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RESEARCH ON THE ECONOMY AND HARMFUL EMISSIONS OF DIESEL WHEN RUNNING ON RAPESEED OIL

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For optical research of the process of PM spraying in atmospheric conditions, a high-speed video recording stand was used, which allows for the recording of fast-moving pulse processes. The diagram of the high-speed video recording stand and the determination of the geometric parameters of the sprayed fuel jet are shown in Fig. 1. The video recording process was carried out on a high-speed camera "Video Sprint/G6". Further data transfer from the camera to a personal computer is carried out via the LA-1.5 PCI ADC board installed on it. The processing of the shooting results was carried out according to the approved method using a computer program [1, 2].

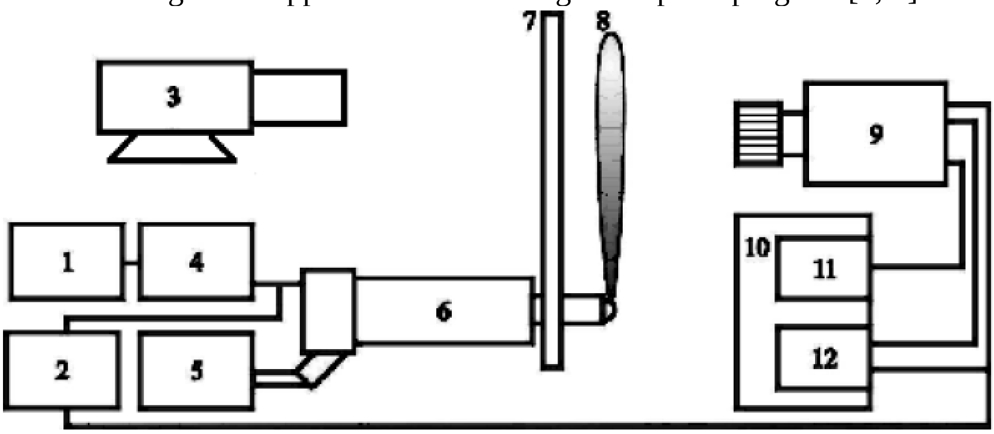


Fig. 1. - Scheme of a high-speed video recording stand for determining the dynamics, speed and length of the atomized fuel jet

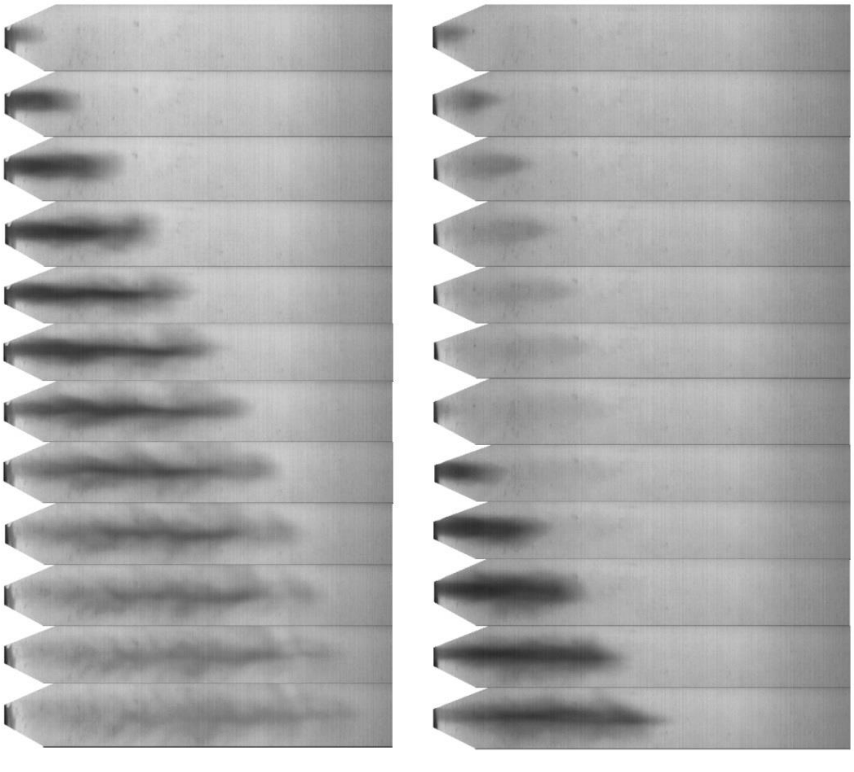
Principle of operation: the device for controlling the operation of the KK-2 installation (1) at a given time, corresponding to a certain position of the engine crankshaft, sends a pulse to the control unit (4), opening the high-pressure electric valve of the injector (6). In the ramp (5) under a given pressure (up to 180 MPa) there is fuel that enters the injector atomizer (6) at the moment of opening the electric valve. The pulse from the electric valve (4) simultaneously enters the synchronization unit (2), which coordinates the voltage levels on the injector with the digital high-speed video camera "Video Sprint/G6" (9) and the ADC board LA-1.5 PCI installed in the personal computer (12). In this way, the start of the operation of the video camera is synchronized with the moment of the leading edge of the pulse entering the injector electric valve. The information signal from the video camera (9) is transmitted via the controller-camera cable to the controller board (11), also installed in the personal computer (10). In addition, the LA-1.5 PCI ADC (12) the exposure signal of the video camera (9) is supplied. The synchronization pulse signals from the synchronization device (2) and the exposure moment signal of the video camera (9) are necessary when determining the recording time of a given frame in the video film, which is recorded by the camera (9) and recorded on a personal computer (10). The fuel jet (9), sprayed by the nozzle (6), moves along the surface of the screen (7) in the form of frosted glass, on the inside of which there is a light source (3) with a 150 W incandescent lamp and a power supply. To register the image of the fuel jet, synchronization was used with an external synchronization pulse - a signal from the EGF electromagnet signal (for the CR TPA) [4].

