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RESEARCH OF DYNAMICS OF PULSE PRESSURE IN HETEROGENEOUS LIQUID

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In article results of research of features of physics of heterogeneous streams which due to the properties are widely used in modern heat power devices are discussed. The brief description of experimental installation and results of research of diffusers influence on dynamics of pulse pressure at electrohydraulic influences in a heterogeneous liquid are given.

Keywords: heterogeneous stream, electrohydraulic influences, diffuser, amplitude of impulse pressure, pulse electric discharge.

In the heat power equipment for maintenance of transition from smaller section of the channel to the greater with the minimal losses of full pressure smoothly extending sites in which kinetic energy of a stream will in part be transformed to energy of pressure are established. Owing to their small extent it is considered to be, that the stream has not time to exchange a heat and energy with an environment. Nevertheless, in diffusers there is an essential reorganization of a mode of flow, which is kept on big distance and determines features of processes of a thermal and mass exchange. Necessity of the account of influence of variable section of the channel is important at research of dynamics of streams of gaseous liquid media at external pulse influences.

Dynamics of bubble liquids, structures in bubble liquids. It is known, that intensity of course it is warm exchange processes in heterogeneous streams it is determined by their hydrodynamics. Modes of current gaseous liquid media are various, complex and chaotic [1,2]. It depend on many factors: volumetric concentration of phases, their density, viscosity, a superficial tension, presence of phase transitions and chemical reactions, diameter and geometrical position of the channel in space, a way of submission of phases in the channel, etc.

There are different classifications of current modes which repeat, but cannot capture all numerous real cases. It is connected by that real physical process in all systems non-stationary and nonlinear, especially if they proceed in liquid or gaseous media [3]. Despite of some seeming arbitrariness and chaos, it is possible to see, hierarchy of a geometrical proportion or fractality of structures, fig. 1. Features of physical properties of systems with fractal structure are connected to display of effects of memory, spatial correlations and processes of self-organizing.

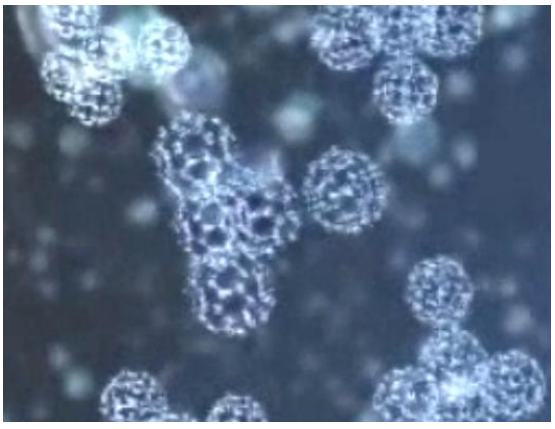


Fig. 1 Fractal structures in water under various conditions

Gas bubbles that moving in a liquid, emerge, in part keeping the spherical form. Around bubble are streams, which move a liquid from a frontal surface of bubble to its back surface. The further from bubble, the with smaller speed the liquid flows, less it «is informed" by that in goes bubble. Actually the liquid, certainly, flows, but the visible result of this current - emerging bubble is visually observed. Therefore, the speed of it emerging depends on how the liquid goes and from physical properties. In a case of very slow emerging of bubble in a viscous liquid, speed of emerging does not depend on density of a liquid, this case the energy transmitted by emerging bubble flowing round it of a liquid is supposed, that, is mainly spent for overcoming of forces of viscous friction, but not on size of kinetic energy [2].

At movement heterogeneous streams on cylindrical pipes, the surface that dividing liquid and gas phases with constantly varying form is formed, but thus possessing some self-similarity. Chaotic distribution of gas bubbles occur on the certain cascade models. By experiments investigated, as far as diffusers presence how strongly influence on distribution of the shock wave accompanying the electrohydraulic discharge in a heterogeneous liquid stream [4].

Experiment. For research of diffuser's influence on the structure of heterogeneous stream at pulse influences in Laboratory of hydrodynamics there is an experimental stand. Experiments were carried out using the a pipe from a strong material with length of 0,5 m, with an extending cone, in which smaller diameter 25mm, the greater - 40mm, fig. 2. A corner of cone equal $\alpha = 10^0$.

