BULETINUL INSTITUTULUI POLITEHNIC DIN IAŞI
Publicat de
Universitatea Tehnică „Gheorghe Asachi” din Iaşi
Volumul 63 (67), Numărul 4, 2017
Secţia
CONSTRUCŢII DE MAŞINI

STUDIES ABOUT AN AXIAL VENTILATOR WITH FLUID EMISSION

BY

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Received: October 17, 2017
Accepted for publication: December 18, 2017

Abstract. In a previous work we analyzed the influence of fluid emission through the trailing edge for a single wing. These experimental determinations emphasized great increase of the bearing power. In this work we will experimentally examine the aerodynamic behavior of the wing, which emits fluid through the trailing edge, by working in the network. The experimental determinations are made on an axial ventilator having 630 mm and for which the blades have in the length of trailing edge a 1 mm slit. The air aspirated through the blades at the hub level is exhausted as a jet through the trailing edge of the blades. As a result of the experimental comparative determinations for the ventilator without jets and the one with jets, we noticed for the ventilator with fluid emission: a debit increase, a pressure increase and an efficiency increase. The experimental attempts have been made for several rotation speeds.

Keywords: axial ventilator; lift force; drag force; ventilator efficiency; power; carrying capacity.

1. Introduction

In a past work (Scurtu, 1998) we emphasized experimentally the influence of fluid emissions through the trailing edge of a single carrying wing.

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Thus we concluded that this perturbation has a direct influence on the carrying capacity, on the lift force and on the drag force. In this way researches have shown an increase of the carrying capacity and implicitly of the lift coefficient with regards to the values that this coefficient can take, we have noticed that starting with a certain value of the fluid flow emitted through the slit situated on the whole length of the trailing edge and with incidence angles relatively small (0°-14°), the drag coefficient takes negative values. This proves that the carrying wing acquires a propulsive nature. This phenomenon amplifies with the increase of the ratio between the medium speed of the fluid emissions from the trailing edge and the speed of the general current (Scurtu and Ciobanu, 2010a).

2. Experimental Research

The rotor of the axial ventilator was designed such as the hub and the blade can allow the suction of an additional flow q through them which would provide the air jets through the blade trailing edge.

The exhaustion slits occupy all the length of the trailing edge, in the case of the tasted model, the slit being of 110x1 mm.

The theoretical examination concerning the phenomenon of flowing through the end of the pallet in the condition of the existence of the fluid emissions as drawn jets is practically impossible to achieve. This is due to the fact that the jets influence the charge from the friction. Also it must considerate the fact that the medium local speed in the jet of fluid is determinate by the centrifugal force, so appear a variation of unlined type, depending of the radius of the ventilator section.

We can state that a direct consequence of the fluid emission for the axial ventilators, the charge and therefore implicitly the fluid circulation, does not stable any longer along the radius.

Excluding these effects, about this point of sight about the fluid emission through the running board of the rotor pallets can be estimated some qualitative effects:

– The self aspiring jets lead to the decrease the advancing resistance and to an increase of the carrying ability, by changing the moving condition in outline area of the profile in the direction of approaching the point of the limit layer detachment, of the running board and, as a direct consequence, the limitation of the whirling zone on the outline area.

– A decrease of the advancing resistance and consequently the decrease of the power absorbed by the ventilator and thus resulting in an improvement of the ventilator output.

– The increase of the carrying ability, which leads to a corresponding, increases oh the ventilator pressure.

– The increase in the axial ventilator flows, and of the self aspirated flow.

The experiments were made on a ventilator with the following dimensions: hub diameter d = 310 mm; rotor diameter D = 630 mm (Fig. 1).

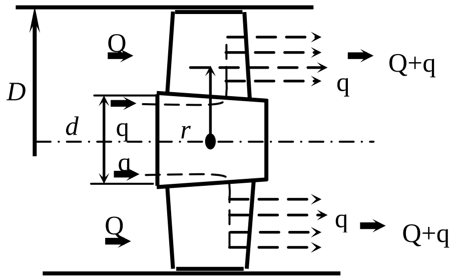

Fig. 1 – Flow through the axial ventilator with fluid emission.

The rotations made in the experimental attempts of the ventilator without fluid emission and with fluid emission have the following values: n_1 = 1000 rot/min; n_2 = 1500 rot/min; n_3 = 2000 rot/min; n_4 = 2500 rot/min.

