MICRO SCALE CAVITATION WITH ENERGY APPLICATIONS

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Abstract

The purpose of this study is finding a cost effective and environment friendly solution to energy searching. It involves analysis for this problem within a research of energy applications of cavitating flows. With the help of cavitating flows from micro-channel configurations of different sizes, there emerges a heat energy. Main concern of this project while using micro-channels is, looking forward the highest heat energy with the results of data which variables that gives the most efficients. This project based mainly on experiments to find out the optimal values for energy, which is planned to use in consumers' electronic devices. It is observed that project have to be based on channel diameter and roughness of nozzles. It highlights the combustion of energy in relation between pressure and water flow with cavitation.

1. Introduction

Before getting into the actual project, there is the initialisation that is our world energy consumption is increasing every year according to institutions like International Energy Agency or the U.S. Energy Information Administration or the European Environment Agency. Their yearly recorded data shows that the world needs more and more energy every year. Therefore new ways of environment friendly energy sources are needed and fast.

This project aims to use cavitation in micro scales and come up with an optimised chip that when water enters at one end, cavitation will form in the middle and it is formed in a significant amount so that its energy can be collected and used. Since cavitation is the formation of bubbles inside the liquids (in this case water) which are formed because of rapid changes in pressure the channel inside the chip varies in cross-sectional area in order to reduce the pressure in the micro channel part (which is the middle also called nozzle). The pressure that causes nozzle pressure to decrease thats is where inception happens. Inception pressure in the micro-channel is what the project aims to optimise.

2. Methods And Materials

Configuration/Setting of the experiment: The chip with the micro-channel which the water flows through consists of two layers: a glass and a silicon layer. The silicon is where the channel is and the glass is the kind of cover off. In order to form cavitation the cross sectional area must be changed. When it is decreased the speed increases and when the speed is increased pressure decreases therefore causing the bubbles we call cavitation to form inside the nozzle. There are three places throughout the channel that are connected to a pressure gauge via a device called the sandwich which holds the chip. There are two tanks connected to the device. First one is the nitrogen tank which generate the pressure formation and is connected to the water tank. The water flows through some pipes and there is also another pressure gauge in between the device and the pipes. Another important part of the setting is the high speed camera and a light source to visualise what is happening inside the chip. In order to record when the cavitation begins, at what pressure and where (at the nozzle or at the extension) visualisation is a crucial step. The upstream pressures that are recorded goes like 150-300-450-600-750-900-1050 PSI. The pressures inside the chip is recorded as P1, being the first pressure before water enters the nozzle; P2, being the pressure inside the micro-channel and P3 pressure at the extension which is usually read as 0, since it is connected to the outside which means its pressure should be equal to the outside pressure.

Some parameters were determined to reach these values since preliminary results have proved that wall roughening (1/3 is roughened, 2/3 is roughened, all the channel is roughened) and the diameter of the nozzle in microchips (152 micrometer, 256 micrometer, 504 micrometer, 762 micrometer) affects the initial flow. Effects of these values in nozzle and latest flows are observed also in separate chips. Flow patterns are visualised using high-speed visualisation systems to obtain data.

The aim for the future potential applications of this project is to make the input pressure as low as possible since it is not so practical with these conditions. Optimising the diameter and geometrical properties of the micro-channel, the intention is to come up with a chip which has a low upstream pressure and P2 decreasing all the way to the negative values in those low P1 values. P2 being negative means cavitation is formed from the beginning of the nozzle at least until the point where pressure gauge 2 is connected which means the cavitation formed is profitable. As we see from the tables 1 and 2, the inception can happen at very different pressures with different chips.

2.1. Experiment Result Examples

P upstream	**P1**	**P2**	**P3**	**Flow rate (V=10ml)**
150 PSI	102	48	0	51
300 PSI	249	96	0	33
450 PSI	406	150	0	25
600 PSI	557	196	-2	21
750 PSI	705	-11	0	21
900 PSI	851	-13	0	15
1050 PSI	1000	-13	0	17

Table 1. Example Chip 9-6

P upstream	P1	P2	P3	Flow rate (V=10ml)
150 PSI	102	46	0	51
300 PSI	249	101	0	33
450 PSI	406	154	0	25
600 PSI	557	212	-2	21
750 PSI	705	250	0	21
900 PSI	851	-14	0	15
1050 PSI	1000	-14	0	17

Table 2. Example Chip 9-5

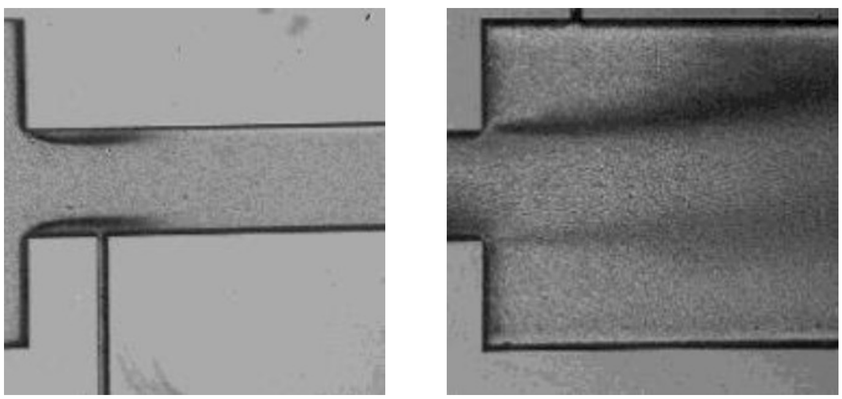

Figure 1. Cavitation at the nozzle and at the extension respectively

3. Conclusion and Future Work

In this study, it is shown that cavitating flows that are exiting the micro-channels which are in different forms, have a capability of rising up the heat at the thin surface of the plate. This heat can be utilized as energy. Primary experiments' results proved that temperature of the surface can be rise in between 0.8 and 5.7°C. To support these results, set of visualisation images was provided. This set went along with preresults that obtained with showing the pattern shifts of flows. Data that consists of power values demonstrates that this energy can be used for miniature electronic devices such as phones, laptops. By optimising the injection conditions, designing a functional solid surface with a large number of optimised cavitation jet arrangements and integrating them into efficient thermoelectric power generators, energy production can be further improved and maintained. This study can end up with providing environment friendly and low cost energy resource for personal energy needs for devices.

References

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