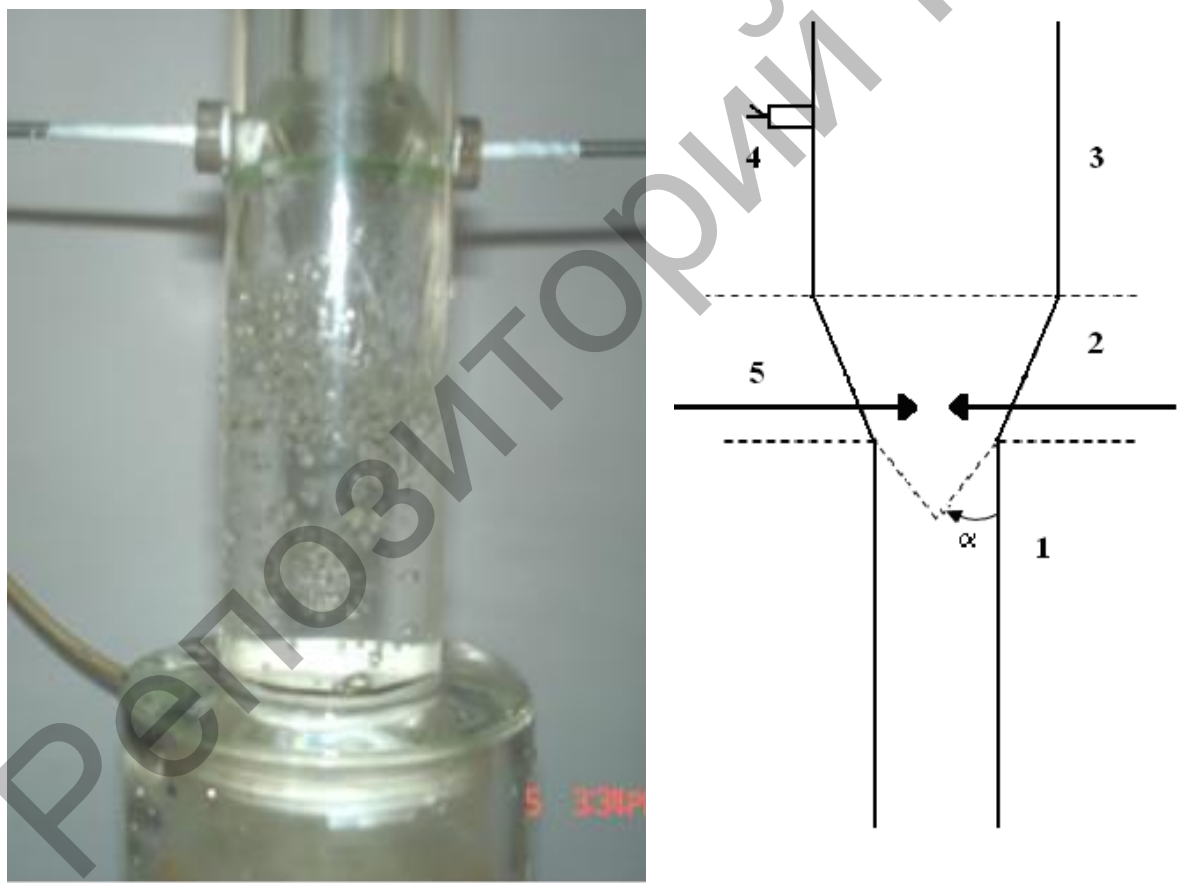


Fig. 2 The circuit of the working measuring stand with diffuser

Because of small convergent-divergent extent usually do not take into account their influence on heat-exchange processes, but at more exact research it is necessary to take into account structural reorganization of a multiphase stream. Pressure upon an entrance of diffuser essentially influences

on speed of phases though at big value of entrance pressure the gas bubbles behave practically as firm balls, their size and the form does not vary [5].

