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Experimental studies of frequency of rotation of smooth rotating disk with coaxial-lateral air flow

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Abstract. The article presents methods for determining the main parameters of a rotating atomizer sprayer. The choice of research methodology is justified based on the general pattern of liquid atomization by rotating atomizers, taking into account the influence of the air flow on them. The main indicators affecting the sprayed drops' dispersal are the air flow rate and the rotational speed of the pneumatic disk atomizer. Therefore, the correct choice of the method for determining the rotational speed ω of a pneumatic disk atomizer makes it possible, at a constant air flow rate, to obtain the required median-mass diameter of the atomized droplets. To obtain a high-quality air-droplet flow, there must be a combination between the initial speed of the main drops discharged from the spray disk's periphery and the fan installation's air flow speed.

1 Introduction

Analytical studies of a smooth spray disk with a coaxial air flow showed that with the help of an air flow, it is possible to increase the productivity of drop formation while maintaining the dispersion of drops or to obtain a monodisperse spray [1-3] at different liquid flow rates.

In this case, the air flow is involved in the process (formation and detachment of drops) crushing and simultaneously serves to transport the atomized drops. As mentioned above, rotary atomizers in monodisperse modes are mainly used in laboratory precision sprayers, in which high-frequency electric motors or belts and other transmissions of complex design are used to rotate disk atomizers.

However, the use of the air flow created by fan sprayers for the rotation of disk sprayers in the process of drop formation and during the transportation of sprayed drops gives a broad perspective on their basis to create a working body for low-volume spraying of cotton.

The lack of experimental data confirming the theoretical premises makes it difficult to use these sprayers as working bodies on low-volume cotton sprayers. This determines the need for experimental studies, the program primarily to investigate the effect of air flow on

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the rotational speed of the pneumatic disc atomizer.

The purpose of the experimental study was to determine the effect of the working fluid's flow rate on the atomizer's speed with a coaxial supply of air flow.

2 Materials and methods

The choice of a method for determining the rotational speed of a pneumatic disc atomizer with a coaxial air flow is reduced to the following.

An electronic block diagram was developed to register the rotational speed of the pneumatic disc atomizer. This is because the existing methods for measuring the rotational speed of working bodies with a pneumatic device in chemically aggressive environments (airborne pesticide flow) of cotton sprayers have significant drawbacks:

- the mechanical connection of the sensor with the working body leads to an increase in the resistance to rotation, thereby violating the mode of operation;
- optical sensors are covered with an opaque film, as a result of which the registration process is disturbed.

The developed block diagram includes an induction sensor, a signal processing circuit, a registration device, a power supply, and an oscilloscope for visual control (Fig. 1). The inductive sensor (Fig. 2) consists of an inductance coil 1 located outside the rotating part of the pneumatic disk atomizer at a distance of 3 ... 4 mm from permanent magnets 2, installed on the atomizer hub evenly in diameter. To improve the accuracy and ease of reading the information, the number of permanent magnets was chosen to be six.

