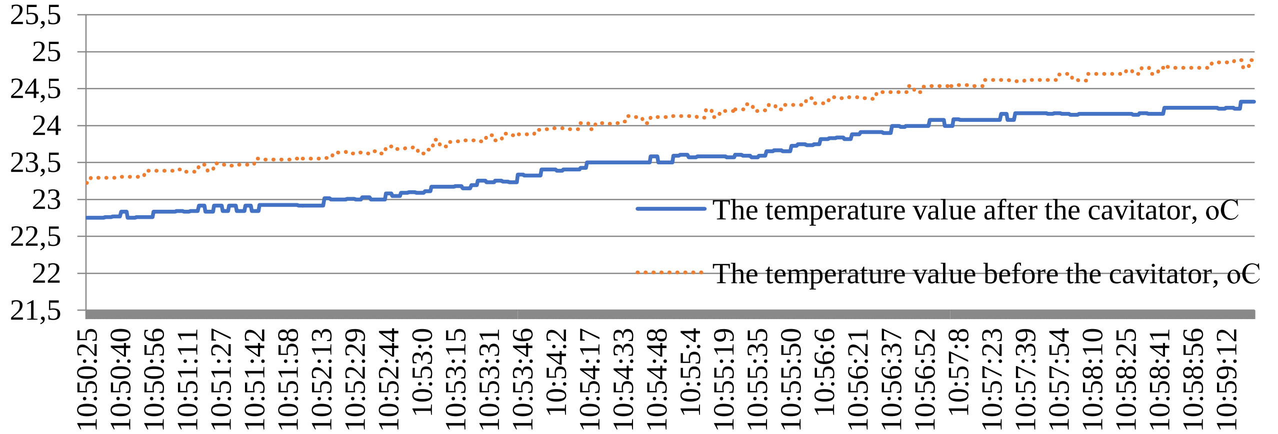

Figure 7.Temperature values before and after the cavitator

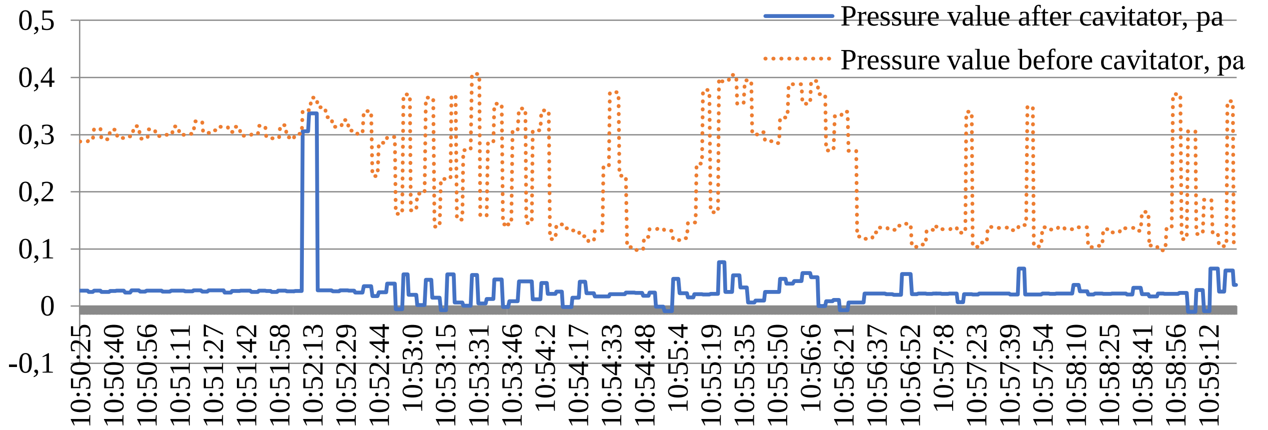

Figure 8. Pressure values before and after the cavitator

Conclusions

After the analysis of the obtained results, we made the following conclusions:

(1). Cavitation when testing a prototype flow body is observed with a pressure drop over the cavitator of more than 0.3pa. Moreover, the maximum value of Δt = 0.67°C is at ΔP=0.32 pa (30 °

conical nozzle). A further increase in the pressure drop across the cavitator reduces the effect of cavitation.

(2). The cavitation effect for a given cavitation sample depends on the time of operation of the cavitator. When the temperature in the circuit rises, the temperature drop decreases.

(3). Installation of a flow body with a conical inlet in the flowing part of the cavitator leads to an increase in the pressure drop, which reduces the effect of cavitation. Moreover, the effect of cavitation in 0.15 °C is observed at smaller cone angles (45°).

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