In figure 3 the circuit of electrohydraulic installation with system of automatic registration of signals is shown. The size of pulse pressure of a shock wave is fixed with the help of a piezometric detector. Signals act on a digital oscillograph 4 or by means of the converter 5 are processed in memory of a computer 6. Connection of system of registration with the electrohydraulic equipment is provided with the block of management 7, developing synchronized on the clock pulses submitted on an oscillograph and the managing electroarrester. For maintenance of safe of work installation is supplied with system of protection, emergency switching-off and removal of a residual voltage. The control and measuring system of electrohydraulic installation allows to observe time displays of a pulse current and pulse voltage with the help of digital oscillograph Velleman PCS-500.

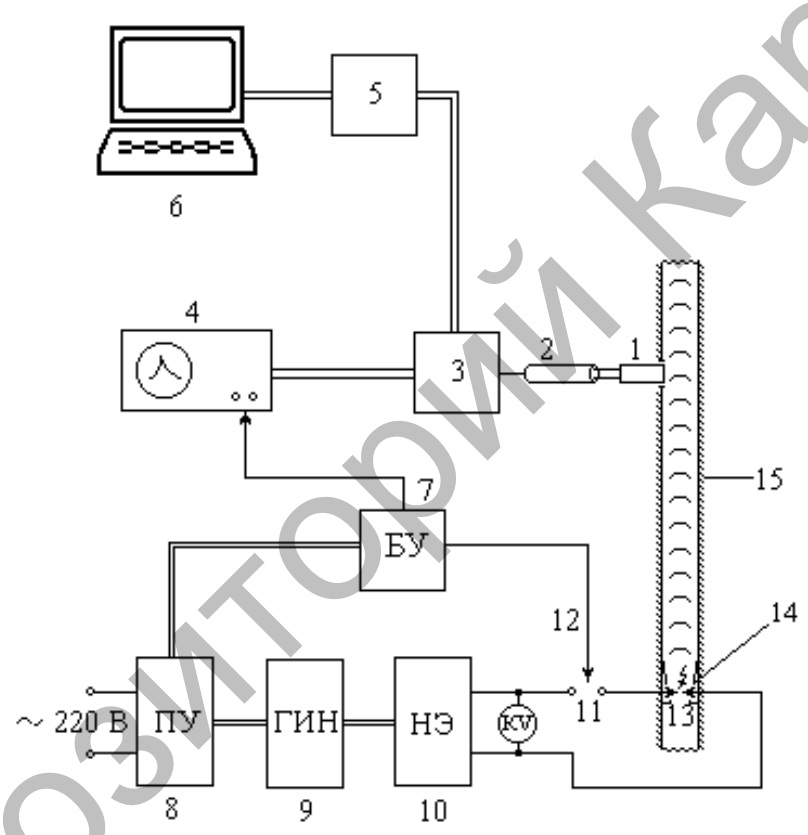
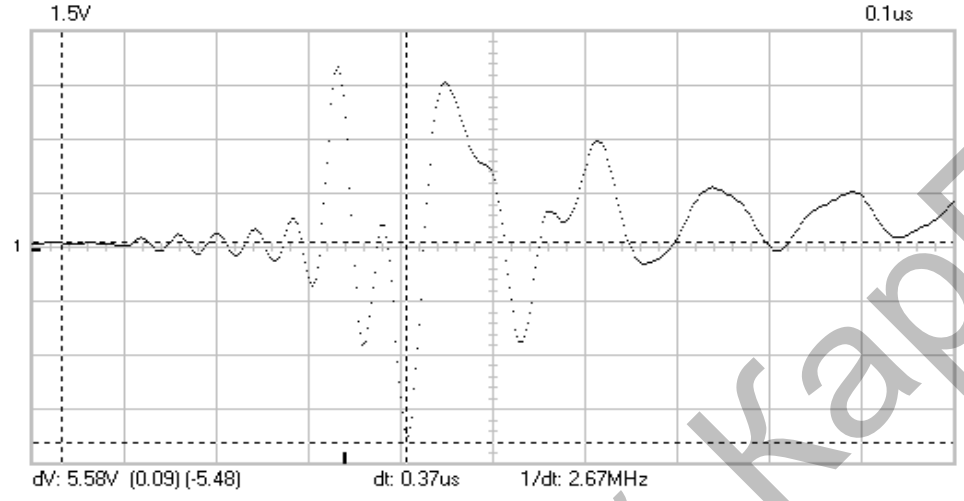


