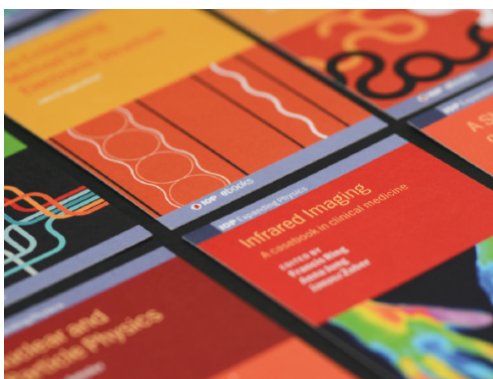


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# The determination of the dependence of the cavern length on the flow velocity on an experimental hydrodynamic workbench

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**Abstract.** An experimental installation for studying developed cavity flows is described, including a separator for removing free air and gases from the stream, and a device for determining the flow rate. Experiments of flow around the restriction in the form of flattened cone were carried out. The dependences of cavern sizes and pressure on the working section from the free-stream flow velocity are obtained.

## 1. Introduction

The fluid flow accompanied by cavitation is a common type of flow with a wide range of physical characteristics changes, operational and geometric parameters of the designed industrial equipment, therefore, the research of such flows is of great applied value. The most effective for solving the problem are research methods based on a generalization of experimental materials.

The current state of the methods of numerical simulation of cavitation processes does not make it possible to ensure fully the acceptable level of their description even when using the most advanced models and supercomputers. This is due to the extreme complexity, immensity, and diversity of physical processes that take place during cavitation. Therefore, one of the main vectors to improve the efficacy of research into cavitation flows is the design and development of experimental equipment and technologies for model and field studies, taking into account the scale effect [1].

Hydrodynamic workbenches are the most important tools for studying flows in confined flows. The obtained experimental results are used in various technical hydraulic devices and mechanisms in order to increase the stability and reliability of the technological installations operation.

