CIEPLNE MASZYNY PRZEPŁYWOWE
No. 133 TURBOMACHINERY 2008

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OPTIMIZATION OF GEOMETRICAL FEATURES OF AXIAL FAN IMPELLER FOR HIGH POWER GENERATOR

In this paper new construction of axial fan impeller (with higher volume in comparison to original) forcing through cooling medium in high power generator TWW-230 has been presented. Designing processes, laboratory flow researches in model scale and practical implementation of new fan have been presented.

Keywords: axial fan, new impeller, generator cooling

1. INTRODUCTION.

Increasing of generators power stimulates intensity of cooling system, where as a working medium is applied hydrogen or air. Cooling medium flow is forced by fans, fixed to generator shaft (Fig.1). We can use axial and centrifugal fans. Axial fans can have constant or changeable blade angle setting.

After modernization of high power generator TWW-230, necessity of cooling system correction has occurred. In 2004 Energoserwis S.A. Lubliniec started cooperation with our Institute of Power Engineering and Turbomachinery. Designing and research works have been completed in the middle of 2007. New axial fans with changeable blade angle setting have been designed and investigated.

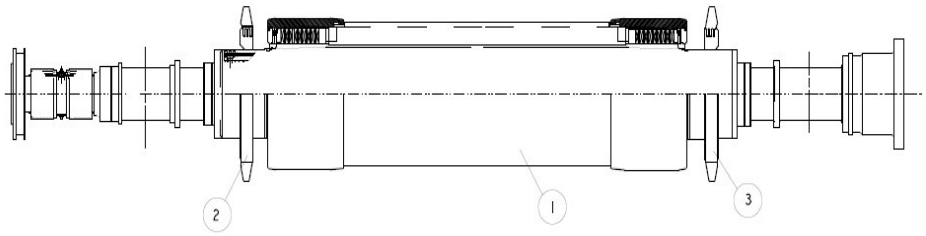

Fig. 1. Rotor of TWW-230 generator (1) with exciter flow fan (2) and power transmission flow fan (3).

2. MODEL INVESTIGATIONS OF THE ORIGINAL FAN FOR THE GENERATOR

In order to investigate original fan, its model with outside diameter D_2=598 mm and diameter ratio D_1/ D_2=0.7786 was made. Rotor has 29 blades with possibility of angle's change. Engine's power is N=2.2 kW, velocity is n=1500 1/min, (Fig. 2).

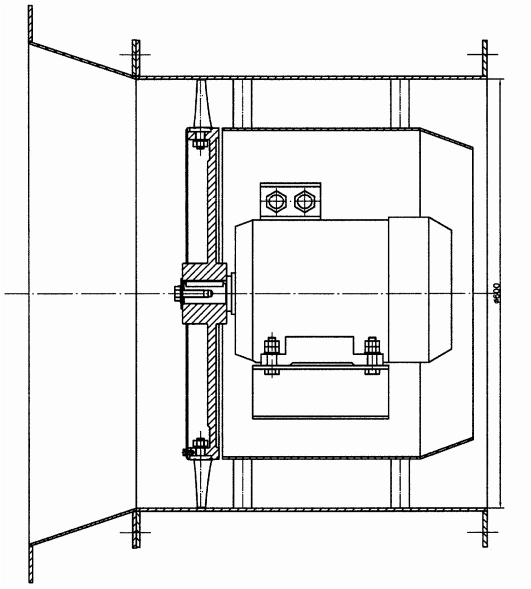

Fig. 2. Construction of model fan.

Dimensional and non dimensional flow characteristics for blade angle α=45° (Fig. 3) have been determined.

