Determination of ejection coefficient of liquid-gas ejector based on theory of attached mass

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Abstract

Introduction. The aim of the research was to develop a theory of ejection processes of gas-liquid ejectors with a dispersed liquid jet, based on the application of the principles of the theory of attached mass.

Materials and methods. Analytical methods for determining the gas phase flow rate were used. To calculate the main characteristics of water-gas ejectors with a dispersed liquid jet, it was proposed to use the modified Butakov-Hemeon theory.

Results and discussion. The basic ejection equation with an energy transfer coefficient not equal to unity is obtained according to the attached mass theory.

The change in the supply pressure of the working medium, which constantly occurs in production conditions, leads to a change in the speed regime of the liquid flow. Accordingly, changes in hydraulic resistances and redistribution of energy losses occur. The energy transfer coefficient for this reason is also variable and the calculation of its numerical value is recommended to be carried out for the nominal operating mode of the existing pumping equipment.

The design of the receiving chamber affects the amount of losses, since a mixed flow is formed in it. The method for determining energy losses in ejectors consists of finding the numerical values of component losses considering different designs and fluid flow rates. The obtained value of the energy transfer coefficient for an ejector with a cylindrical mixing chamber and a dispersed liquid jet is 1.075, which corresponds to the numerical value of the ejection coefficient of 3.918 (the actual ejection coefficient is 3.47). For an ejector with a combined mixing chamber, the energy transfer coefficient is 1.727, and the ejection coefficient is 6.72 (the actual ejection coefficient is 4.71).

Conclusions. The calculation of flow characteristics considers both the flow rate regime in the ejector elements and the design features of the mixing chamber. The accuracy of the determination the ejection coefficient is 12–14%.

Introduction

Ejection devices combine high intensity of the process flow with reliability in operation, which is explained by the simplicity of the design and the absence of moving elements (He et al., 2020). They apply to carry out various technological processes in the food industry, in particular, sulfitation of liquids in the production of sugar (Ponomarenko et al., 2017). In addition to the food industry, they are indispensable in gas production, in the aerospace industry as the main element of engines. The range of applications of liquid-gas ejectors is expanding every year, designs are being improved, theoretical, simulation, and experimental research of their operation is being conducted.

However, with a sufficiently simple design of ejectors, it is impossible to theoretically considered the processes and phenomena occurring in the ejector mixing chamber (resistance to the entry of the active flow into the mixing chamber during sudden expansion of the channel, degassing of the liquid in the zone of reduced pressure, vortex cavitation, which contributes to the dispersion of liquid droplets, the formation of vortex zones with local pulsations of velocity and pressure, the phenomenon of reverse circulation flows, evaporation of water into the gas phase to a saturation state). In addition, the length of the zone of formation of the dispersed composition of the spray jet droplets is sometimes proportional to the length of the mixing chamber. The transfer of energy from the liquid to the gas is accompanied by friction, and therefore irreversible losses. This is only a part of the phenomena that cannot be considered in the theoretical description of the ejector hydrodynamics.

Some of these phenomena significantly affect the ejection processes, the influence of other phenomena within the error range. When the ejection conditions change, the influence of the parameters changes due to the change in the speed regime.

Theoretical works describing ejection processes are based on a number of classical physical laws: the law of conservation of mass, the law of conservation of energy, the law of conservation of momentum (Ponomarenko et al., 2022; Zhang et al., 2019). This approach is traditional, however, this theory does not consider the state of the active flow of the ejector: whether a dispersed or compact liquid jet is used as the active flow. However, depending on this, the ejection coefficients may differ by several times. It is known that the ejection coefficients of devices with a compact liquid jet are within 0.5–1.5 (Zhao et al., 2022), and for ejectors with a dispersed jet they reach values of 1–5 (Ponomarenko et al., 2017). The classical theory of the description of ejection processes cannot explain this difference (the results are corrected by introducing experimental constants). In addition, the mathematical description of some processes, for example, the process of liquid jet disintegration (Villermaux et al., 2004) and droplet formation (Tang et al., 2023), which is important in describing ejection processes, is at the stage of formation.