Fig. 3 The circuit of experimental installation: 1 - the gauge of pressure, 2 - a coaxial cable, 3 - the amplifier, 4 - an oscillograph, 5 - converter, 6 - a computer, 7 - the block of management, 8 - a control panel, 9 - the high-voltage generator, 10 - the store of energy, 11 - an arrester, 12 - a managing electrode, 13 - system of electrodes, 14 - cone diffuser, 15 - a working site

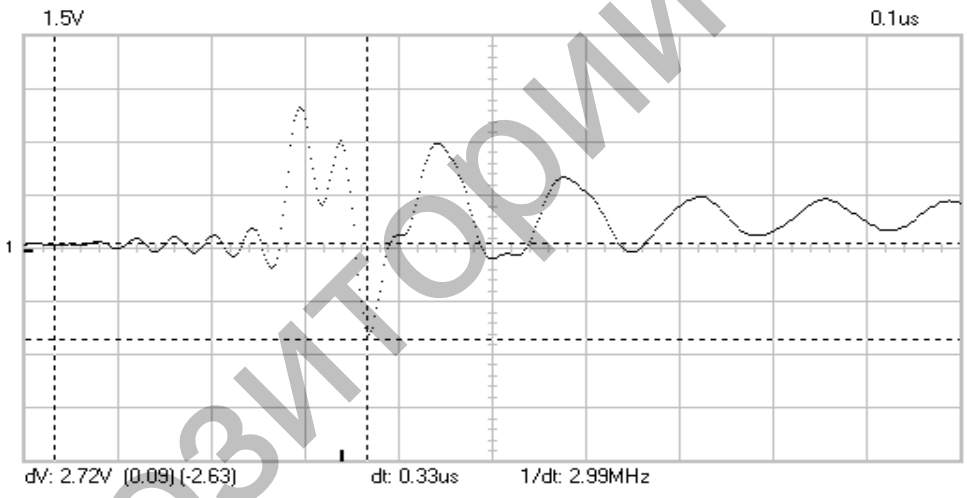
The pulse electric discharge in a liquid in essence represents microexplosion, i.e. it is a momentary energy output in small volume. The given volume represents the volume of steam-gas mixture which appears under action of high electric potential between opposite charged electrodes. Fast, a momentary energy output in a heterogeneous liquid generates the strong mechanical action enclosed to macroscopical volumes of environment and surfaces, got in a zone of the electric discharge. Speed of allocation of energy is much faster, than speed of transfer of indignation to an environment [4]. After the beginning of breakdown some time occurs a stage of formation of the electric discharge which is characterized by increase of size of a electric current with simultaneous recession of a voltage, and coming to the end with formation the high-conductivity electric channel. Under action of a high pressure the liquid is compressed. In the end the area of this compression is

formed moving front of a shock wave where pressure and all other parameters of the heterogeneous liquid vary by high-gradient change [6].

Use of digital oscillograph Velleman PCS-500 has allowed to fixing the pulse signals. On fig.4 characteristic oscillograms of the pulse voltage accompanying the high-voltage electric discharge in a non-uniform liquid are showed.



а)



б)

Fig. 4 Signals of a pulse voltage, capacity of condenser *C=0.1* microfarad, entrance voltage *U=3* kilovolt, interelectrode distance *l* =: а) 2 mm, б) 1 mm

Results. In experiments there was constants a capacity of the store of energy and inductance digit a contour, the interelectrode distance from 0,5mm up to 5mm, and accordingly a voltage of an arrester changed. On pulse displays the maximal peak corresponds to pressure, which is registered by a piezometric detector directly after realization of the electric discharge in a liquid, subsequent lower peaks, correspond to the pressure created by the reflected shock wave. The further registered pressure corresponds to fading fluctuations in the heterogeneous liquid in which electric explosion was carried out. In figure 5 schedules of dependence of amplitude of pulse pressure are resulted at various concentration of gas from size of a corner entrance diffuser.

