SPECIAL DESIGNED REGENERATIVE BLOWER FOR BIPHASE FLUID FLOWS

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The paper is presenting an original idea for mixing biphase fluids. The proposed mechanic process using a special designed regenerative blower is an alternative to jet method for obtaining a homogenous mixture. One is presenting a special designed regenerative blower in order to obtain a high degree of fluid whirling motion at outlet. As regenerative blowers can be used for high pressures and low flow rates due to working principle and because of the low efficiency of these turbomachineries modification for the rotor, side channel and outlet were considered. In this respect the discharge section of the blower will be hydrodynamic to avoid head losses and pressure shock. The hydrodynamic discharge of the blower is responsible for smaller values of the head (approx. 1/3) at same flow rates by comparison with an unmodified blower. The experimental research performed using laser technology confirmed the design modifications of the blower and by the presence of strong vortex at outlet.

Key words: regenerative blower, homogenous mixture, vortex

1. Introduction

Studies concerning the hydrodynamics of regenerative turbomachinery are relative scarce due to limitation of the total efficiency of this type of working machinery. The difficulties does not consist in the three dimension theoretical modelling of the main vortex emerged due to the fluid motion between the lateral channel and blade impeller, but in the technical impossibility to convert with good efficiency the kinetic energy in pressure energy at the blower outlet. The situation is even complicated in the blowers were the lateral channel has a variable geometry depending of the fluid compression. Still, research for dedicated applications has been developed, especially experimentally based. Regarding the theoretical connected to experimental studies, [1],[2],[3],[4],[5], the attention was focused on the shape of side channel, separately or simultaneous with the profiled

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or sloped impeller blades, or in order to identify and improve the possibility to convert the kinetic energy in pressure energy at the blower outlet [6],[7].
In this paper one propose an original study regarding the use of the regenerative blowers, aimed for mixing biphasic fluids, using air and sawdust mixture.

2. The influence of geometric and kinematics parameters on the energetic characteristics of regenerative blowers

There are known a lot of theoretical and experimental researches regarding the fluid flow in the impellers of the turbo-machines with side channel, who underline the increase of the machines efficiency, with the increase of radial dimension of the impeller blades (h_1) (figure 1a); also, a good efficiency is obtained when the blade width is approximate equal with those of the lateral channel (b_2) (figure 1b), when the centre of the vortex in absolute motion is on the impeller's blade edge, allowing a good flowing. Regarding the side channel geometry and the number of the blades, the improvement of the turbo-machines characteristics is made using a trapezoidal side channel (figure 1c), due to the high velocity flow at the base of lateral channel once with the fluid input in the impeller; it result an increase of the kinetic energy, proportional with the number of blades. As a remark, the slope of the head curve decrease proportional with the reduction of the channel section. Researches regarding the distribution of speed and pressure at the blower with side channel discharge, underline that the conversion of the kinetic energy in pressure energy is avoid especially by hydraulic shocks at the impeller outlet (by changing the direction of the fluid flow). So, a partial improvement of the flowing can be made by a special hydraulic design at the discharge, using elements to dissipate the main fluid vortex**.**

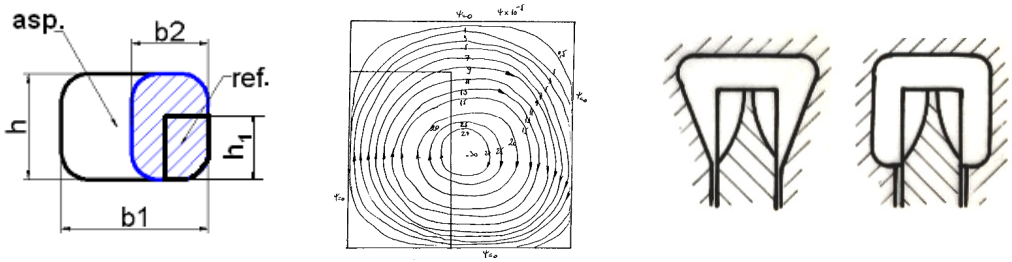

Fig. 1. Meridian section of a blower with side channel
a. channel dimensions b. flushing spectrum c. trapezoidal and squared section

The suction section has double feature: is placed at the blades base, where the fluid is naturally input in impeller, (simultaneous with the fluid recirculation) and cover a segment of impeller according to the number of blades associated

with the pressure coefficient ψ. The discharge section is placed tangent to the impeller, so, on the fluid act a centrifugal force proportional with the impeller rotation speed (figure 2).

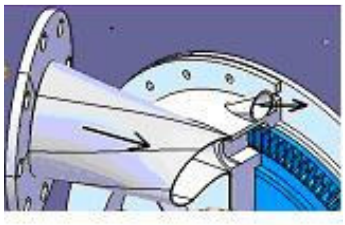


Fig. 2. Suction and discharge sections

Ploting the static pressure characteristic depending of the fluid flow $\Delta p_{tot}(Q)$, it results that the hydrodynamic profiles of the suction and discharge sections decrease the head with approximate 30%, due to the incomplete conversion of the kinetic energy in pressure energy (figure 3).