In connection with the above, performing a mathematical description of ejection processes and theoretically obtaining their operating characteristics considering the noted phenomena in the ejector elements and in its mixing chamber is a rather complex, relevant and unresolved problem to date.

One of the approaches to describing ejection processes is based on the principle of the theory of the attached mass effect, which considers the particle dispersion and was first used to describe the ejection of a gas phase by a flow of bulk material (the Butakov-Hemeon theory). This approach was proposed to be used for the theoretical description of the ejection processes of a water-gas ejector (Ponomarenko et al., 2022). Under the assumptions made (liquid droplets are of equal size, quasi-stationary, and the resistance to the droplets is directly proportional to the velocity) and with an energy transfer coefficient equal to unity, equations

(Ponomarenko et al., 2022) were obtained that describe ejection processes similar to the equations of the Butakov-Hemeon theory.

Analysis of this theory, at first, analysis of the magnitudes of energy losses in the ejector elements showed that the energy transfer coefficient is not equal to unity. The development of the theory is to find an expression for the main equation of the ejector considering losses, which is considered by the energy transfer coefficient. According to this method, determining its numerical value is the main difficulty in calculating the ejection coefficient, since it depends on the speed regime of the liquid phase flow and the design of the ejectors, that is, it is variable. In addition, it requires clarification of the definition of the quantities describing the flow of a mixed flow, based on the basic provisions of the theory of homogeneous flow.

Materials and methods

Objects

The ambiguity of the results of studies of water-gas jet devices with a dispersed liquid jet at low pressures of the active medium prompted the conduct of full-scale experiments to establish the laws of hydrodynamics of a two-phase flow.

The object of the study was ejectors with a cylindrical and conical-cylindrical mixing chamber nozzles. The design of an ejector with a receiving chamber and a cylindrical mixing chamber is presented in Figure 1.

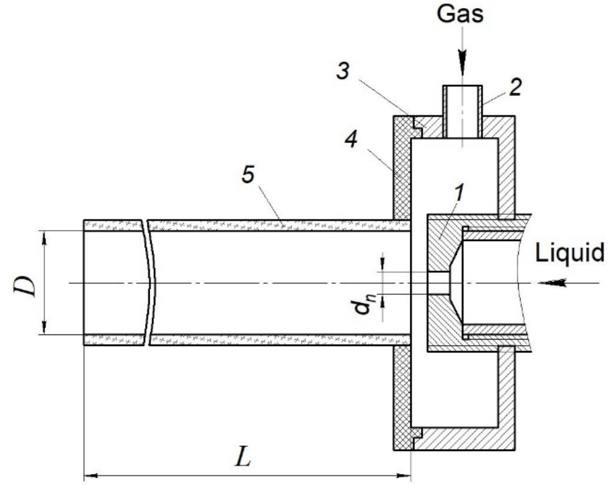

Figure 1. Design of ejector with receiving chamber and cylindrical mixing chamber: 1 – nozzle; 2 – inlet pipe; 3 – housing; 4 – cover; 5 – cylindrical mixing chamber

Main dimensions: diameter of the nozzle of the centrifugal jet nozzle with inclined channels 4 mm, diameter of the ejector mixing chamber 19 mm, which corresponds to the geometric characteristic of the ejector (ratio of the area of the mixing chamber to the area of the nozzle) m = 22.56. Length of the mixing chamber – 0.2 m, values of physical properties of the phases are taken at a temperature of 20 °C.

A study was also conducted on an ejector with a conical-cylindrical (combined) mixing chamber (Figure 2), which has an ejection coefficient (ratio of active flow to passive flow) 15–20% higher than that of a classical ejector with a cylindrical mixing chamber of the same geometric characteristics (Ponomarenko et al., 2023). The angle of the conical part of the ejector is 25°, the length of the conical part is 0.014 m, the length of the cylindrical mixing chamber is L = 0.2 m, the diameter of the base of the truncated cone is 225 mm, and the diameter of the cut is 50 mm.