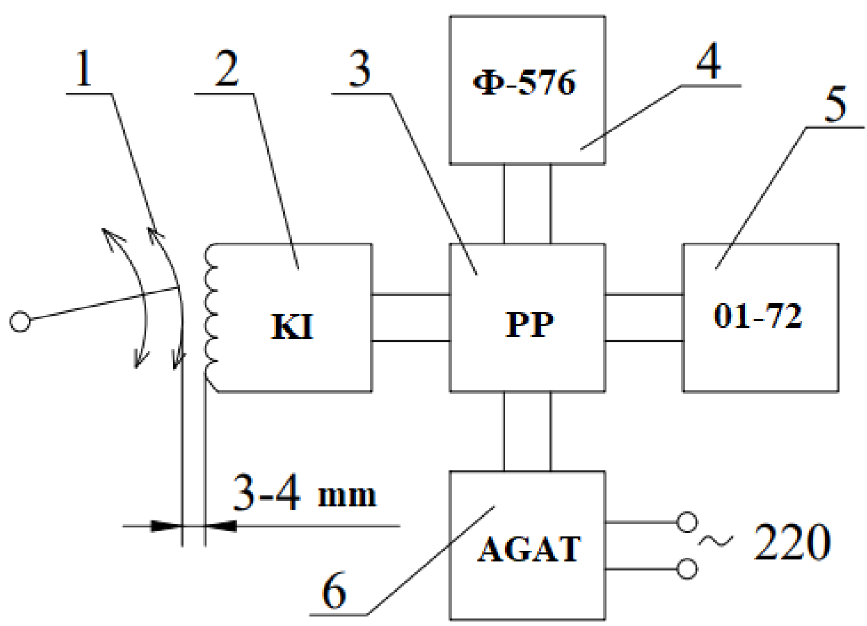

Fig. 1. Block diagram of the experimental setup: 1 is permanent magnets; 2 is inductor; 3 is pulse converter; 4 is frequency counter CI-72; 5 is oscilloscope Ф-576; 6 is power supply "Agat".

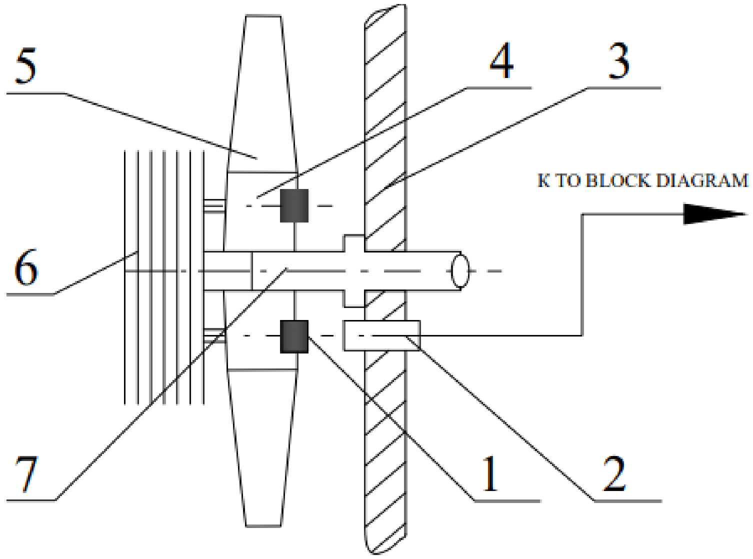

Fig. 2. Scheme of installation of the inductive sensor on the pneumatic disc sprayer: 1 is permanent magnets; 2 is inductor; 3 is mounting bracket; 4 is hub; 5 is wind wheel; 6 is rotating discs; 7 is axis sleeve for supplying fluid to the atomizer.

Registration of information was carried out by digital frequency meter Ф-576. In addition, visual control over the quality of information signal pulses was provided using an C1-72 oscilloscope. The power of the entire rotation speed registration system was provided by the Agat power supply unit. To measure and control the rotational speed of the working body in the field, a converted individual device was used (Fig. 3).

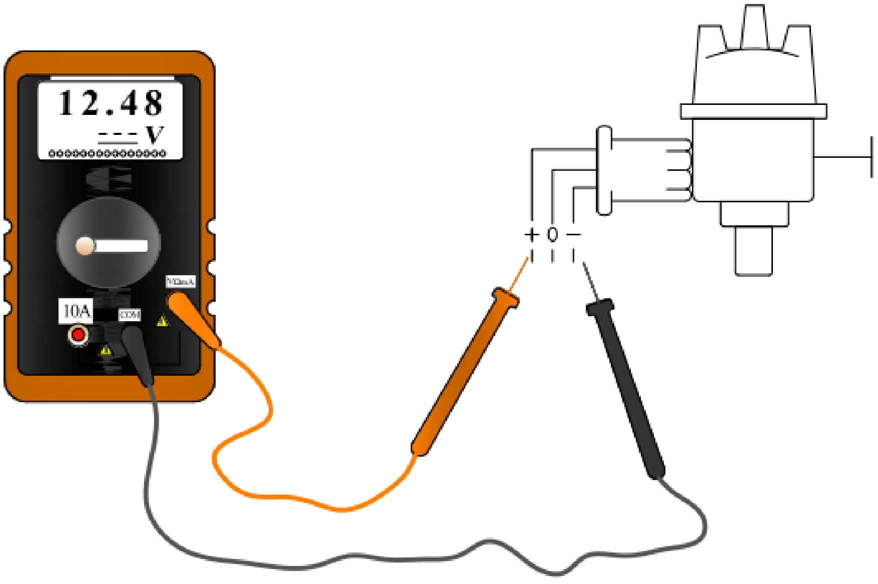

Fig. 3. A device for measuring the speed of the atomizer.