The experiments were made on a close circuit stand for the test of axial ventilators of 630 mm diameter. The electric motor used to drive the ventilator has a continuous adjustment of the rotation speed in the range 0÷3000 rpm.

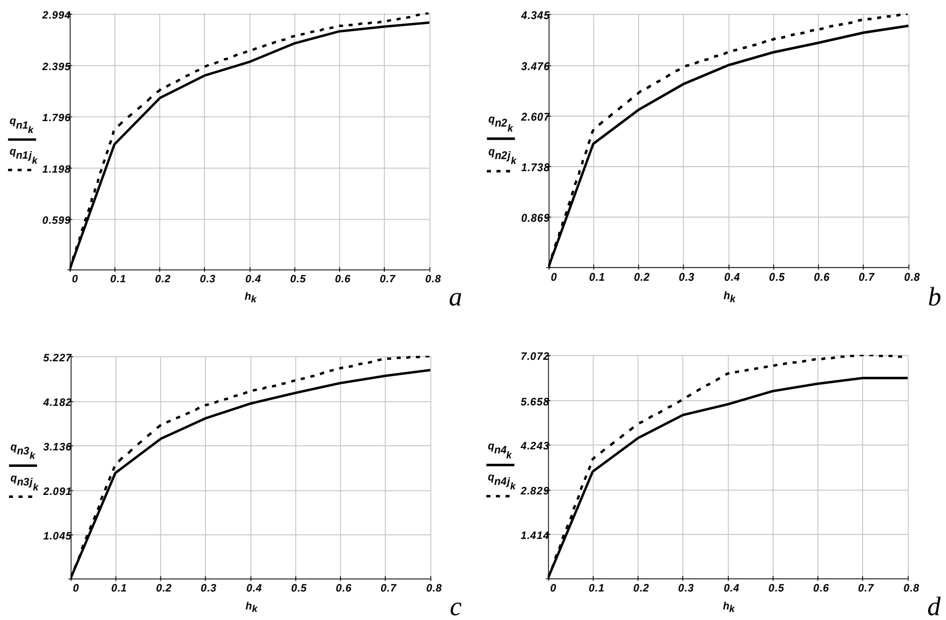

Fig. 2 – Influence of output opening h_k on flow variation q for different rotation speeds n.

The ventilator's charge adjustment is conceived on the stand's aspiration. The value of evacuation section areas for which the experimental determination are: $S_1 = 0$ m^2; $S_2 = 0.20$ m^2; $S_3 = 0.40$ m^2; $S_4 = 0.59$ m^2; $S_5 = 0.79$ m^2; $S_6 = 0.99$ m^2; $S_7 = 1.19$ m^2; $S_8 = 1.39$ m^2; $S_9 = 1.59$ m^2.

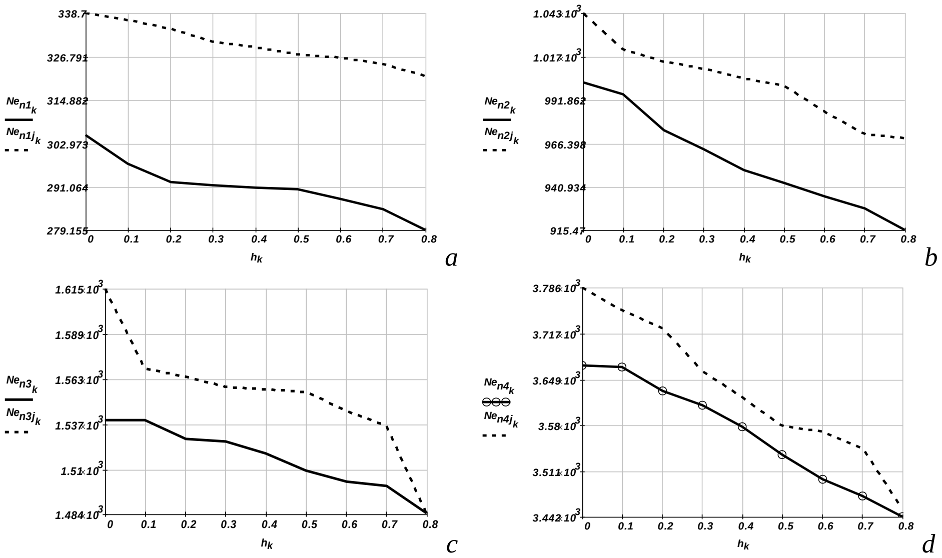

Fig. 3 – Influence of output opening h_k on power variation N_e for different rotation speeds n.