The fuel system operating parameters are precisely recorded on the control panel of the UK-2 installation, which allows experiments to be conducted for various stable injection pressures and crankshaft rotation angle, which, in turn, is closely related to the synchronization pulse of the "Video Sprint/G6" camera control.

The use of external synchronization for the "Video Sprint/G6" camera has some specifics, which is that the synchronization pulse received by the camera starts its work of shooting and transferring video frames to the memory of the controller (11) of the computer for 8 μs. In one second, at a crankshaft speed of 1700 min^{-1}, 14 injections occur. The frequency of the frame pulses is constant and is determined by the camera settings by the operator. Thus, the "Video Sprint/G6" camera starts at the first pulse of the fuel injector valve opening and continuously records the captured image in the controller's memory, and subsequent fuel injector valve pulses may no longer coincide on the front with the frame pulse. As a result, there is uncertainty in the time of shooting the first frame after the injector valve is triggered for all subsequent sprayings, except the first. Recording and further processing of oscillograms of signals from the camera frame pulse and the injector valve opening pulse allows us to calculate the time between the pulses from the injector valve and the first frame of the atomized fuel flow [5, 6].

The high-speed video shooting stand allows for digital high-speed shooting of images that reflect the dynamics of fuel atomization by a high-pressure nozzle for various liquid fuels in light, to determine the length and describe the presence of internal optical seals of the jets in each image. The jet is recorded on a light background and has dark outlines of the borders and internal optical seals that are connected to each other in a gradient manner.

As an example, images of mono- and fractional injection for the maximum of the investigated injection pressures of 160 MPa are shown respectively in Fig. 2.



a) mono injection b) fractional injection

Fig. 2. - Image of the fuel atomization process at a pressure of 160 MPa mono- and fractional injection

The presented images show that with the use of fractional injection, the main part of the injected fuel falls into the wake of the previously injected fuel. Thus, it can be assumed that the propagation speed of the front of the main part of the injected fuel decreases due to the reduction in the mass of this portion and the collision with drops of previously injected fuel, which means a decrease in the range and an increase in the proportion of volumetric mixture formation. The area of the zone with a more uniform distribution of fuel increases, which indicates better homogenization (i.e., uniform distribution in the volume of fuel and oxidizer) [7].

Dynamics of changes in bright zones of a jet of atomized fuel. When light radiation passes through a atomized jet due to a decrease in the light flux that has passed through zones with a high concentration of fuel droplets, the area of this zone will correspond to lower brightness, and vice versa [9], which is caused by the optical inhomogeneity of the jet. Optical inhomogeneity is understood as the phenomenon of unequal transmission and absorption of light by different zones of the fuel jet, which causes a non-uniform color of the jet image, as a result of its unequal brightness along its entire length. This, in turn, is caused by the real inhomogeneity of atomization and distribution of fuel droplets in a real jet [10-12].

Experimental studies of the dynamics of the fuel jet development were carried out with the allocation of six bright zones of the sprayed PM jet on the stand. Each point was obtained by processing fuel jet images using the method of calculating the areas of bright zones of the jet, developed and tested by Professor Eskov O.V. [3]. The areas of the zones on all graphs are normalized to the total area of the entire jet.

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