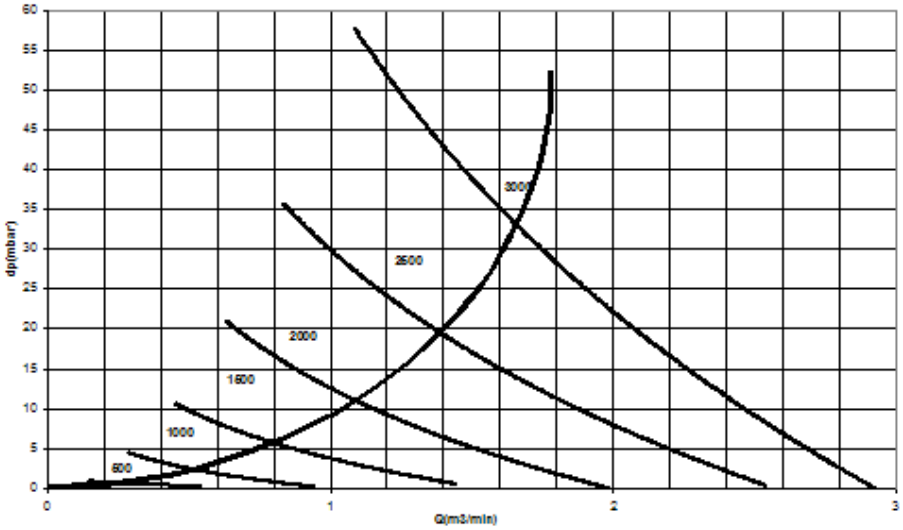

Fig. 3. Characteristic curved at different speeds

3. Experimental researches regarding the degree of the biphasic fluid mixture using a regenerative blower with side channel

This paper underlines the efficiency of the internal flowing in a blower with side channel for a biphasic fluid mixture. To study this, a mixture of air and dry

sawdust was used. According to the working principle of the studied blowers, the fluid is passing many times between impeller and case; the number of the fluid recycling is theoretically equal with the pressure coefficient ψ. The aim of the study is to find the most efficient methods for a maximum degree of fluid mixing (air-sawdust); the solution was to profile the suction and discharge sections. To visualize the flow, the experimental stand has a transparent pipe, and a perpendicularly laser fascicle (laser sheet) was used at the discharge nozzle of the turbo-machines. The experimental stand is presented in figure 4 and consists in:

- Blower with lateral side designed for a pressure coefficient $\psi=5$;
- Suction and discharge pipes; it was used a closed plant to mixing the fluid air-sawdust;
- Laser with red light (5mW) placed to a distance of two discharge diameter $l = 2d$, mounted on a setting device;
- Apparatus for electrical characteristics;
- Tachogenerator to determinate the rotation speed of the impeller and to establish the working point on the curves in figure 3;
- Video apparatus to recording images in different operating conditions.

Fig. 4. Experimental stand

The tests were realized for different working conditions concerning nominal point and different speed as shown in figure 3 (characteristic curves previous plotted). Flowing visualize was made in two sections perpendicularly on the flow and longitudinal (in this case the laser was rounded and displaced in a light section parallel with the transparent pipe).
Working conditions correspond to the rotation speed of 1500 rot/min and 2500 rot/min – characteristic curves are represented in figure 3, in the intersection point between the curves at the two-rotation speed and the curve at nominal working points.

It was used a video apparatus with adjustable exposure and with the possibility to take images at small distance („smart zoom"); in this case it was obtained images from *6 cm* distance to the studied section.
During the all-registering range, it was checked that the plant vibrations do not displaced the visualized section.
In figures 5 and 6 are presented the results obtained in a transversal section visualized in the flowing direction, remarking the reproductibility of the recording for both rotation speed analyzed.