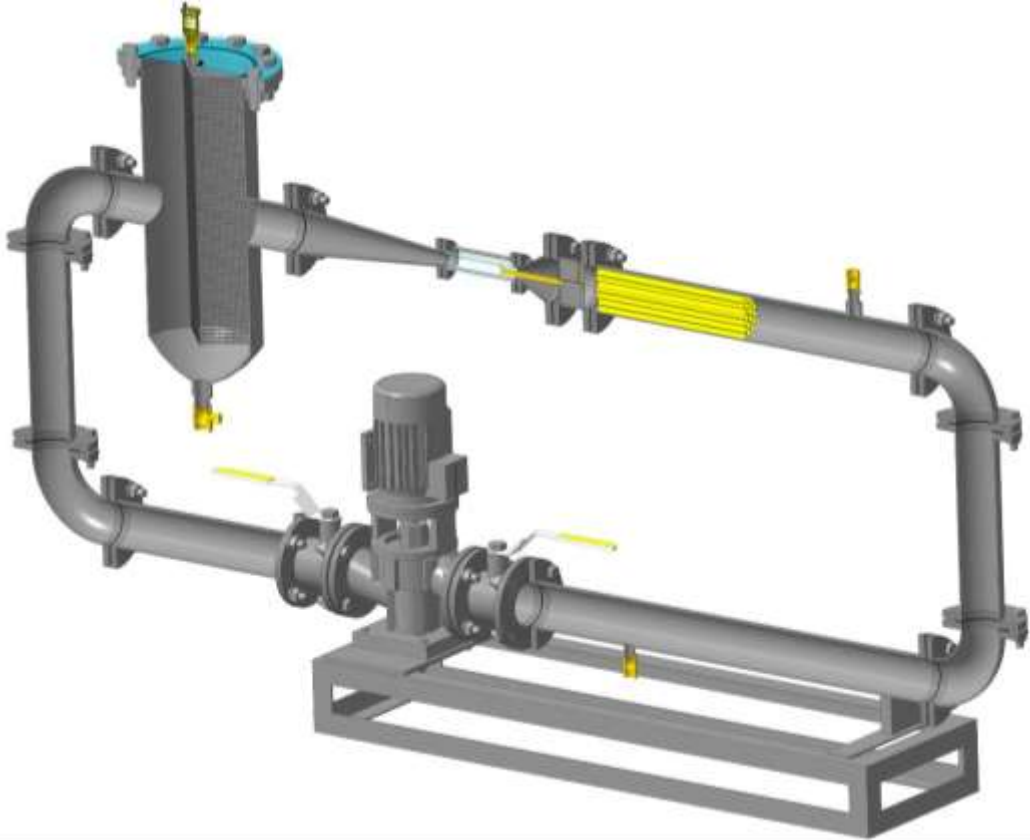
## 2. Experimental installation

The experimental installation [2, 3] is a closed hydrodynamic circuit and is designed to study the cavity flow regimes in confined flows (figure 1). The installation circuit is made of steel pipes with an inner diameter of 100 mm with flanged connections. The movement of fluid is carried out by a centrifugal pump with a nominal performance of 20 m<sup>3</sup>/min and an available fluid head of 25 m of water column. The marked capacity of the pump motor is 2.8 kW. The capacity regulation of the pump is controlled by two rotary slides at the inlet and outlet of the pump.

During installation work, a large amount of dissolved gas is released from the stream. To remove gas, a separator is used in the installation, which is a cylinder installed transversely to the flow, having



an outlet in the lower part for removing sludge and a float air valve in the upper part to remove free air. Inside the separator there is wire gauze with a mesh cell size of 5 by 5 mm (figure 2).



**Figure 1.** Scheme of the experimental setup.



**Figure 2.** Separator of free air and gases.

Initially, the separator was installed in front of the working section (figure 3, (a)), however, this arrangement led to significant instability of the flow and vibration. To prevent these characteristics, the separator was moved beyond the working section (figure 3, (b)).



(a)

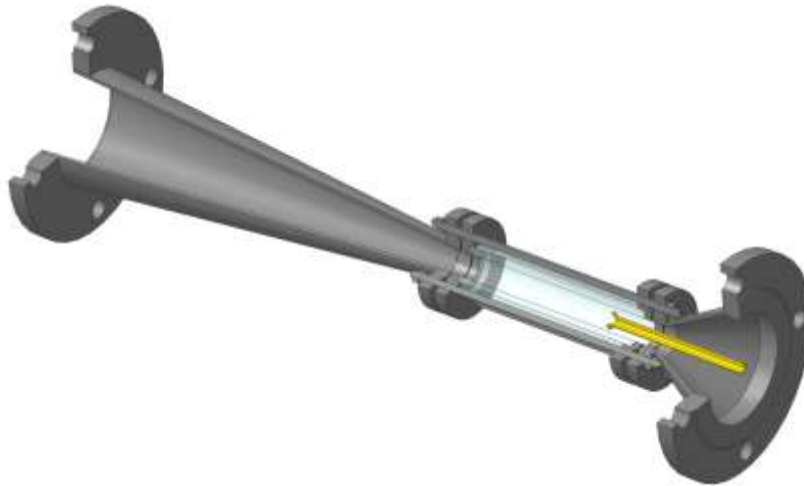


(b)

**Figure 3.** Location of the separator in front of (a) and beyond (b) the working section.

In front of the work section, the flow is leveled, passing through a 300 mm long Hoynekomb, which is a set of pipes with an inner diameter of 14 mm and a pipe wall thickness of 1 mm, then into the work section.

The working section consists of a confuser and a glassy cylindrical pipe (inner  $d = 30$  mm,  $l = 200$  mm) with the resistance set in it in the form of a flattened cone (figure 4). The cone has a hole along the axis and is mounted on the pipe, which allows pressure measurement in the cavern.