It is established, that addition of a gas phase up to concentration until 8-10 % practically does not influence on of pressure amplitude, but the further increase in the contents of a gas phase leads to reduction, is observed damping effect of a gas phase. Graphic dependences of amplitude of a

pulse pressure on concentration of mineral impurity and gas are received. The influence of the sizes of mineral particles and bubbles is investigated. The experiences, which have been carried out with mineral impurity, also have shown effect of nonlinear decrease in amplitude of a pulse pressure depending on the sizes and concentration of firm particles [6]. Influence of pulse pressure at small concentration of gas on character of current is insignificant, fig. 6.

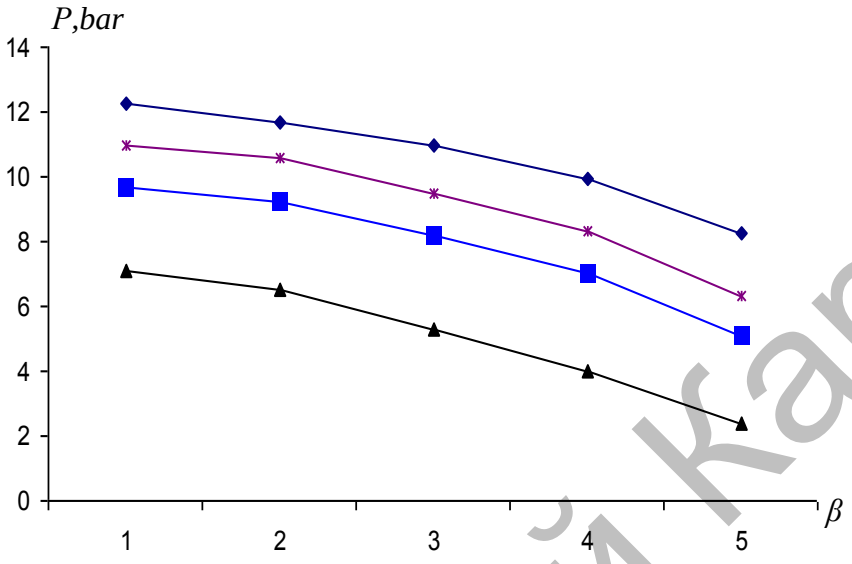


Fig. 5 Dependence of pressure amplitude from contents of the gas phase in heterogenous liquid (water + air bubbles) at interelectrode distance *l* =: ♦ - *4 mm; *-3mm; × - 2mm;* ▲*-1mm*

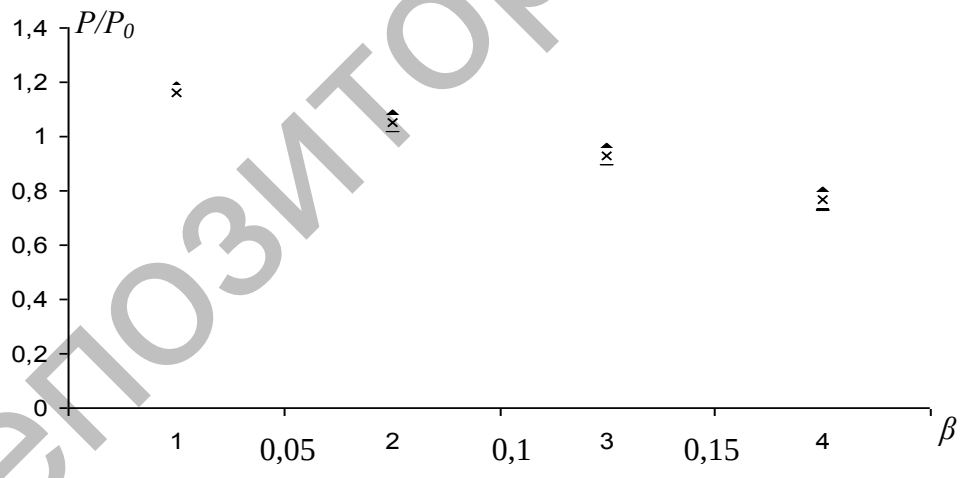


Fig. 6 Dependence of dimensionless pressure the resulted pressure on concentration of carbonic gas into entrance diffuser with $\alpha = 10^0$ at interelectrode distance *l* =: ×-2mm; ▲ - 4mm