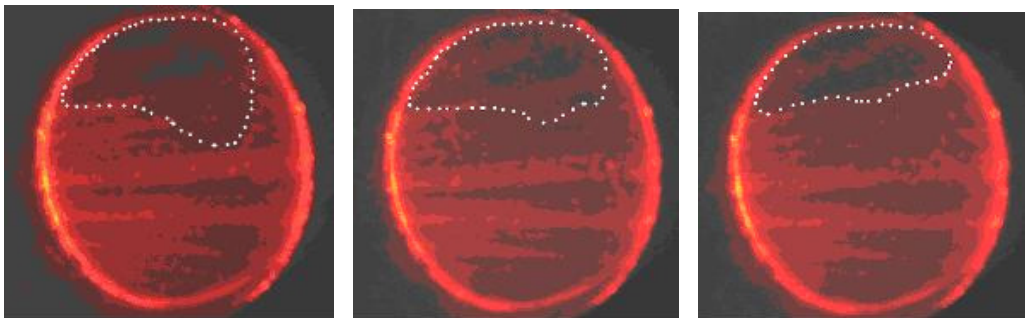

Fig. 5. Flowing spectrum at rotation speed n = 1500 rot/min

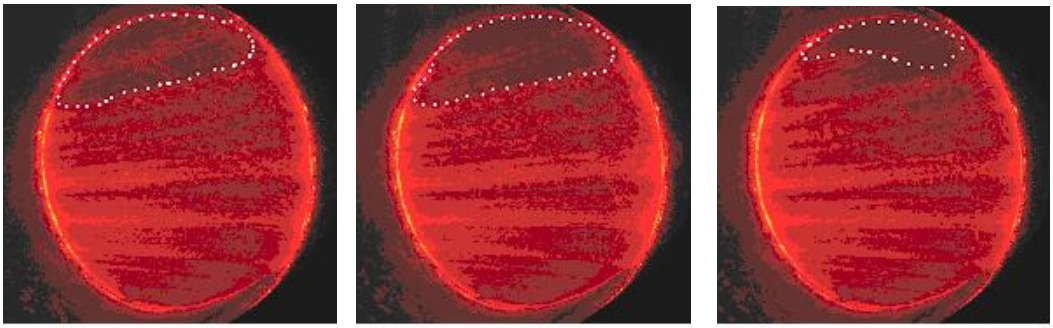

Fig. 6. Flowing spectrum at rotation speed n = 2500 rot/min

The flowing visualized in longitudinal direction was realized in two sections, first at 1/3 from the upper side of transparent pipe and the second at 1/3 from the lower side of the discharge pipe (figure 7a). In figures 7b and 7c are depicted results for the rotation speed *n =1500 rot/min.*

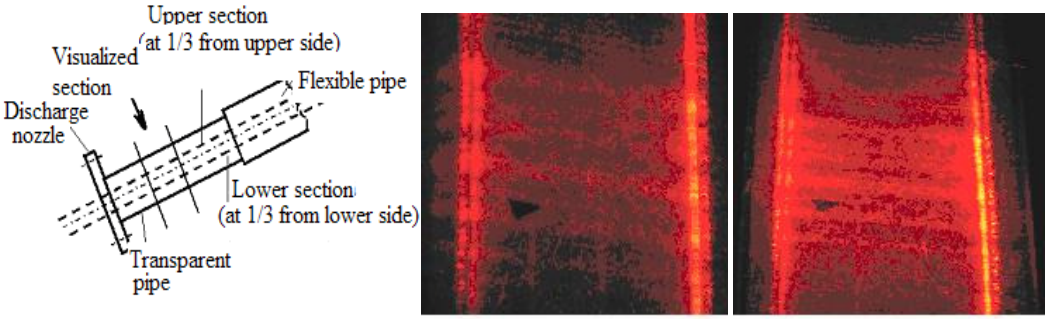

Fig. 7. Spectrum of longitudinal flowing for n = 1500 rot/min
a. Position of sections ; b. upper side section; c. lower side section

4. Conclusion

The experimental results have a high degree of reproductibility, which conclusion that the identified process can be considerate specific for side channel blowers, for studied working conditions.
On the experimental studies we can conclusion:

a. The side channel blower, with a design of the impeller like in figure 1.a and suction and discharge sections like in figure 2, realize a mixture air and dry sawdust with a high degree of homogenous;
b. In the visualized transversal section, was established that, for both rotation speeds the flowing is segregated. So, in the upper side section output a vortex, with motion in clockwise direction, but in lower side section, the flowing in not disturbed. The vortex appears due to the tangential output from the impeller and lateral channel, the action place is due to the centrifugal force who want to output the fluid on external pipe flowlines;
c. With the increase of the rotation speed, the vortex tends to reduce his effect; this observation must be confirmed, because the quantity of the sawdust was constant, which created a concentration of the solids particles in the section, unfavourable for comparative conclusions;
d. Experimental results were according with other theoretical and experimental researches, makes on side channel blower [21], as depicted in figure 8.

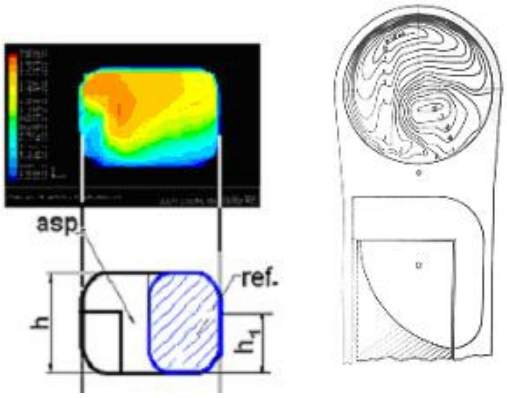

Fig. 8. Speed distribution
a. in the output section of the blower [21]; b. in the discharge section (M.D.Cazacu)

e. Results praised at b. was confirmed, also by visualizes performed in longitudinal flowing section; so, in figure 7.b (upper side) it observe a high intensity of flowing, with good dispersion of the sawdust particles, but in figure 7.c (lower side), the flowing is a little disturbed in transversal direction;

Researches praised that the mixing phenomenon is present and efficient. The biphasic fluid vein has a good internal energy to make up a integrated jet, with diameter equal of this of the discharge pipe. In the future will realize researches regarding the diffuser angle influence on the observed vortex, also regarding the output pipe direction for a good homogenous flowing.

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