ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 7, Issue 10 , October 2020

# Study of Geometric Parameters of Open Branching Flow

**Yunusov Ganisher Gafirovich, Juraev Olim Ismoilovich**

Associate professor, Department of Mathematics,Bukhara Institute of Engineering Technologies, Buxara, Uzbekistan,Assistant,Information and Communication Technologies, Bukhara Institute of Engineering Technologies, Buxara, Uzbekistan,

**ABSTRACT:**The article investigates the geometric parameters of an open flow in the division of water into network. A device was created to monitor the experiment and Division of water into networks and the occurrence of fluctuations in the flow was observed. The results obtained were analyzed and a mathematical model was created. And also given a conclusion and recommendations on the results obtained.

## I. INTRODUCTION

It is convenient to determine the flow of a liquid, gas, or their mixtures in a region bounded by solid boundaries and liquid (gaseous) media by methods of solving the theory of jets. A flow region with unknown boundaries, which are often either a free boundary, a cavity, or the interface of various liquids or gases that emerge during the solution process. Determination of the process of fluid flow depending on geometric and hydrodynamic parameters, as well as on its physical and mechanical properties on the aerodynamic wake or in the area of outflow from vessels of various configurations is the first task of modern hydrodynamics. The ability to simulate these zones allows one to obtain a solution to real problems of flow around or outflow, i.e. reliably take into account the influence of viscous effects in the problems under consideration [11,12,13,14].

In many practically important flows occurring in nature and technology at low Reynolds numbers, the velocity of a liquid particle in the vicinity of branching changes sharply [7, 8]. During fluid flow, especially in the separation section, vorticity appears, which is created due to the separation of the boundary layer or due to the presence of a zone with a negative pressure gradient. To explain the structure of the flow taking into account the separation, the jet theory was created [2,3,4]. Based on these theories, one can write the vorticity region with angular velocity [4,10,11]. To clarify the definition of the geometry of the vortex zone and its effect on the flow rate and depth of the flow, we carried out experimental studies.

The purpose of the experiment is to establish the reliability of the adopted jet models, which is solved by the method of N.E. Zhukovsky, and to determine the hydrodynamic parameters of both homogeneous and non-uniform flow during fluid flow in a channel with a side outlet. For this purpose, a special experimental setup with a lateral outflow has been developed. The experimental setup (Fig. 1) allows, based on modeling theory, to obtain all the main parameters in the process of flow separation.

The installation is a straight section of the main channel with a rectangular cross-section of 5 cm and a length of 215 cm, at a distance of 103 cm from the beginning of the main channel. To it are connected the outgoing parts of the channel also 5 cm wide, 133 cm long, and 5 cm high.

The installation is made of plexiglass to reduce hydrodynamic resistance and better visual observation. The experimental setup was made with different division nodes formed by prismatic channels of the rectangular cross-section at separation angles and different tilt angles to the horizon.