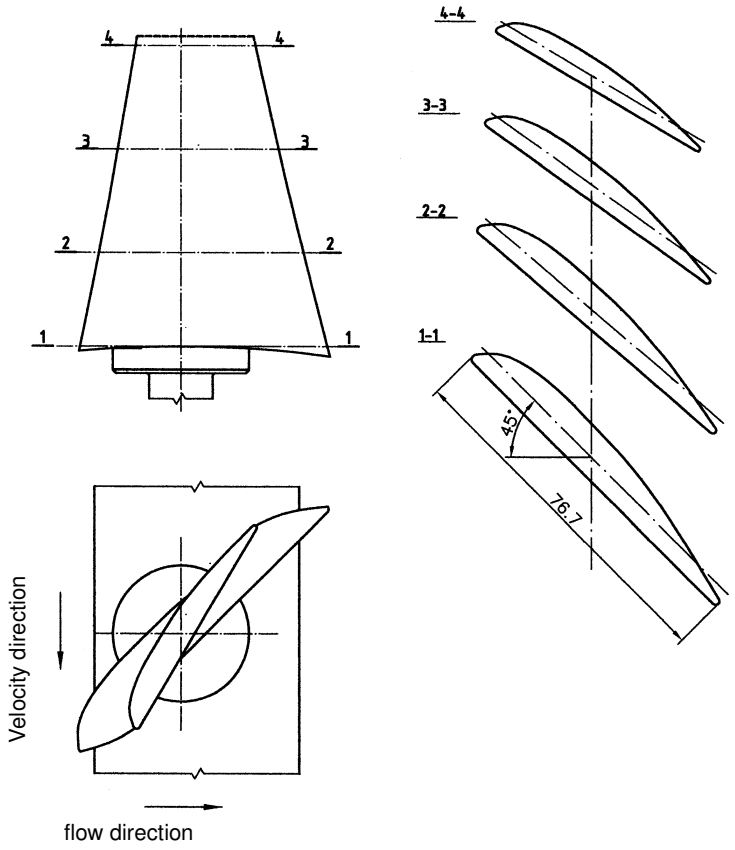

Fig. 3. Cross-section of original model fan blade.

In Fig. 4 real fan flow characteristic has been presented, recounted from model characteristic.

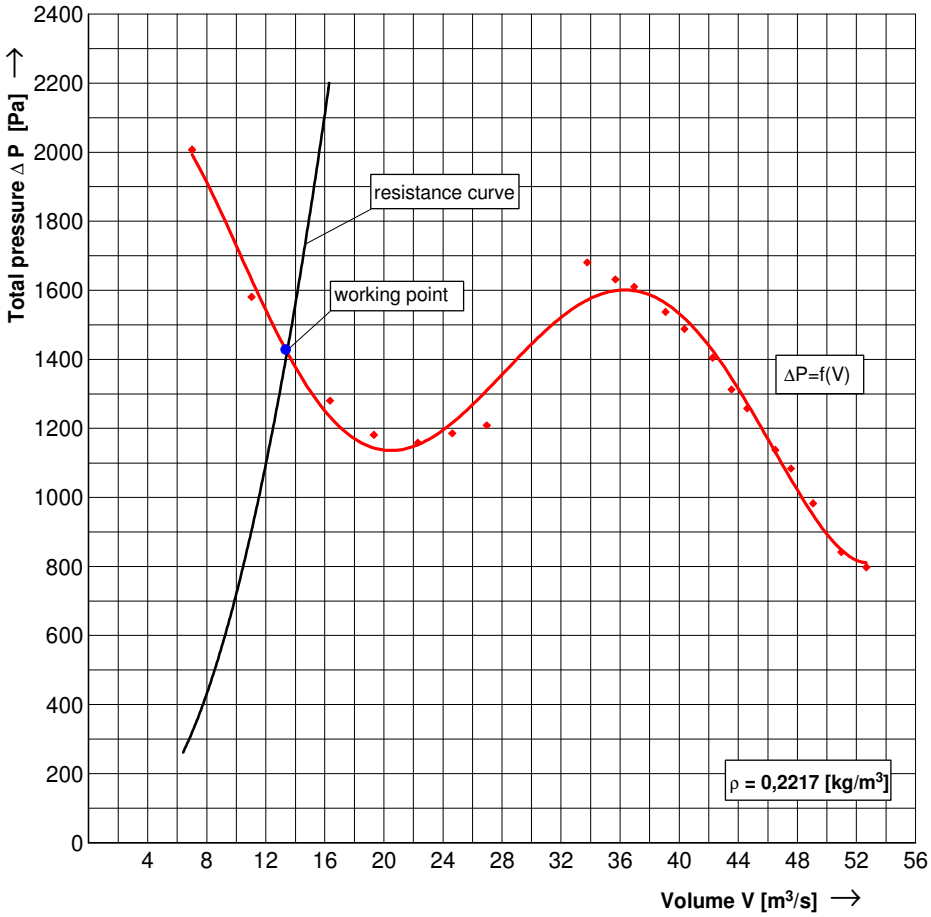

Fig. 4. Original fan characteristic for TWW-230 generator.

3. DESIGNING AND RESEARCHES OF NEW FANS

New fans designing assumptions:

- higher volume (about 20 %),
- the same blade diameters,
- possibility of blade angle change,
- stability of characteristics while changing blade angles.

