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THE MODEL OF FIELD OF CAVITATIONAL BUBBLES IN A HYDRODYNAMIC CAVITATIONAL DEVICES

МОДЕЛЬ ПОЛЯ КАВІТАЦІЙНИХ БУЛЬБАШОК В ГІДРОДИНАМІЧНИХ КАВІТАЦІЙНИХ ПРИСТРОЯХ

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Abstract. *In the work was considered the possibility of processing diffusion juice of sugar production in a hydrodynamic cavitation device with a static cavitator. Studies had shown that the effectiveness of the impact on the environment is manifested in the action of cavitation bubbles, which burst to create a cavitation effect. As a result, a mathematical model of creating a field of cavitation bubbles for different stages of cavitation was developed.*

Key words: *cavitation, mathematical model, bubbles, diffusion juice, collapse, cavitator.*

Getting a technological effect in devices and food manufacture machines is associated with a certain energy consumption. It can be noted that in some cases the index of the energy input is low. In particular it applies to processes of homogenization and dispersion in a liquid environments. It should be noted that the these processes take place during the fluid flow through the devices of cavitation machines. The hydromechanical effects of the environment on the disperse phase, which is accompanied by its decomposition is happening in cavitation machines. In most devices for homogenization and dispersion this effect is manifested in action of cavitation effects on the technological environment. The effects above are seen in action of cavitation bubbles on the environment field. Size cavitation effect on the environment depends on the size and number of cavitation bubbles that "splashing" create a particular cavitation effect [1].

The source of bubbles in the cavitation device is a layer of vapor-gas mixture, which is formed on the edge of the cavity mixture (Fig. 1) [2]. Due to fluctuations of tail cavity along the flow direction and in the radial direction crushing of cavity is taking place, on the vapor-gas bubbles.

Number of cavitation bubbles formed per unit of time from the volume element of vapor-gas mixture boundary layer from the side of cavity will depend on the speed of the liquid and vapor mixture in the boundary layer (Fig. 2).

A hypothesis is proposed according to which the main source of cavitation bubbles is pulsating boundary layer of gas-vapor mixture on the surface of the cavity. Wave energy that is transferred along the surface of cavity is concentrated in the boundary layer [1]. In the condition if the entire volume of the cavity boundary layer is fully decomposed into vapor-gas bubbles the number of cavitation bubbles that cavity generates can be determined. The distribution of cavitation bubbles in size and number is seen in Fig. 3.

Formed cavitation bubbles during their collapse causing homogenization and dispersion of food environments. Simultaneously, due to the collapse of the bubbles with the preservation of symmetry a release of energy in the boundary layer of bubble that surrounds it is taking place, and it initiates different effects in the flow in a stream of liquid food environment [1, 4].

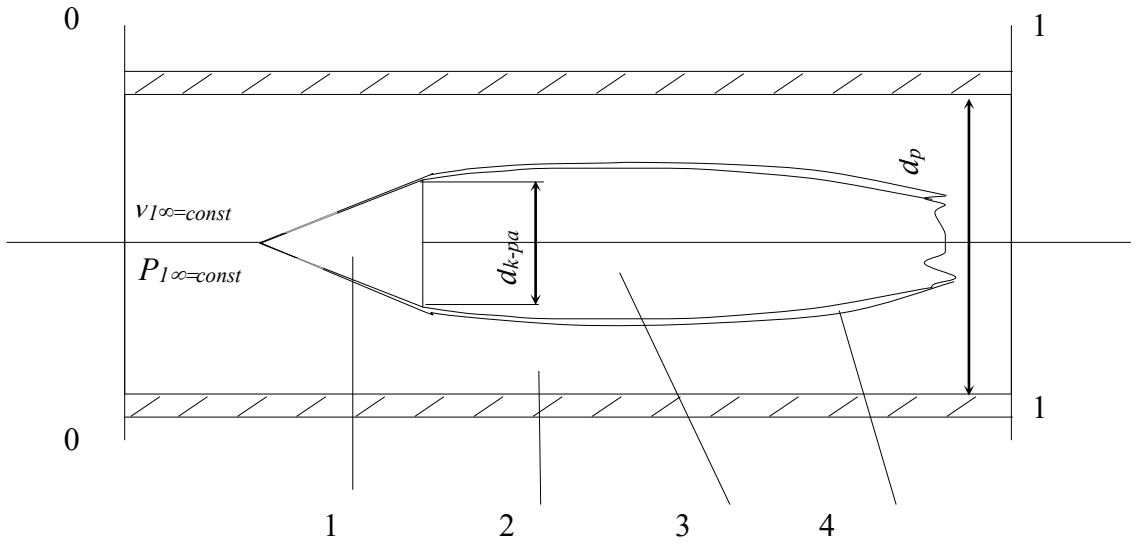

Figure 1 - The scheme of the attached cavity attached to conical cavitator: 1-cavitator; 2-flow chamber; 3-connected cavity; 4 - boundary layer of cavity.