## II. GENERAL VIEW OF THE EXPERIMENTAL SETUP WITH A VARIABLE FLOW DEPTH AT

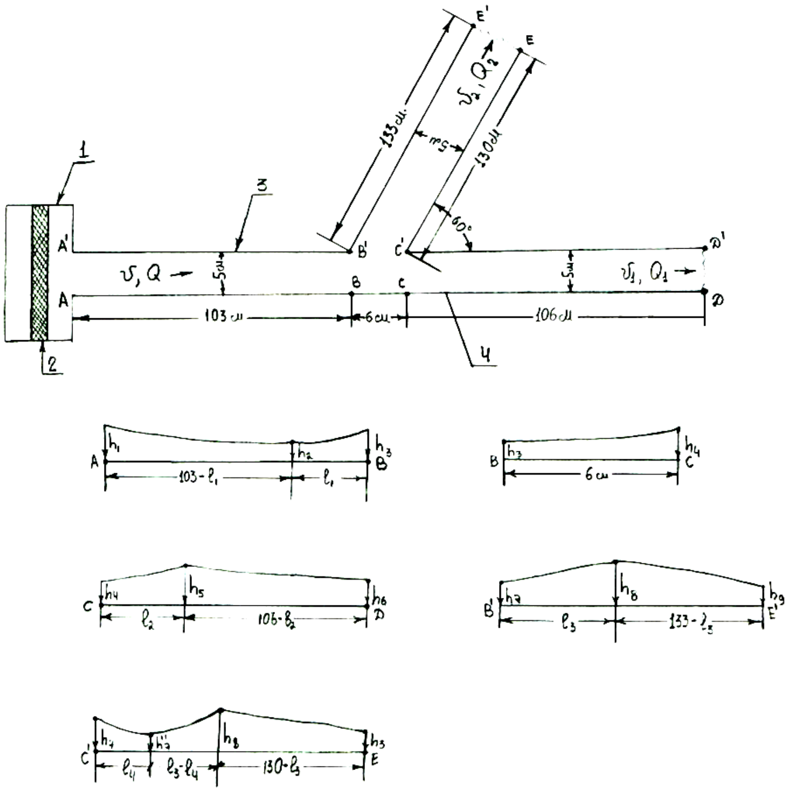


Fig. 1

Let us present the research results in the case of flow separation. The control of the supplied liquid flow rate was carried out using valves mounted in the pressure pipeline. The total consumption can be controlled using the following formula, where is the initial consumption; - consumption of a continuous section; - consumption in separation. Following the set research objectives, in the course of the experiments, various parameters of the flows in the fission unit were measured.

The change in the flow depth in the bifurcation with the change in the length of the channel tray for a uniform flow is shown in the graph in Fig. 2.

Change in the depth of a uniform flow along the length of the tray for different flow rates

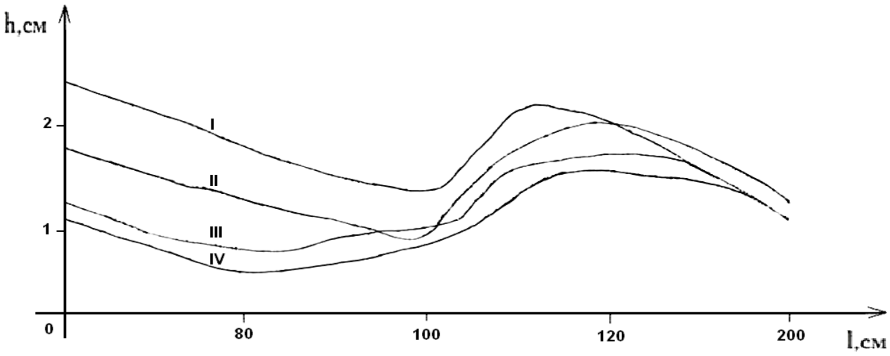


Fig. 2:

**I-Q = 197.5 ml / s; II - Q = 147.5 ml / s; III-Q = 131.2 ml / s; IV-Q = 73.3 ml / s;**

To identify the kinematic characteristics of the flows that make up the fission unit, the longitudinal velocities of the motion of a homogeneous and inhomogeneous fluid were measured at various sections of the sections. The depth velocity was determined using the formula [5]. The nature of the flow of the sediment-carrying flow and the "relief" formed at the bottom of the flow was measured with a thin, strong stainless needle, which was lowered with a pointed tip until it touched the water surface. The calculation was determined using a ruler.

Each series of experiments with a sediment-carrying flow was carried out for one hour. After that, the flow stopped. A picture of the nature of the deposited sediment was obtained through visual observations and transparent graph paper (Fig. 3).

The experiments were performed for one fixed concentration, i.e. 500 g of soil with a particle size distribution of less than 0.25 mm was passed into the water for 10 minutes with a special dispenser at a certain water flow rate. During the experiment, the flow rates, geometric characteristics of the flow, as well as the depth and dimensions of the dense flow at the bottom of the tray were measured.

Thus, the laboratory study of the issue of flow division is reduced to setting up a multifactor experiment [1]. For a complete analysis of the obtained dependencies, the least-squares method was applied.

## III. THE LOCATION OF THE VORTEX IN THE FLOW DIVISION OF WATER INTO NETWORK.

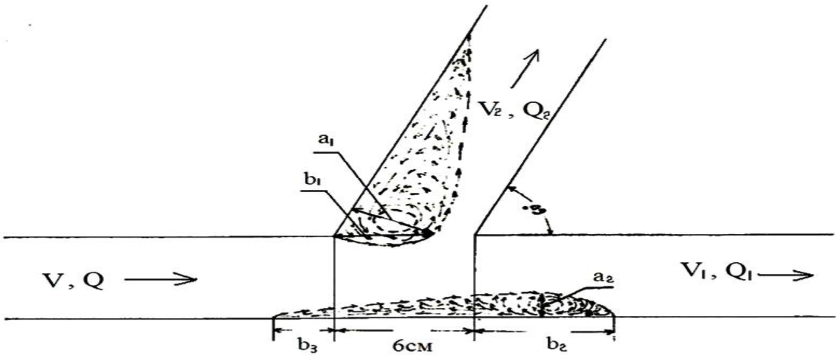


Fig. 3

During the experiment, the relative and absolute deviations of the parameters were determined. For this, the following mathematical formulas were used:

$$\sigma_Q = \sqrt{\left(\frac{\partial Q}{\partial h}\right)^2 \sigma_h^2 + \left(\frac{\partial Q}{\partial t_{cp}}\right)^2 \sigma_t^2}$$

where is the root mean square error in determining the depth; - root mean square error of time recording, determined by the expression:

$$\sigma_t^2 = \frac{\sum_{t=1}^{n}\left(t_{cp} - t_i\right)}{n-1}$$

where is the measurement number; - measurement time. Thus, you can get the following dependency:

$$\sigma_Q = \frac{V}{t_{ñð}} \sqrt{\sigma_n^2 + \left(\frac{h}{t_{ñð}}\right)\sigma_t}$$

Each specific flow rate has a root-mean-square error. Relative error

$$\varepsilon = \pm \frac{\Delta Q}{Q},$$

where is the absolute error in measuring the flow rate, is taken equal to twice the root-mean-square error.

The study of flow separation in rectangular sections showed that the general picture of fission is similar to that noted in [6]. An analysis of the nature of depth changes for a homogeneous flow is shown in Fig. 2 and Fig. 3, where the characteristic values are connected by straight lines.

The depth change has been found to depend on the flow rate and flow regime. The flow regime is calculated using the following formula:

$$\mathrm{Re} = \frac{4R\upsilon}{\nu}$$

where is the Reynolds number; - kinematic viscosity of the test fluid; - wetted perimeter; - flow rate in the investigated sections.

Hydrodynamic drag coefficient:

$$\lambda = \frac{8RgJ}{\upsilon^2}$$

where is the slope of the liquid surface.

From the graphs in Fig. 4, a, bit can be seen that on the left bank in the initial sections a vortex is formed, depending on the flow rate and flow regime, creating a backwater of the level. On the right bank in the initial section, a drop in the water level is formed. From this, it can be concluded that a compressed section is formed near the right bank at the beginning of separation [9, 10, 11,15].

Let us calculate the compression ratio using formula (1) derived from the jet theory:

$$K_u = \frac{1}{1+\Phi_3(c)} = \frac{(f-c)\sqrt{c}}{(f-c)\sqrt{c} + \left(\sqrt{f}+\sqrt{f-c}\right)(e-c) + \Phi_2(c)}$$

To determine the size of the vortices in the sediment-carrying flow, we set up a special experiment at the angle of diversion. The flow rate of the second measurement of the liquid flow rate was from 73 to 200 cm3 / s with the aforementioned concentration (Fig. 4).

Determining the geometry of the dimensions of the vortex zone was difficult since the vortex zone from the transit stream does not have sharp outlines. Visual observations showed that vortex formations are wave-like, and such waves are characteristic, also characterized by a rapid change in the numerical values of the width and length of the vortex, as well as the outlines of the boundary from the transit flow.

Nevertheless, despite the difficulties in measuring them, we measured the size of the vortex after the experiment near the separation of the flow for individual flow rates of the liquid flow, Table 1, Fig. 5.

## IV. CHANGE IN DEPTH ALONG THE LENGTH IN THE SEDIMENT-CARRYING FLOW AT THE SECTION

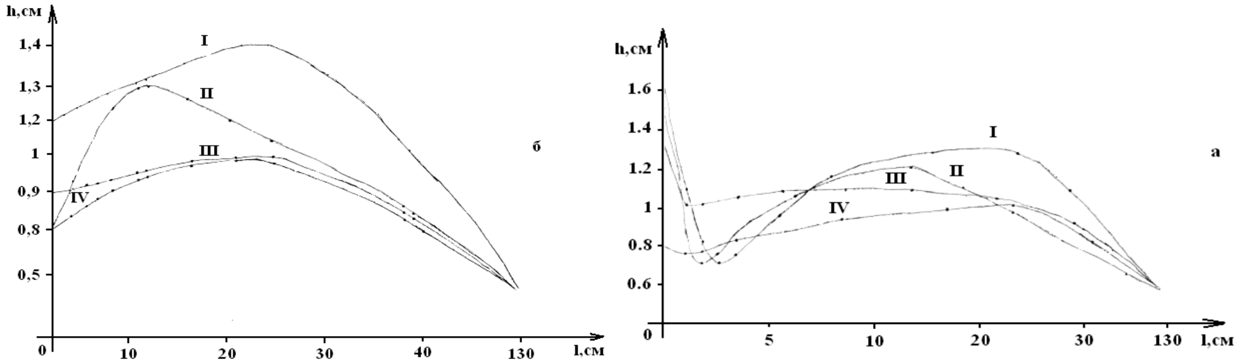


Fig. 4:

a - right bank, b - left bank.