The studies were conducted in the water-air system at a phase temperature of 20°C and a relative humidity of 85% in order to minimize the influence of heat exchange processes on ejection processes. The circulation of the liquid in a closed circuit (measuring capacity–ejector–measuring capacity) ensures the constancy of its physical properties for all experiments. The physical properties of the liquid depending on the temperature were determined on the basis of tables of the thermophysical state of water and water vapor.

For hydraulic tests of ejectors, a pouring instalation was made, shown in Figure 3. The stand is equipped with a volumetric meter PREMA G 1.6 for measuring gas flow. The liquid flow was measured with a rotary flow meter of the KV-1.5 type, accuracy class 1.5. The liquid pressure in the nozzle was controlled with a manometer OBM1-160, accuracy class 1.5. The rarefaction in the mixing chamber was recorded with a differential manometer in mm of water.

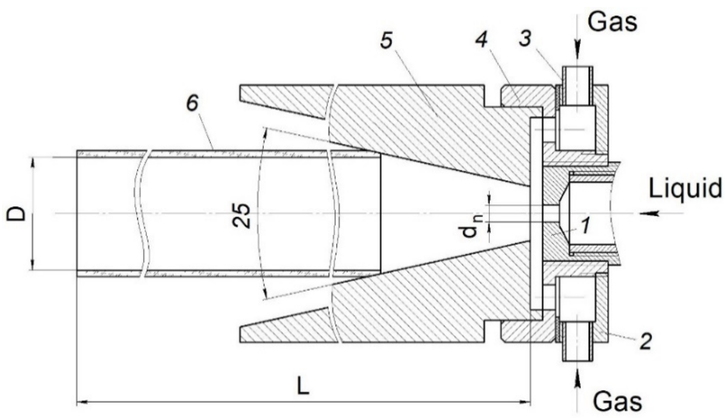

Figure 2. Water-gas ejector with a combined mixing chamber:
1 – working nozzle; 2, 4 – receiving chamber assembly; 3 – branch pipe;
5 – conical adapter; 6 – cylindrical mixing chamber

The studies were conducted according to the plan of a randomized two-factor experiment in the pressure range of 0.08–0.25 MPa. Changing the ejector operating modes was carried out by adjusting the pressure of the liquid supplied to the working nozzle of the ejector using regulating valves and controlled by a pressure gauge. At least three experiments were conducted. Each study lasted two minutes. The readings of the liquid and gas flow meters at the beginning and end of the experiments, as well as the liquid pressure, were recorded.