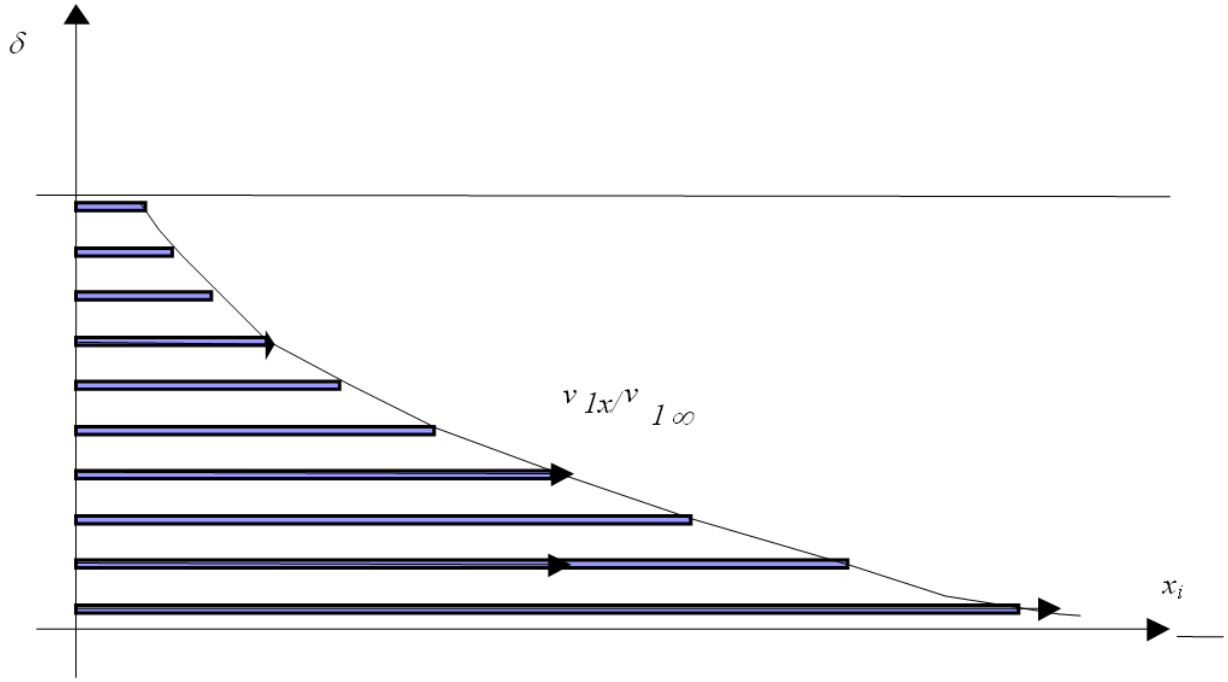

Figure 2 - Scheme of distribution of speed velocity profile v_{1x} / $v_{1\infty}$ in the boundary layer of the cavity from the side of liquid.

In particular, during the processing of milk with 2.7% fat content in the device with static cavitation device (Fig. 4), there is a maximum homogenization at cavitation stage 3 ... 3.5, and twice processing of milk in the area of cavitation. The results of cavitation processing of milk studies is given in the table.

The maximum technological effect was observed on the stage of cavitation, which corresponds to the maximum emit power during the collapse of cavitation bubbles [2].

Calculation of the proposed model of cavitation bubbles helps to identify energy during their collapse, needed for some changes of substances that are in the contact with the cavitation bubbles in a flow of cavitation devices. The following model of cavitation bubbles field forming can be used to calculate the structures of hydrodynamic cavitation device for handling liquids.