I - Q = 50.7 ml / s; II - Q = 39.2 ml / s; III-Q = 27.1 ml / s; IV-Q = 17.3 ml / s;

## V. THE QUANTITATIVE VALUE OF THE RELIEF IN THE FLOW SEPARATION AREA

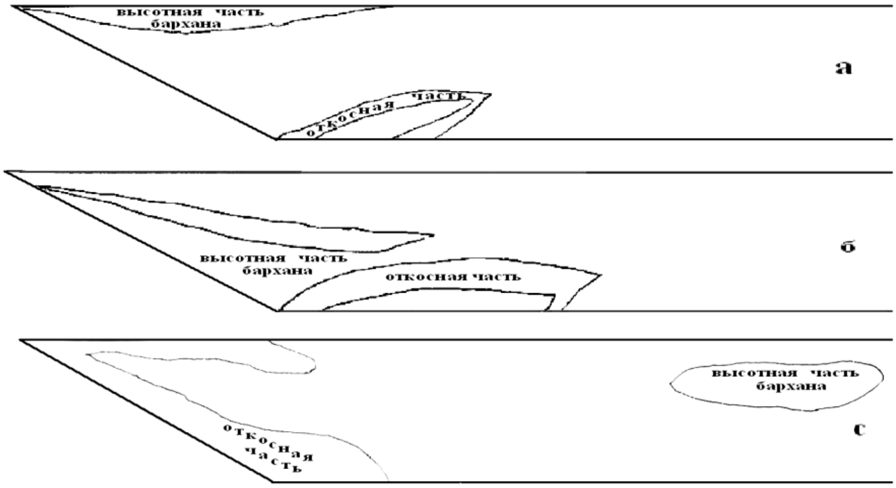
Table 1

| № | | $h_1$, см | $h_2$, см | $h_3$, см | $h_4$, см | $h_5$, см | $h_6$, см |
|---|---|---|---|---|---|---|---|
| I | 1 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 |
| | 2 | 0 | 0.4 | 0.65 | 0.7 | 0.8 | 1.1 |
| | 3 | 0 | 0.7 | 0.7 | 0.9 | 0.9 | 1 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 4 | 0 | 0.7 | 0.8 | 0.8 | 0.9 | 0.9 |
| | 5 | 0.1 | 0.9 | 0.8 | 0.7 | 0.8 | 0.8 |
| | 6 | 0.3 | 0.8 | 0.7 | 0.7 | 0.8 | 0.7 |
| II | 1 | 0.2 | 0.28 | 0.4 | 0.3 | 0.3 | 0.3 |
| | 2 | 0 | 0.6 | 0.5 | 0.4 | 0.6 | 0.9 |
| | 3 | 0 | 0.1 | 0.6 | 0.4 | 0.6 | 0.8 |
| | 4 | 0 | 0.1 | 0.5 | 0.4 | 0.5 | 0.7 |
| | 5 | 0.1 | 0.1 | 0.7 | 0.4 | 0.5 | 0.6 |
| | 6 | 0.2 | 0.3 | 0.7 | 0.5 | 0.5 | 0.6 |
| III | 1 | 0 | 0 | 0 | 0 | 0.3 | 0.5 |
| | 2 | 0.7 | 0.8 | 0.8 | 0.7 | 0.7 | 0.4 |
| | 3 | 0.6 | 0.7 | 0.8 | 0.9 | 0.9 | 0.8 |
| | 4 | 0.3 | 0.5 | 0.6 | 0.7 | 0.9 | 0.9 |
| | 5 | 0.3 | 0.4 | 0.5 | 0.6 | 0.9 | 0.7 |
| | 6 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.5 |

Note: a: I - first experiment Q = 50 cm3 / s; b: II- second experiment Q = 70 cm3 / s; s: III- third experiment Q = 80cm3 / s.