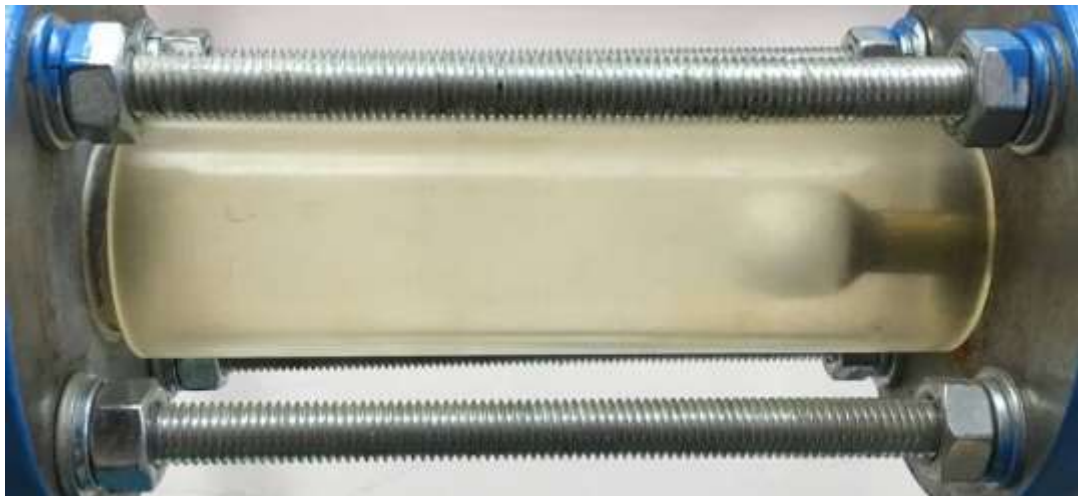


**Figure 4.** Installation working section.

It was impossible to measure the flow velocity with a simple Portaflow SE type ultrasonic flow meter, which is apparently due to the presence of gas bubbles in the flow. To determine the flow velocity, an ultrasonic doppler velocimeter DOP4000 was used, which makes it possible to measure the flow profile and its velocity with high accuracy (figure 5). The length of the cavitation cavern was determined visually (figure 6).



**Figure 5.** Flow velocity measurement.



(a)



(b)



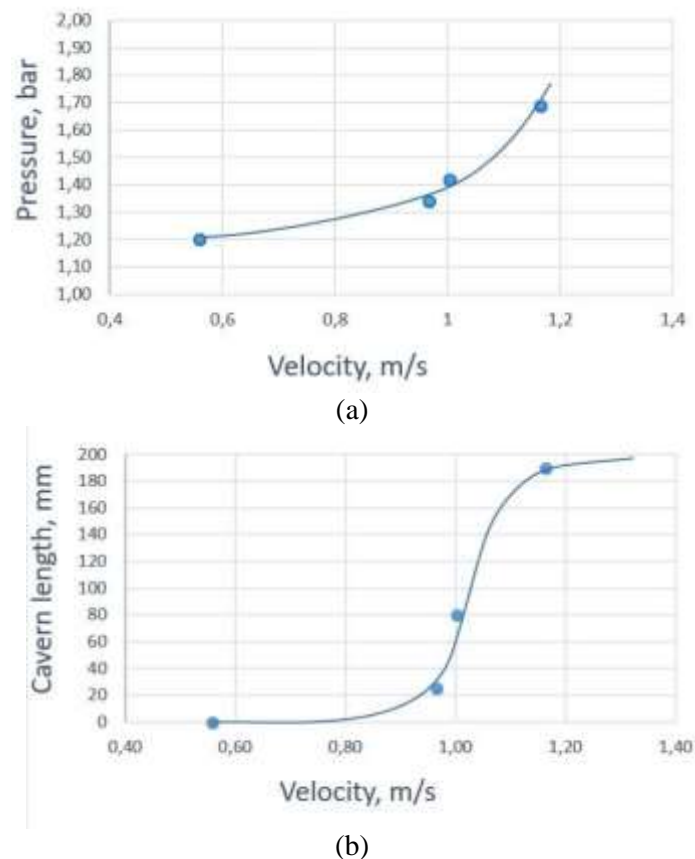
(c)

**Figure 6.** The cavren length at the flow velocity at the entrance to the experimental section:  
(a) - 0.56 m/s; (b) - 1.0 m/s; (c) - 1.16 m/s.

### 3. The results of measurements on the experimental installation

With increasing flow velocity, the zone of the two-phase region, due to the development of cavitation processes, increases, which is observed visually in the glassy part of the working section. The experimental data on the dependence of cavern length and pressure on velocity are shown in figure 7.

The qualitative dependence of the cavitation cavern length on the flow velocity is physically justified and is in satisfactory agreement with the experimental results of other authors [4-6].



**Figure 7.** The obtained measurement results depending on the flow velocity: (a) - pressure beyond the working section; (b) - cavern length.

### 4. The discussion of the results

The presented hydrodynamic workbench allows studying a large number of hydrodynamic problems about the approach flow on the studied profile in a wide range of velocity values.

The obtained results on the development and geometry of the cavitation cavern in time, depending on the velocity fluid can be of independent interest in the analysis of cavitation phenomena in technological installations, and also contribute to the research development in the field of interaction of the approach flow and restrictions, in particular, the formation of transition and developed cavitation modes.

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