3 Results and discussion

The signal processing circuit of this device allows you to measure the speed in the range from 50 to 10 4 rpm. The device has a pointer indicator showing the number of thousands, hundreds, and tens of revolutions per minute. The device is powered both from the onboard network of the tractor (12V) and from the battery (9V); the current consumption is 150 mA. The device is installed in the tractor cab. It consists of a control panel on the front panel: a pointer indicator, a power switch, a signal light, an external power cord, and a socket for connecting an induction sensor.

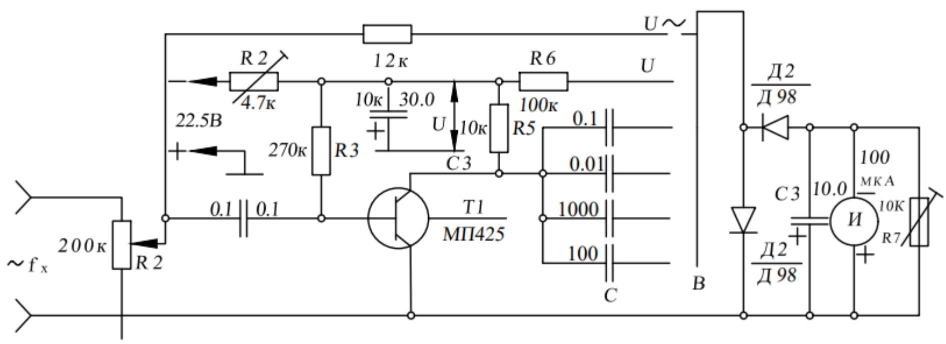

Fig. 4. Schematic diagram of the device for measuring the speed of the atomizer.

The schematic diagram of the device is shown in fig. 4. It contains an input amplifier-limiter on the V1 transistor, a square-wave trimmer on the V2 and V3 transistors, an emitter follower on the V4 transistor, a DC amplifier on the V5 transistor, and a pointer indicator-microammeter.

To unify the design of the wind wheels, further tests were carried out to determine the effect of the specific fluid flow on the speed of the wind wheel with a change in the number of blades on the wind wheel. For this, 2- and 4-bladed versions of wind turbines were used. Figure 13 shows the dependence of the wind wheel rotation speed on the specific flow rate of the working fluid for various numbers of blades

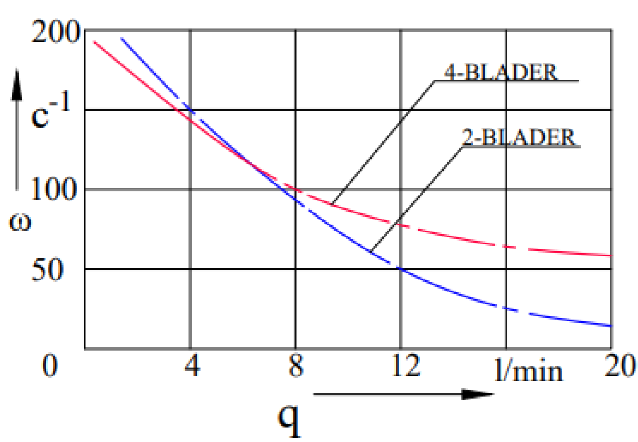

Fig. 5. Dependence of the rotational speed of the pneumatic disk atomizer with a screw wind wheel on the minute flow rate of the liquid.

As seen from the graph, a wind turbine with a 4-bladed version is more stable to the influence of the specific fluid flow rate. At the same time, the radius of the wind wheel was Rv=160 mm, the linear size of the wing b_l=8 mm, the angle of attack $\alpha=90^0$, the radius of the hub r_c =65 mm, the weight of the wind wheel was 350 g.

4 Conclusions

As a result of experimental studies, it has been established that an increase in the number of blades of a pneumatic disc atomizer leads to a decrease in the rotational speed from the air flow speed. Still, at the same time, it is more stable to a change in the flow rate of the working fluid. Therefore, for further research, a wind wheel with a 4-bladed version was chosen, with the following parameters: the radius of the wind wheels Rv=160 mm, the linear size of the wing b_l =8 mm, the angle of attack $\alpha=90^0$ and the radius of the hub r_c =65 mm.

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