ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 8, Issue 3 , March 2021

Methodology for Determining the Influence of Gas-Dynamic Heat Exchange in Piston Gas-Exchange Lines Internal Combustion Engines

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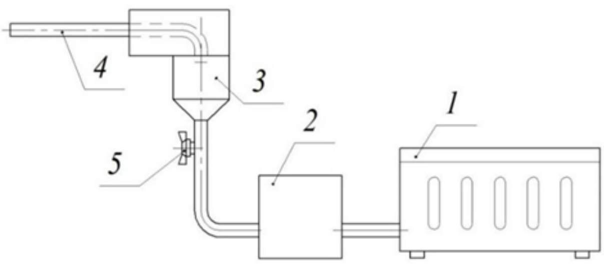
ABSTRACT:. The purpose of determining the degree of influence of gas-dynamic unsteadiness on the intensity of heat transfer in the gas exchange paths of piston internal combustion engines was carried out to study the model of a piston engine. The gas distribution mechanism of the experimental installation is borrowed from the Nexia automobile engine. The periods of the valve timing and the amount of valve lift in the experimental setup corresponded to the parameters for this engine. It is known that there can be many types of nonstationary, depending on specific power plants and their operating modes. And they all have their characteristics and characteristics. In this paper, the unsteady flow of gas flows, typical for the working processes of internal combustion engines (ICE), was considered.

KEY WORDS: Internal combustion engines, Data Mining, Machine Learning, Predictive analysis, Social Networking Spam, Spam detection.

I.INTRODUCTION

First, we will consider an experimental setup for determining the degree of unsteadiness of gas flows in circular channels, as well as a system for collecting and processing experimental data. In this case, as a model process, a transient process was chosen that is characteristic of the gas-air channels of piston internal combustion engines, namely, the restoration of the flow when the inlet or outlet valve opens after a pause. The studies were carried out on a laboratory setup, the diagram of which is shown in Figure 1. In it, compressed air from compressor 1 was supplied to receiver tank 2, which had an equalizing grid to stabilize the flow. From the tank - the receiver, the air entered the cylinder-blast chamber 3 (having a honeycomb). From where the air was supplied to the investigated pipeline 4 with a total length of 1000 mm and an inner diameter of 30 mm. Hot-wire anemometer sensors were installed in the investigated pipeline to determine the instantaneous values of the airflow rate. A pulsating unsteady flow regime, a transient process in the system was created using a bypass valve 5. In the pipeline under study, there were 4 control sections at distances from the window in the cylinder head

l_1 = 150 mm, l_2 = 300 mm, l_3 = 600 mmandl_4 = 900 mm



Picture 1. - Diagram of the experimental setup for assessing the degree of gas-dynamic unsteadiness: 1 - compressor; 2 - receiver tank; 3 - blast chamber (cylinder); 4 - investigated pipeline; 5 - bypass valve

To determine the instantaneous values of the airflow velocity wx, a constant-temperature hot-wire anemometer was used [2]. A nichrome thread with a diameter of 5 μm and a length of 5 mm was a sensitive element of the hot-wire anemometer sensors. The maximum systematic error in measuring the airflow velocity was 5.36%.
In this study, the hot-wire anemometer was dynamically calibrated to determine the hot-wire anemometer time constant. As a result, it was found that it does not exceed 3.5 m / s and decreases with an increase in the flow rate of the gas flowing around the thread. A review of the literature and further experiments showed that such a speed is sufficient in the studied range of gas flow rates since the time constant of the hot-wire anemometer in all modes was 3-5 times less than the transit time of the pulsation front. Such ratios satisfy the requirements for measuring systems [12]. To collect