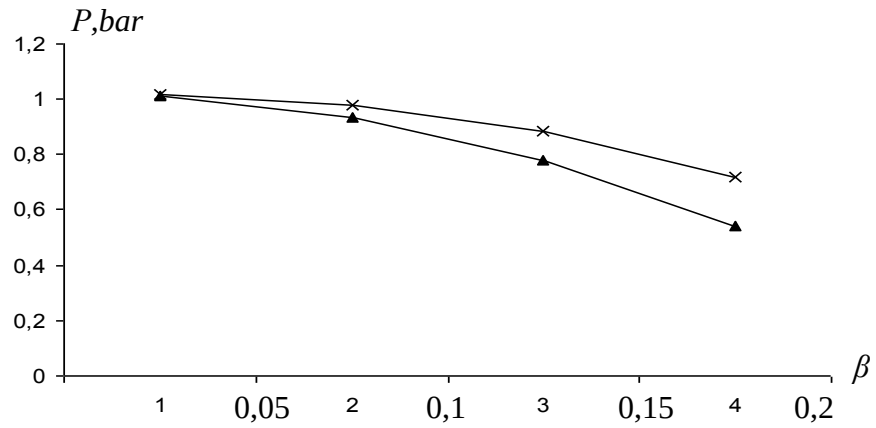


Fig. 7 Dependence of dimensionless amplitude of pressure on the contents carbonic gas bubbles: × - diffuser; ▲ - confusor

At low pressure of a stream because of reduction of pressure lengthways diffuser there is a significant change of the sizes of gas bubbles, at high pressures of diffuser's influence practically is not present, fig.7. Character of change concentration of gas lengthways diffuser for various initial concentration is identical, but depends on the sizes of bubbles, which determine structure clusters. The effect of non-uniform influence of pulse pressure in diffuser is caused by clustering leads to formation of macroscopic structures of gas bubbles, which influence on hydrodynamics and heat exchange of heterogeneous stream.

Thus, as a result of the done experiments on research of influence diffuser (confusor) with a corner of narrowing (expansion) $\alpha = 10^0$ on dynamics of pulse pressure heterogeneous streams, it is established, that at concentration of a gas phase up to 8-10 % the amplitude of pulse pressure at electrohydraulic influence does not change. At the further increase in the contents of a gas phase it is observed damping effect of a gas phase. At addition of firm impurity the effect of nonlinear reduction of amplitude of pulse pressure is observed depending on the sizes and concentration of firm particles. Influence diffuser (confusor) is found out at concentration of a gas phase of 8-10 % and only at small speeds of current of a heterogeneous liquid.

References:

1. Wallis G. one-dimensional two-phase flows. M.:Mir, 1972. - 132 pp.
2. Valukin N.V., Kozmenko B.K., Kashinskyi O.N. Characteristic monodisperse gas and liquid mixes at current in a vertical pipe. // Engineers and Physical Journal. -1979, **Vol. 36**, №4. - 695-699 pp.
3. Zhanabaev Z.Zh. Fractal model of turbulence in jet. // Proceedings of the SB of Russian Academy of Sciences. Technical Sciences. - 1988, **Vol.4**, №15.- 57-60 pp.
4. Kusaiynov K. Gidrodynamics, heat exchange and the electrohydraulic phenomena at movement of biphase media in pipes. - Karaganda: KarSU.-1998.-114 p.
5. Kusaiynov K.K., Sakipova S.E., Ospanova D.A., Abilkasimov B.B. Distribution of a pulse pressure in decreasing channels. // Materials of 9-th international scientific conference « Physics of a firm body ». - Karaganda: KarSU.- 2006 - 158-160 pp.
6. Sakipova S.E., The computer analysis of nonlinear processes in electric pulse processing of heterogeneous media. // Eurasian Physical Technical Journal.-Karaganda: KarSU, 2008, **Vol.5**, №2(10). - 10-16 pp.