A general picture of the topography of the channel bottom in the branch



section

Fig. 5:

a) Q = 50cm3 / s; b) Q = 70 cm3 / s; s) Q = 80cm3 / s.

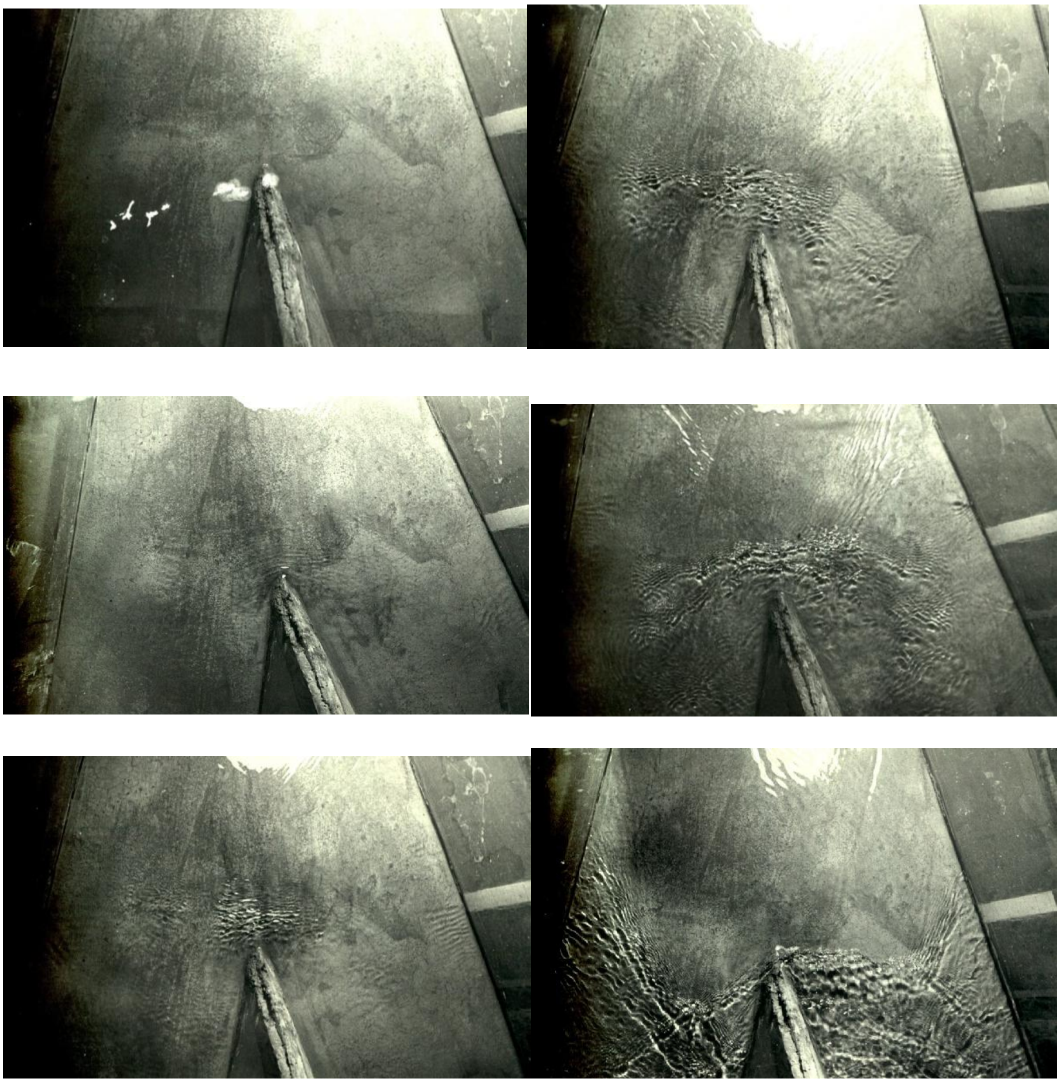
Experimental studies with sediments have shown that with a change in the concentration of sediment within the mouths of the separate zone, in some cases, two compressed sections are formed, and a dune appears in the middle of the channel, which grows over time. The formation of a whirlpool zone in the outlet channel is caused by a sudden increase in the width of the main channel and the rotation of the outlet stream by a certain angle, as well as by a change in the flow regime. During separation, due to a change in the direction of the flow stream, a centrifugal force arises in the outlet channel, as a result of which transverse circulation appears. As established (Fig. 3.6, a, b, c, a ', b', c '), the appearance of eddies and their size largely depend on the intensity of turbulence and circulation:

$$k = \frac{\sqrt{\overline{V_1^2}}}{\overline{V}} \cdot 100 \ ,$$

where is the pulsation rate; - the average speed.