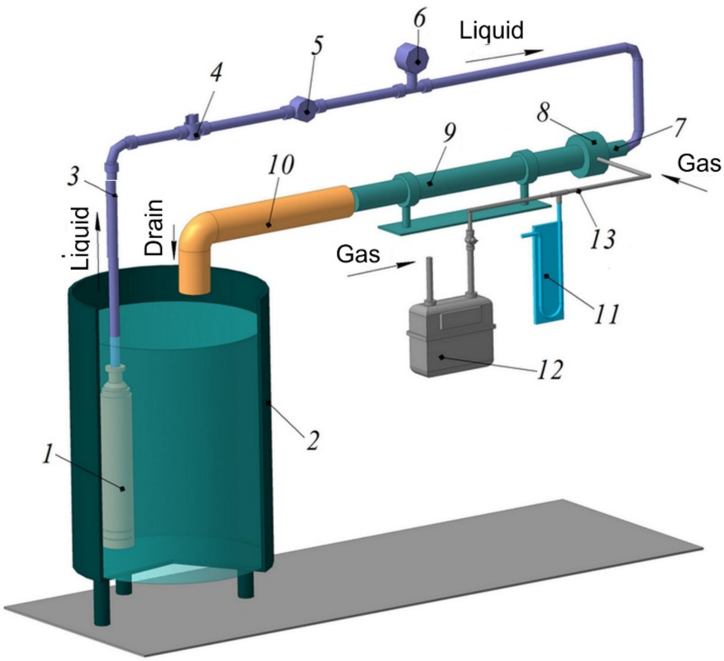

Figure 3. Hydraulic pouring instalation:
1 – pump; 2 – measuring tank; 3 – pipeline; 4 – regulating valve;
5 – liquid flow meter; 6 – pressure gauge; 7 – nozzle; 8 – receiving chamber;
9 – mixing chamber; 10 – drain pipeline; 11 – differential pressure gauge;
12 – gas flow meter; 13 – gas pipeline

Analytical methods for researching ejection processes

To describe the ejection processes in a jet apparatus with a dispersed liquid jet, the Butakov-Hemeon theory (for the flow of bulk materials) was used, modified to describe the ejection processes of liquid-gas ejectors (Ponomarenko et al., 2022). According to the model, part of the kinetic energy of liquid droplets is lost to overcome the resistance of the medium. The magnitude of the losses is determined by the force of the aerodynamic resistance of these particles. An expression for the basic ejection equation with an energy transfer coefficient equal to unity was found.

Results and discussion

Basic equation of ejection with energy transfer coefficient not equal to unity

The main thesis of the Butakov-Hemeon theory (Ponomarenko et al., 2022) to describe the process of air ejection by loose material was the proposition that the lost kinetic energy of the movement of droplets per unit time is converted into the kinetic energy of the gas phase flow, which moves together with the droplets (attached mass effect):

$$dE_g = Q_g dp \quad (1)$$

where Q_g – the volumetric air flow rate (attached mass) m^3/s, dp – the driving force of the air movement (pressure difference along the length of the mixing chamber), Pa.

For n liquid droplets, the lost energy can be found by the expression:

$$dE_g = nR_0 dx \quad (2)$$

where R_0 – the aerodynamic drag force, dx – the coordinate of the path traveled by the particle.

Or:

$$nR_0 dx = Q_g dp \quad (3)$$

Integration of the last expression within the length of the mixing chamber considering the expression for pressure losses in the ejector mixing chamber

$$\Delta p = \sum \varsigma \frac{v^2}{2} \rho \quad (4)$$

where ς – the total resistance coefficient (sum of local resistance and along the length), v – the velocity of the mixture, ρ – the density of the mixture in the mixing chamber and by introducing the energy transfer coefficient ξ_e we obtain the expression:

$$Q_e \sum \varsigma \frac{v_g^2}{2} \rho_g = \xi_e \int_0^l nR_0 dx \quad (5)$$

The solution of this equation was obtained (Ponomarenko et al., 2022) for the simplest case, when the energy transfer coefficient $\xi_e = 1$ and they are similar to the equations of the Butakov-Hemeon theory for solid particles, however, the determination of the quantities used in determining the state of the gas-liquid phase has its own characteristics. This allowed us to conclude that the method is universal and that it can be used in calculating the flow characteristics of water-gas ejectors with a dispersed liquid jet. This was sufficient at the stage of auditing the theory to describe the ejection processes.

Let us turn to the correctness of the assumption of the equality of the energy transfer coefficient to unity. As has already been partially noted, quite complex physical phenomena occur in the mixing chamber, the main ones being:

– the movement of liquid droplets in a cylindrical mixing chamber under the action of gravity leads to a change in their trajectory (*Sedano* et al., 2020), and when they hit a solid wall, liquid droplets either form a film that moves along the walls, or are partially reflected from it and move along a new trajectory *(*Alizadeh Kaklar et al., 2018*)*. When the liquid film moves along the walls of the mixing chamber, a tangential stress or friction force arises, which is accompanied by energy losses *(Li* et al., 2023*)*. In both cases, a part of the energy is lost;
– the flight of droplets in a gas environment occurs with resistance (Dadash-Zade et al., 2024; Kong et al., 2021), which leads to a decrease in kinetic energy, and when droplets are formed near the injector nozzles, when the gas phase has almost zero velocity, the resistance to the movement of droplets is the highest. At the outlet of the mixing chamber, the velocities of the liquid and gas are equalized, the resistance decreases (Kong et al., 2020);
– the formation of a drop at the outlet of the nozzle is accompanied by a change in its shape and size *(*Chen et al., 2025; Liu et al., 2023*)*, i.e. transient processes occur that occupy almost a third of the time the liquid droplets spend in the ejector mixing chamber, which is accompanied by a redistribution of energy, its partial loss;

- due to the imbalance of phases and the appearance of rarefaction zones in the ejector receiving chamber (Rosenberger et al., 2018), liquid degassing processes occur, which affect the formation and formation of droplets. At the same time (Yan et al., 2023), the process of saturation of the gas phase with water vapor occurs, which reduces the energy of the flow of the liquid-gas mixture. All processes are intensified by cavitation phenomena (Zhang et al., 2022), which occur when a liquid jet leaks from the nozzle of the injector (Zhou et al., 2024; Salim et al., 2023). These processes are the most complex and practically cannot be explained mathematically.

As follows from this analysis, as a result of energy exchanges between phases, a part of the energy is lost to the accompanying processes, and the equality of the energy transfer coefficient to unity can be said only in the context of the motion of an ideal fluid in a vacuum without friction.

Let us find the general expression of the main ejection equation for an energy transfer coefficient not equal to unity.

Let us assume that the aerodynamic drag force of liquid droplets R_0 is proportional to the cross-sectional area of the droplet d and the square of the relative velocity (Dadash-Zade et al., 2024):

$$R_0 = f_0 \frac{\pi d^2}{4} \frac{(v_l - v_g)^2}{2} \rho_g , \tag{6}$$

where f_0 – the drag coefficient of the droplet, v_l – the velocity of the liquid flowing out of the nozzle, v_g – the velocity of the gas entrained by the liquid droplets.

We transform expression (5) by multiplying it by $\frac{F}{F}$ and denote R_g (resistance to the gas phase per unit area of the mixing chamber) by:

$$R_g = \sum \varsigma \frac{\rho}{2} \frac{1}{F} . \tag{7}$$

Integrating expression (5) within the length of the mixing chamber and considering relations (6) and (7), we obtain the expression:

$$(Q_g R_g F - \zeta_e n f_0 \rho_g l \frac{\pi d^2}{8}) v_g^2 - \zeta_e n f_0 \rho_g l \frac{\pi d^2}{8} v_l^2 + 2\zeta_e n f_0 \rho_g l \frac{\pi d^2}{8} v_l v_g = 0 \tag{8}$$

After a series of simple transformations, the basic equation of ejection with an energy transfer coefficient not equal to unity takes the form:

$$Q_g^3 - Q_g^2 \zeta_e (n f_0 \rho_g l \frac{\pi d^2}{8} \frac{1}{F}) \frac{1}{R_g} + Q_g \zeta_e (2 n f_0 \rho_g l \frac{\pi d^2}{8} v_l) \frac{1}{R_g} - \zeta_e n f_0 \rho_g l \frac{\pi d^2}{8} v_l^2 \frac{F}{R_g} = 0 \tag{9}$$

Let us introduce the notation:

$$a = -n f_0 \rho_g l \frac{\pi d^2}{8} \frac{1}{F} \frac{1}{R_g} ; \tag{10}$$

$$b = 2 n f_0 \rho_g l \frac{\pi d^2}{8} v_l \frac{1}{R_g} ; \tag{11}$$

$$c = -n f_0 \rho_g l \frac{\pi d^2}{8} v_l^2 \frac{F}{R_g} ; \tag{12}$$

$$A = n f_0 \rho_g l \frac{\pi d^2}{8} \frac{1}{R_g} . \tag{13}$$

With the introduced assumptions and accepted notations, the basic ejection equation (9) is reduced to the form:

$$Q_g^3 + Q_g^2 \zeta_e a + Q_g \zeta_e b + \zeta_e c = 0 \,. \tag{14}$$

The solution of this equation allows us to obtain the amount of gas phase ejected by the liquid in the ejector mixing chamber, considering energy losses.