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International Journal of Advanced Research in Science, Engineering and Technology
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and process data based on an ADC (analog-to-digital converter), an automated system was developed that allows transferring experimental data to a personal computer in real-time. The experimental technique was as follows. The compressor was started (see Figure 1) and after a certain period, a stationary mode of the gas flow in the pipeline was established, which was controlled using hot-wire anemometers. In this case, the measuring thread of one of the hot-wire anemometer sensors was located approximately in the middle of the channel, perpendicular to the movement of the airflow in it. And the other thread was installed at a distance of 0.2d from the channel wall in the same position along with the movement of the airflow. After that, the bypass valve was closed and the air was discharged into the atmosphere, bypassing the investigated pipeline. The holding was again carried out until a steady-state of the airflow in the pipeline was reached. After that, the valve opened abruptly, and the air was again directed into the investigated pipeline. In more detail, its configuration and installation locations of the hot-wire anemometer sensors are shown in Figure 2.

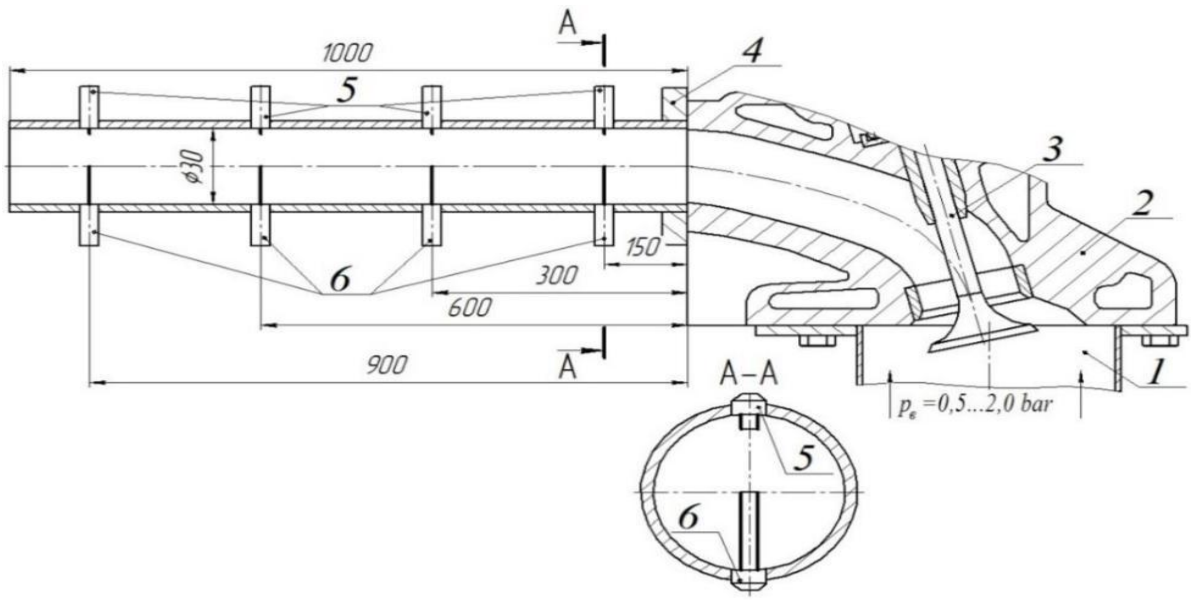

Figure 2. - Configuration of the investigated area: 1 - blast chamber (cylinder); 2 - body (blockhead); 3 - valve (outlet); 4 - investigated pipeline; 5 - hot-wire anemometer sensor for measuring gas velocity near the wall; 6 - hot-wire anemometer sensor for measuring instantaneous velocity in the channel.