Thus, the results of the studies carried out give grounds to assert that we have established the regularity of changes in the depth of homogeneous and inhomogeneous flows, the geometry of the vortex region, and, in some cases, its dimensions. The general relief picture and their calculated values by coordinates are presented in Fig. 5 and Table 1.

## VI. flow characteristics, as well as the depth and dimensions of the dense flow at the bottom of the tray.



(laminar and transient mode) (turbulent regime and quadratic region)

Fig. 6

## VII. SCOPE

The experimental results show that the current distribution would be optimal at a channel separation angle of $30^0$, . if it had a sharp angle. This conclusion was obtained on the basis of a mathematical analysis of the experimental results. We found the flow compression ratio based on the mathematical analysis of the roof. The experiments were carried out in single-phase and multiphase flow regimes; the dynamic change in the channel bottom was investigated. As a result, the channel bottom changes as a result of compression and flow rate. It was based on a theoretical and experimental basis.

## REFERENCES

[1]. Митропольский А.К. Техника статистических вычислений. -М.; 1970. С.250-305.
[2]. Хамидов А.А. Плоские и осесимметричные задачи о струйном течении идеальной сжимаемой жидкости.- Ташкент: ФАН, 1978.-180с.
[3]. Хамидов А.А. Плоские струи смеси идеальных жидкостей // Труды ТашГУ.- Ташкент, 1988. Вып.583. С.14-18.
[4]. Хамидов А.А., Усманов Г.У. Определение влияния внешних и внутренних сил на нестационарное течение идеальной несжимаемой неоднородной жидкости // Узбекский журнал «Проблемы механики».- Ташкент: ФАН.-1995.- №34.-С.33-36.
[5]. Шакиров А.А. Обоснование эффективных параметров гидродинамических процессов в канале и пористых средах: Автореф. дис. докт. техн. наук. Ташкент, 1994.-39с.
[6]. Шоазизов Ф.Ш. Совершенствование методики гидравлического расчета разделяющихся потоков: Дис. канд. техн. наук- Ташкент, 2000.- 122с.
[7]. Pedley T. The Fluid Mechanics of large blood vessels. London; New York, New Rochelle, 1980.
[8]. Toshinori Watanabe, Taizo Horikomi. Experimental and numerical visualization of the oscillatory flow field in a branched tube. Journal of Flow Visualization & Image Processing, 2001. Vol.8. Pp.213-231.
[9]. Г.Г.Юнусов Гидродинамическая структура открытого потока на участках разветвления. Автореферат диссертации соискани ученой степени кандидата технических наук. ИМиСС им М.Т.Уразбаева, Ташкент 2007. https://vivaldi.nlr.ru/bd000200944/view/
[10]. Yuusov G.G., Axmedov M.Sh. Theoretical study of the side flow of the liquid from the channel. Monograph. LapLambert. 2018.
[11]. Юнусов Г.Г., Жураев О.И., Нуритдинов Б.З. Теоретическое исследование бокового оттока жидкости из канала. Монография . LapLambert. 2017.
[12]. Юнусов Г.Г. Асосий оқимдан ажралаётган струянинг бурчагини аниқлашда Фруд сонининг таъсири. http://dx.doi.org/10.26739/2181-9696-2020-5-2.
[13]. Yunusov Ganisher Gafirovich INVESTIGATION OF THE PROBLEMS OF LATERAL OUTLOAD OF LIQUIDS. PHYSICAL AND MATHEMATICAL SCIENCES. VOLUME 4, ISSUE 1. TASHKENT-2020. http://dx.doi.org/10.26739/2181-0656-2020-4-3
[14]. 14. Юнусов Г.Г. Гидродинамическая структура открытого потока на участках разветвления. Автореферат на соискание ученой степени кандидата технических наук. Институт механика и сейсмостойкости сооружений имена М.Т.Уразбаева АН Республика Узбекистан Ташкент 2007. https://vivaldi.nlr.ru/bd000200944/view.
[15]. R.D. Aloev, M.M. Nurullaev, “Software, algorithms and methods of data encryption based on national standards”, IIUM Engineering Journal, 21 (1), (2020) pp. 142-166. DOI: 10.31436/iiumej.v21i1.1179