It should be noted that when the pressure of the liquid in the nozzle changes, and such changes during the sulfation of the liquid in production occur constantly, almost all the main calculated values change, which leads to:

- the liquid velocity in the nozzle changes, which leads to a change in one of the main calculated parameters–the droplet size (Tsai et al., 2019);
- a change in the liquid velocity when the pressure changes leads to a change in the Reynolds criterion *Re*, which is equivalent to a change in the droplet resistance in the mixing chamber;
- a change in the mixture velocity in the cylindrical part of the mixing chamber is similar to a change in pressure losses along its length (Joshi et al., 2019).

Such preliminary analysis leads to the opinion that the first estimated calculation of the ejection coefficients and the energy transfer coefficient is advisable to be carried out for a fixed value of the liquid pressure in the injector nozzle considering the nominal mode of the installed pumping equipment.

If the calculated value of the ejection coefficient for a given ejector is satisfactory, calculations can be performed for other values of the liquid pressure in the nozzle (in general, it is advisable to perform such calculations for the limit values of the liquid pressure, which will allow obtaining the range of operating ejection coefficients). The final stage is the construction of the operating characteristics of the ejector for the entire operating pressure range.

Ejection coefficient for an ejector with a cylindrical mixing chamber

We present the data for calculating the energy transfer coefficient and gas phase flow rate for an ejector with a cylindrical mixing chamber (Figure 1). The calculation is performed at a liquid pressure in the nozzle opening of 0.2 MPa, which corresponds to a liquid flow rate through the nozzle of 1.835×10^{-4} m^3/s and is the nominal tick of the pumping equipment during liquid sulfation.

An important parameter for the calculation is the droplet diameter, which we will take as d_{32} = 724 µm. This diameter was obtained experimentally when studying a centrifugal jet nozzle with a nozzle-opening diameter of 4 mm (Fang et al., 2024).

The fluid loss coefficient in the mixing chamber was determined at the value of *Re*:

$$\mathrm{Re} = \frac{v_l D \rho_l}{\mu_l} = 2.747\times10^5 \,,$$

where v_l – the velocity of the liquid along the wall of the mixing chamber, taken equal to the velocity of the liquid in the nozzle opening, ρ_l, μ_l – are the density and dynamic viscosity of the liquid, respectively, D – the diameter of the mixing chamber.

With this value of *Re*, we apply the Altshull formula, which is recommended for determining the loss coefficient in the transition region (tabular value of the coefficient $k = 7\times10^5$):

$$\lambda = 0.11\left(\frac{k}{D} + \frac{68}{\mathrm{Re}}\right)^{0.25} = 0.028$$

From where the pressure losses of the liquid due to its friction on the wall of the mixing chamber will be equal to:

$$\Delta P_1 = \varsigma \rho_l \frac{v_l^2}{2} = 3.09 \times 10^4 \text{, Pa.}$$