The purpose of determining the degree of influence of gas-dynamic unsteadiness on the intensity of heat transfer in the gas exchange paths of piston internal combustion engines was carried out to study the model of a piston engine. The gas distribution mechanism of the experimental installation is borrowed from the Nexia automobile engine. The periods of the valve timing and the amount of valve lift in the experimental setup corresponded to the parameters for this engine. The crankshaft was driven by an electric motor, the rotational speed of which was in the range from 600 to 3000 min-1 (regulation was carried out using a frequency converter with an accuracy of ± 0.1%). Figure 3. shows the configuration of the working section of the inlet tract of the unit. Experiments on a piston engine model were carried out in static and dynamic modes of blowing gas-air ducts. In the study of the intake process in a static mode, which served as the base one, the intake valve was in the open position, and the air movement was created by a small exhauster pump sucking air from the cylinder cavity. Conversely, when examining the exhaust process in a static model, the exhaust valve was also in the uppermost open position, and the air movement was created by a compressor that forced air through the cylinder into the exhaust system. In dynamic mode, when the crankshaft is rotated using an electric motor, the valves are opened and closed by the standard valve timing of the Nexia automobile engine. Thus, a technique was developed for assessing the degree of unsteadiness of gas flows under conditions characteristic of the processes of gas exchange of piston internal combustion engines, and a system for collecting and processing experimental data was created, which has the necessary speed, accuracy, and reliability.

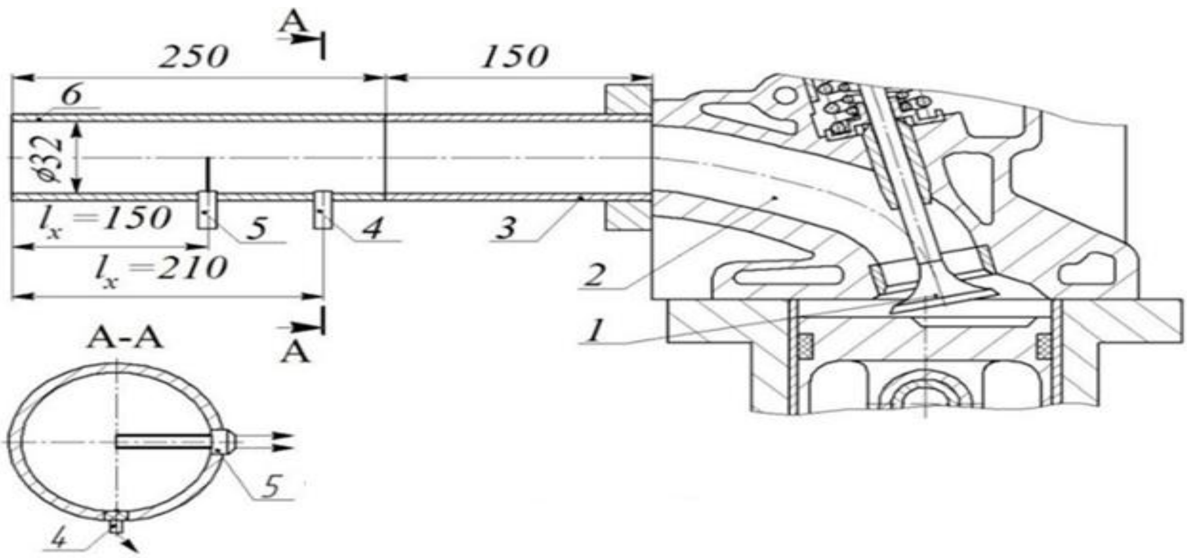

Figure 3. - The investigated configuration of the inlet system of the experimental setup: 1 - inlet valve; 2 - curved channel in the cylinder head; 3 - inlet pipeline; 4 - hot-wire anemometer sensor for determining the local heat transfer coefficient; 5 - hot-wire anemometer sensor for determining the flow rate; 6 - measuring channel.

Figure 4 shows the dependences of the airflow rate w_x in a round channel on time after opening the bypass valve and supplying air to the pipeline under study. The graphs under consideration were obtained for a stationary airflow in the control section at a distance of l_x = 300 mm from the channel entrance at an average speed w = 20 m / s. Similar oscillograms were obtained for average flow velocities equal to 20 and 24 m / s for all investigated control sections along the length of the pipeline. It was found that immediately after opening the bypass valve, a sharp increase in the airflow velocity is observed, and its values for some time exceed the average velocity into the channel w, the so-called velocity overshoot occurs. Then the flow is stabilized: the instantaneous values of w_x fluctuate around the average value. These regularities of flow are typical for all airflow rates in the pipeline and all control sections along the length of the pipeline. As a result of experiments on the dependences w_x = f (τ) (Figure 4), two characteristic times were determined: the recovery time of the flow τw (the time of recovery of the flow velocity to the initial average value) and the relaxation time of the flow τp, when, after the injection, w_x began to fluctuate around the average value [14]. Thus, for each control section, two values of the characteristic relaxation times were obtained: some values for the flow along the axis, others for the flow near the channel wall.