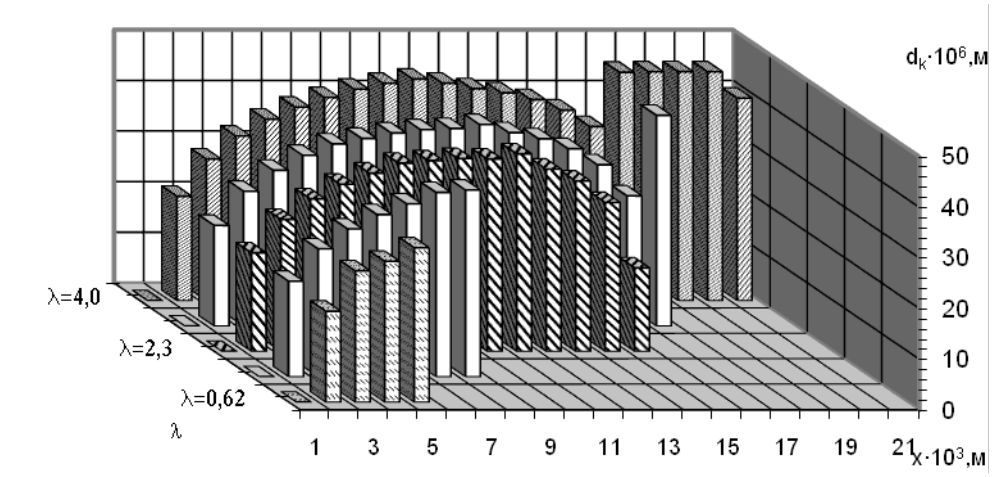

Figure 3 - The distribution of cavitation bubbles in size at different stages of cavitation.

Table

The effectiveness of milk homogenization in the cavitation device

Environment	Processing tempreture, °C	Relative length of the treatment zone	Times of processing	Homogenization effectiveness, %
Milk, mass fraction of fat 2,7%	47-50	0,5	2	77,2
			4	73,4
			10	70,8
		2,5	2	83,2
			4	80,0
			10	74,3
		3,0	2	87,5
			4	82,2
			10	73,0
		3,5	2	85,7
			4	84,1
			10	83,2
		4,0	2	84,0
			4	82,4
			10	79,2

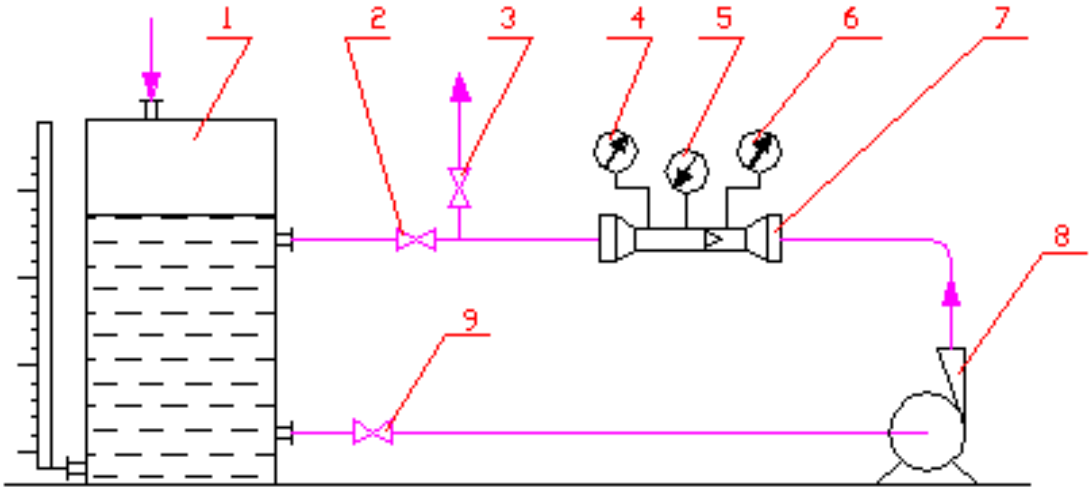

Figure 4 - The experimental GC scheme of cavitation installation:
1 – corpus; 2, 3, 9, 10 - valves, 4, 6 – steam gauges, 5 – vacuum gauge; 7 - working area with statically placed cavitator; 8 – rotary vane pump.

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Анотація. *В роботі розглянуто можливість оброблення дифузійного соку цукрового виробництва у гідродинамічному кавітаційному пристрої із статичним кавітатором. Проведені дослідження показали, що ефективність впливу на середовище виявляється у дії на нього кавітаційних бульбашок, які сплескуючись створюють кавітаційний ефект. В результаті була розроблена математична модель створення поля кавітаційних бульбашок для різних стадій кавітації.*

Ключові слова: *кавітація, математична модель, бульбашки, дифузійний сік, колапс, кавітатор.*

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