The second component of the losses is the pressure loss due to the movement of liquid droplets in the gas that have flown out of the nozzle. For simplicity, let us assume the droplet drag coefficient (Dafsari et al., 2021) to be constant and equal to 0.38, then the pressure loss will be:

$$\Delta P_2 = \varsigma_d \rho_l \frac{v_l^2}{2} = 4.05 \times 10^4$$

In addition to these losses, according to the theory of homogeneous flow, it is possible to calculate energy losses that were not considered when determining the ejected gas flow rate. These are losses from the action of gravity, which changes the trajectory of the drops:

$$\Delta P_g = \rho g = 2.667 \times 10^3$$

where ρ – the density of the mixture, and from the acceleration of the gas flow due to energy transfer from the liquid phase:

$$\Delta P_a = \frac{Q_g \rho_g}{F} a_v = 3.117 \times 10^3 .$$

Calculating energy losses allows you to find the numerical value of the energy transfer coefficient, as the ratio:

$$\psi = 1 + \frac{\Delta P_g + \Delta P_a}{\Delta P + \Delta P_g + \Delta P_a} = 1.075$$

Further calculation of the ejected gas phase flow rate according to equation (14) gives the value $Q_g = 7.188 \times 10^{-4}$ m^3/s, or the calculated ejection coefficient $k_e = 3.918$.

Experimental studies of the ejector with a cylindrical mixing chamber (MC) allowed us to establish the actual ejection coefficient (Figure 4) and at a liquid pressure in the nozzle of 0.2 MPa it was 3.47. The calculation of k_e according to the modified attached mass theory gives slightly overestimated results, since not all losses were considered.

The second reason for the error lies in the fact that at present there is no reliable theoretical description of the process of dispersing liquid droplets. The described mechanisms of droplet formation show that significant fluctuations in their shape occur: from films, cylinders to drops (Khan et al., 2023). According to the ideas of the theory of attached mass, such fluctuations in shape change the amount of attached mass of the gas phase. For example, the value of the attached mass of gas for a liquid in the form of a film differs from the attached mass of gas to a liquid drop of the same mass by almost 22 times. In the ejector mixing chamber, such non-stationary processes of droplet formation take place, which occupy up to 1/3 of the residence time of the phases in the ejector mixing chamber, but at present it is not possible to take such transformations into account.

In addition, some data (for example, the diameter of the drops) according to different primary sources may differ significantly. There is no reliable method for calculating the diameter of the drops or such experimental data for nozzles, especially those that have been developed recently.

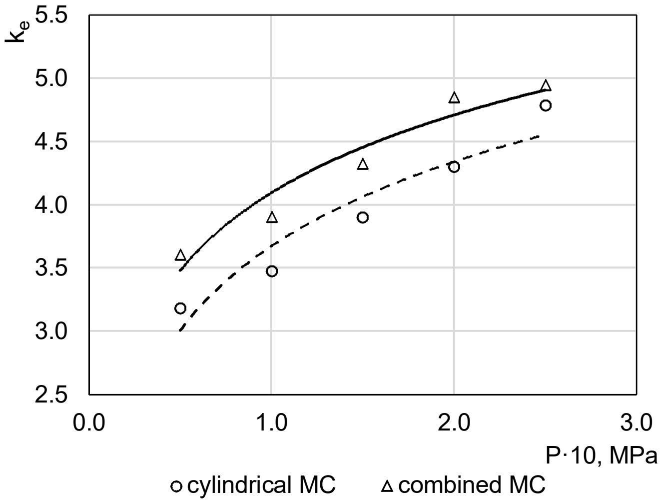

Figure 4. Dependence of ejection coefficient on liquid pressure in the nozzle

Ejection coefficient for ejector with a combined mixing chamber

We present the data for calculating the flow rate of gas phase according to the proposed method for an ejector with a combined mixing chamber, shown in Figure 2 (the initial part of the mixing chamber is conical, which turns into a cylindrical one) at a nominal operating mode of 0.2 MPa. The initial data for the calculation are similar to the calculation of k_e for an ejector with a cylindrical mixing chamber.

With the specified dimensions of the ejector and flow parameters, we calculate the energy losses in the ejector from the acceleration of the flow, due to friction on the walls of the ejector, from the action of gravity. The results are as follows:

- Losses along the length in the cylindrical part of the mixing (Ugli et al., 2023) chamber are 2.56×10^4 Pa.
- Pressure losses due to gravity at the level of 2.462×10^3 Pa.
- Losses due to acceleration of the gas phase, to which energy is transferred from the liquid – 4.3781×10^3 Pa.