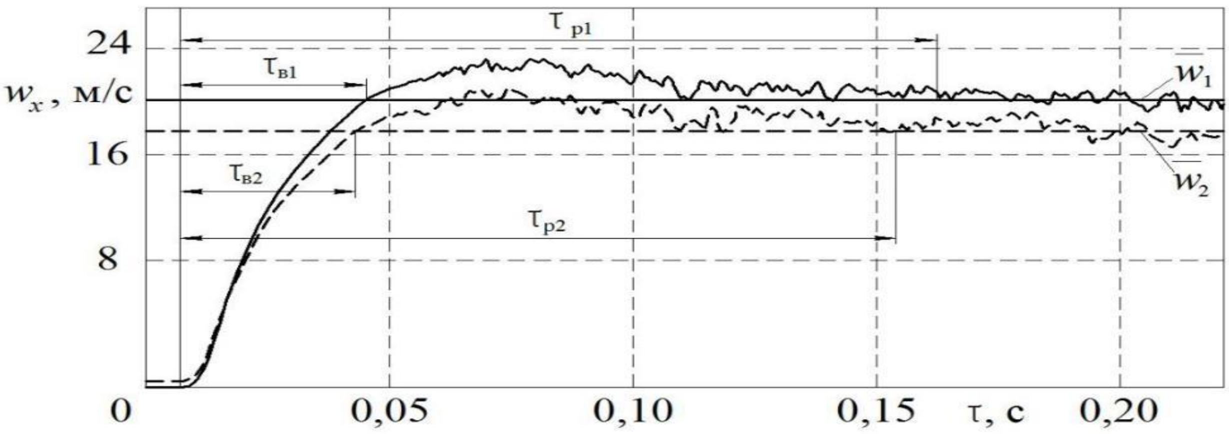

Figure 4 - Dependences of the instantaneous velocity wx of the gas flow in a round channel on the time τ (d = 30 mm; lx = 300 mm):

————— - average speed in the channel;

- - - - - velocity near the channel wall

$\tau_в$ - recovery time;
τ_{p}- is the relaxation time of the gas flow rate;
w - local average gas flow rate.
From the dependences, it can be noted that at an average flow velocity of 20 m / s, the relaxation time τp monotonically increases downstream, i.e. as the control section moves away from the entrance to the pipeline. If at l1 l_1 = 150 mm τ_{p1} is 0.112 s, then at l_4 = 900 mm τ_{p4} = 0.220 s.

II. FINDINGS

Obtained for a stationary airflow in the control section at a distance of l_x = 300 mm from the channel entrance at an average speed w = 20 m / s. Similar oscillograms were obtained for average flow velocities equal to 20 and 24 m / s for all investigated control sections along the length of the pipeline. It was found that immediately after opening the bypass valve, a sharp increase in the airflow velocity is observed, and its values for some time exceed the average velocity into the channel w, the so-called velocity overshoot occurs. Then the flow is stabilized: the instantaneous values of w_x fluctuate around the average value. These regularities of flow are typical for all airflow rates in the pipeline and all control sections along the length of the pipeline. As a result, it was found that it does not exceed 3.5 m / s and decreases with an increase in the flow rate of the gas flowing around the thread. A review of the literature and further experiments showed that such a speed is sufficient in the studied range of gas flow rates since the time constant of the hot-wire anemometer in all modes was 3-5 times less than the transit time of the pulsation front.

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ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 8, Issue 3 , March 2021

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