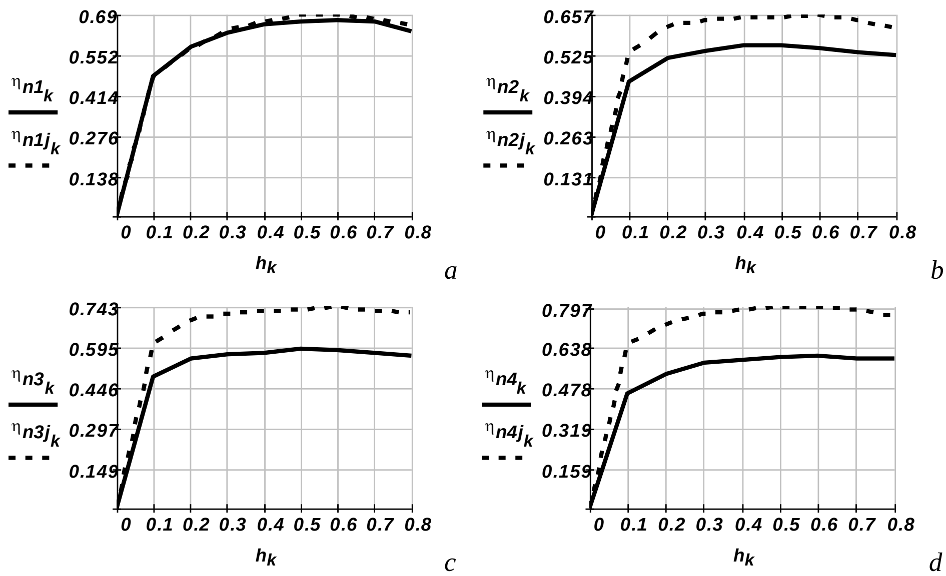

Fig. 4 – Influence of output opening h_k on efficiency variation η for different rotation speeds n.

As a result of the experimental trials the following characteristic measurements have been established for both types of ventilators:

– Flow q, [m^3/s];

– Power absorbed from the grid N_e, [kW];

– Ventilator efficiency η.

The "j" index is established for the jet ventilator (fluid emission) and the "o" index describes the measurements characteristic of the classical ventilator.

The variations of the mentioned parameters, based on the exit section S_i and for all the n rotation speeds are shown in Figs. 1-3.

3. Conclusions

Based on the experimental data the diagrams analysis allows the establishment of the following conclusions:

The flow variation – Figs. 2*a*, *b*, *c*, *d*

1. The flow variation is positive thus indicating that the flow of the fluid emission ventilator is bigger than the one for the classical ventilator.

2. At a constant S span, the debit variation increases with the rotation speed increase.

The absorbed power variation – Figs. 3*a*, *b*, *c*, *d*

1. The variation of the absorbed power is positive, indicating that the absolute power of the fluid emission ventilator is bigger than the power absorbed by the classical ventilator

2. At a constant rotation, the power variation decreases with the increase of the evacuation section from the repression

3. At a constant evacuation section, the power variation increases with the rotation speed increase.

The efficiency variation – Figs. 4*a*, *b*, *c*, *d*

1. At constant rotation, the efficiency variation increases from zero value to the maximum value than it slowly decreases based on repression section span.

2. At a constant evacuation section the output variation increases with the rotation speed increase.

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CERCETĂRI PRIVIND EMISIA DE FLUID PRIN PALETAJUL UNUI VENTILATOR AXIAL

(Rezumat)

Lucrarea are în vedere funcționarea aripii portante cu emisie de fluid prin bordul de fugă lucrând în rețea. În acest scop a fost proiectat un ventilator axial cu diametrul de 630 mm pentru care paletele au prevăzute pe toată lungimea bordului de fugă o fantă cu deschiderea de 1 mm. În ansamblu, pe lângă debitul aspirat de ventilator acesta mai vehiculează un debit suplimentar. Sunt analizate caracteristicile de: debit, putere și randament atât pentru ventilatorul clasic cât și pentru ventilatorul cu debit autoaspirat.