The main energy losses are along the length of the cylindrical part of the mixing chamber, and they are considered when finding the ejection coefficient. Unaccounted losses are from acceleration and the action of gravity.

With total pressure losses in the ejector of 9.403×10^4 Pa, the unaccounted losses from acceleration and gravity are 6.84×10^3 Pa, which allows us to find the numerical value of the energy transfer coefficient of 1.727 to compensate for the unaccounted losses.

The calculation of the ejection coefficient at a given energy transfer coefficient allowed us to find the ejection coefficient k_e = 6.72 (the actual ejection coefficient according to experimental data for the ejector with these dimensions is 4.71).

Features of determining ejection coefficient according to attached mass theory

As previously noted, one of the main calculation parameters in determining the energy transfer coefficient is the diameter of the droplets formed during the dispersion of the liquid by the nozzle. There is no unambiguous information regarding the diameter of the liquid droplets. Different authors, based on their own research, give different values of the diameters, which can be partially explained by the different designs of the nozzles studied. So, when studying a centrifugal nozzle (Bezrodny et al., 2013) with a nozzle diameter of 0.94 mm, a swirl chamber diameter of 6 mm, a nozzle length of 0.4 mm at a liquid pressure in the nozzle of up to 0.6 MPa. The diameter d_{32} of the liquid droplets was 130 µm.

In numerical simulation of the spraying process of a two-nozzle centrifugal nozzle (Shulhin et al., 2022), the average droplet diameter was 0.43 µm. These data were confirmed by other studies (Shulhin et al., 2022) of liquid leakage from a nozzle with a diameter of 0.2 mm. The average droplet size was 300 µm, which is confirmed with sufficient accuracy by their CFD studies.

When determining the diameters of liquid droplets (Martins et al., 2021) of various hydraulic sprayers, it was found that the droplet sizes at a liquid pressure of 207 kPa lie in the range of 285–388 µm.

It was found (Zhu, 2023) that the droplet diameter depends on the nozzle diameter and the liquid pressure. Thus, at a liquid pressure of 207 kPa and a nozzle diameter of 3.8 mm, the droplet diameter is 1.00 mm.

The mentioned works on determination of droplet diameter show that there is no unambiguous information about droplet size. However, the correct choice of numerical value of droplet diameter allows to determine ejection coefficient quite accurately theoretically. That is, when choosing droplet diameter when determining ejection coefficients according to the theory of attached mass, it is necessary, if necessary, to conduct additional studies of the dispersed composition, or to use known data, however, the nozzle design should be as close as possible to the design of the sprayer, which is used in the ejector under study.

With insufficiently justified choice, the error in determining k_e can reach several times.

Conclusions

1. By mathematical modeling of the ejection processes of liquid-gas devices with a dispersed liquid jet based on the modified Butakov-Hemeon theory, an expression of the basic ejection equation with an energy transfer coefficient not equal to unity was obtained.
2. It is shown that the energy transfer coefficient is a variable value that depends on the ejector operating mode and its design features. An algorithm for determining the components of energy losses in ejector elements of different designs at nominal operating pressure is given, which allows finding a discrete numerical value of the energy transfer coefficient.
3. According to the given dependencies, for an ejector with a cylindrical mixing chamber, its numerical value of 1.075 at a liquid supply pressure of 0.2 MPa was found, which allows theoretically determining the ejection coefficient with satisfactory accuracy.
4. For an ejector with a combined (conical initial part and subsequent cylindrical) energy transfer coefficient was 1.727, which allowed theoretically determine the gas phase flow rate and the ejection coefficient 6.72. The error in determining k_e is 12–14%.
5. Further research will be aimed at refining the mathematical model of water-gas ejectors with a dispersed liquid jet.

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