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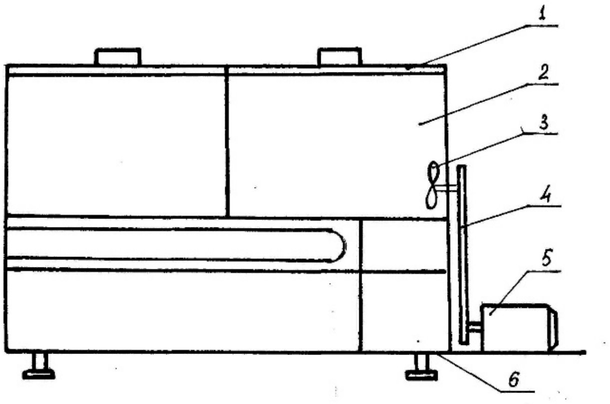
METHOD OF CALCULATING A WASHING MACHINE WITH A PROPELLER ACTIVATOR

Prytula M., recipient of higher education "Master's" degree
Dmytro Motornyi Tavria State Agrotechnological University, Zaporizhzhia, Ukraine

Small annual production programs of work of technical service points of agricultural enterprises determine the design of a washing machine with small overall dimensions and a volume of a bath for washing solution. Heating of the solution to the working temperature is advisable to carry out with electric heaters, intensification of the cleaning process - with a blade activator [1].

The machine consists of two washing chambers, which are mounted in one body of the bath, mounted on a stand (Fig. 1). In one washing chamber, parts are cleaned with a washing solution, the movement of which is created by an activator. In the other chamber, already cleaned parts are rinsed. The activator is driven by an electric motor through a V-belt transmission.



1 – cover, 2 – washing chamber, 3 – activator, 4 – V-belt drive,
5 – electric motor, 6 – frame

Fig. 1. Washing machine

The motor power for the activator drive and its rotation frequency depend on the required activator power and the drive shaft rotation frequency. The required electric motor power for the P_{AK} activator drive, kW, can be determined by the formula [2],

$$P_{AK} = \frac{Q \cdot p \cdot m}{1000 \cdot \eta_{AK} \cdot \eta}, \quad (1)$$

where Q – volumetric fluid flow, m^3/s;

p – pressure created by the activator, Pa;

m – power reserve factor;

η_{AK}, η – efficiency of the activator and the drive, respectively.

The volumetric flow depends on the size and speed of the activator's working elements [2]

$$Q = \pi \cdot D \cdot в \cdot \upsilon_{л}, \quad (2)$$

where D – impeller disk diameter, m;

в – impeller rib width, m;

$\upsilon_{л}$ – absolute impeller speed, m/s.

The dimensions of the impeller depend on the diameter of the washing machine tub and are selected from the ratios: $D = (0{,}3...0{,}9) \cdot d_B$, $в = (0{,}005...0{,}09) \cdot d_B$.

The pressure created by the activator is determined by the formula

$$p = \rho \cdot q \cdot H, \quad (3)$$

where ρ − density of washing liquid, kg/m^3;

q – acceleration of free fall, m/s^2;

H – activator pressure, m. It is taken equal to the height of the washing liquid in the bath.

Rated engine power $P_{НОМ}$ is selected according to the value larger, but closest to the required power $P_{НОМ} \geq P_{ДВ}$. The installed engine power, taking into account the starting torque, should exceed the calculated value by 10-15%.

Propeller activators are recommended for use with a washing solution viscosity of up to 10 MPa. The design of the most common three-blade cast propeller activator with a wing-shaped profile is shown in Fig. 2.

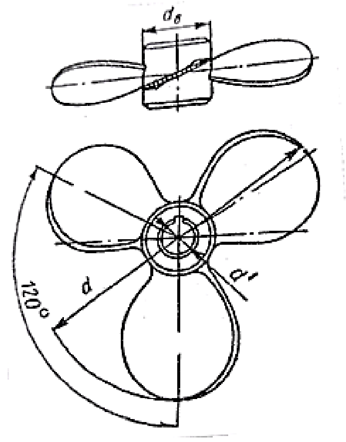


Fig. 2. Propeller activator with a wing-shaped profile

The main geometric parameter of the actuator is the pitch S, which is related to the angle of inclination of the blades. Usually the blade of a propeller actuator is part of a helical surface with a constant pitch. The inclination of the blades changes continuously: the minimum is on the outer circle, the maximum is at the hub..

Often the pitch is set equal to the diameter of the activator S = d. However, the best circulation of the washing solution is provided at S = 2d. In this case, the circulation speed can reach 2.0 m/s. For some geometric parameters of propeller activators, the following optimal ratios have been established: average blade width b = (0,2…0,35) d; blade thickness C = (0,03…0,07) d; bushing diameter $d_{ВТ} \geq d$.

The diameter of the activator can vary within very wide limits. d = 100…2500 mm; at the same time, the edge speed of the blades must be at least 6…15 m/s.

Having a significant pumping effect, vane activators can create powerful turbulent flows in the washing solution (radial, axial, radial-axial) [3].

References.

1. Дашивець Г. І. Обґрунтування вихідних даних для технічного завдання на створення очисного обладнання. Технічне забезпечення інноваційних технологій в агропромисловому комплексі : матеріали IV Міжнар. наук.-практ. Інтернет-конференції (Запоріжжя, 01-25 листопада 2022 р.). Запоріжжя : ТДАТУ, 2022. С. 179–180.

2. Мандрус В. І. Гідравлічні та аеродинамічні машини (насоси, вентилятори, газодуви, компресори) : Львів : «Магнолія 2006», 2018. 340 с.

3. Дашивець Г. І., Бужора Д. А. Обґрунтування і оптимізація параметрів процесу очищення деталей зануренням. *Технічне забезпечення інноваційних технологій в агропромисловому комплексі* : матеріали II Міжнар. наук.-практ. інтернет-конференції, м. Мелітополь, 02-27 листопада 2020 р. Мелітополь : ТДАТУ, 2020. С. 599–604.

Research supervisor: Dashyvets H., Ph.D., Assoc.