Two types of blades: A (Fig.5) and B (Fig.6) with different geometrical features have been designed comparing to original shape (fan no 1). Basing on this 4 new fans have been configured:

- with A blade and blade number z=29, (fan no 2)
- with B blade and blade number z=24, (fan no 3)
- with B blade and blade number z=29, (fan no 4)
- with B blade and blade number z=36. (fan no 5)

All fans were investigated for different blade angle setting $\tilde{\alpha}$

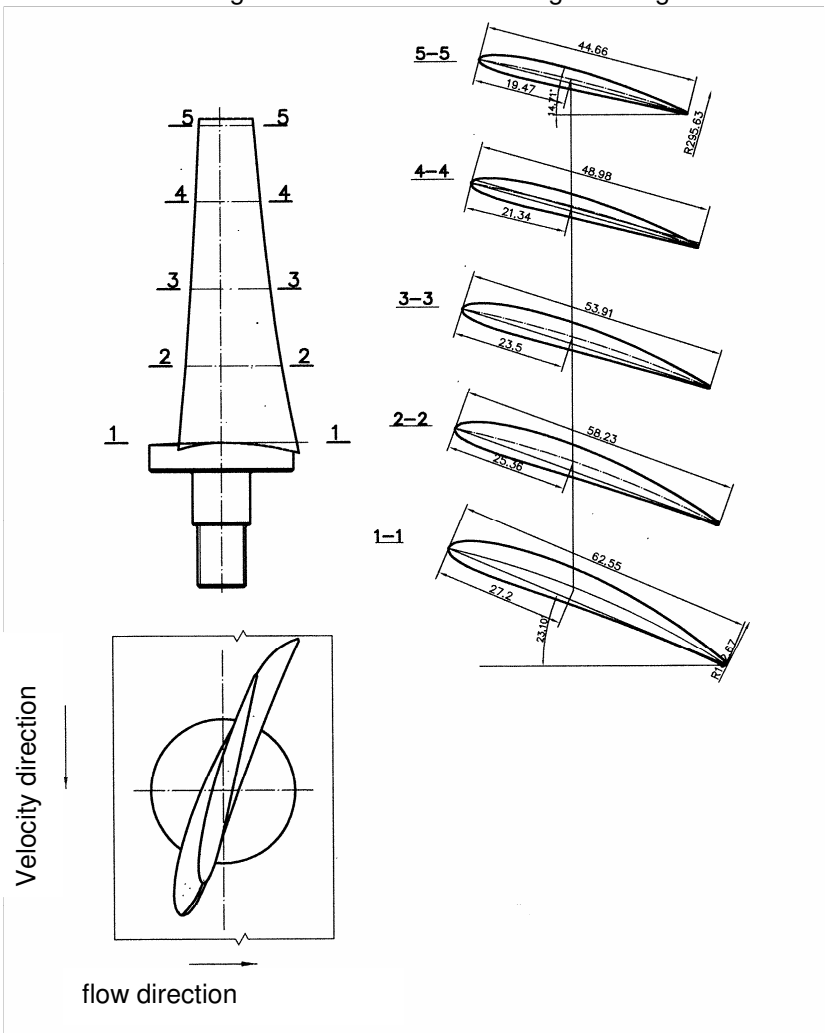

Fig. 5. Cross-section of model fan A blade.

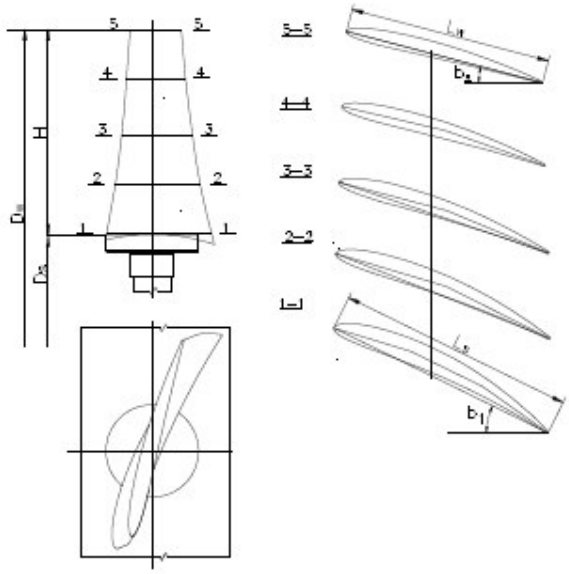

Fig. 6. Cross-section of model fan B blade.

Dimensional and non-dimensional flow characteristics for different blade angles have been determined.

4. COMPARISON OF ORIGINAL AND NEW FANS WORKING POINS FOR TWW-230 GENERATOR

In Fig. 7. there is presented comparison of characteristics of original fan and new fans for best angle settings. Working point parameters for those fans are presented in tab.1.

Tab. 1. Working points parameters of new fans with blade angle setting and fan with original blade.

Blade number	Blade angle setting	Volume [m^3/s]	Total pressure [Pa]	Efficiency in working point %]
z=24	α =25°	15,6	1900	41,5
z=29	α =36,5°	15,6	1895	43
z=36	α =36,5°	15,7	1940	44
z=29	α =45 °	13,3	1425	27

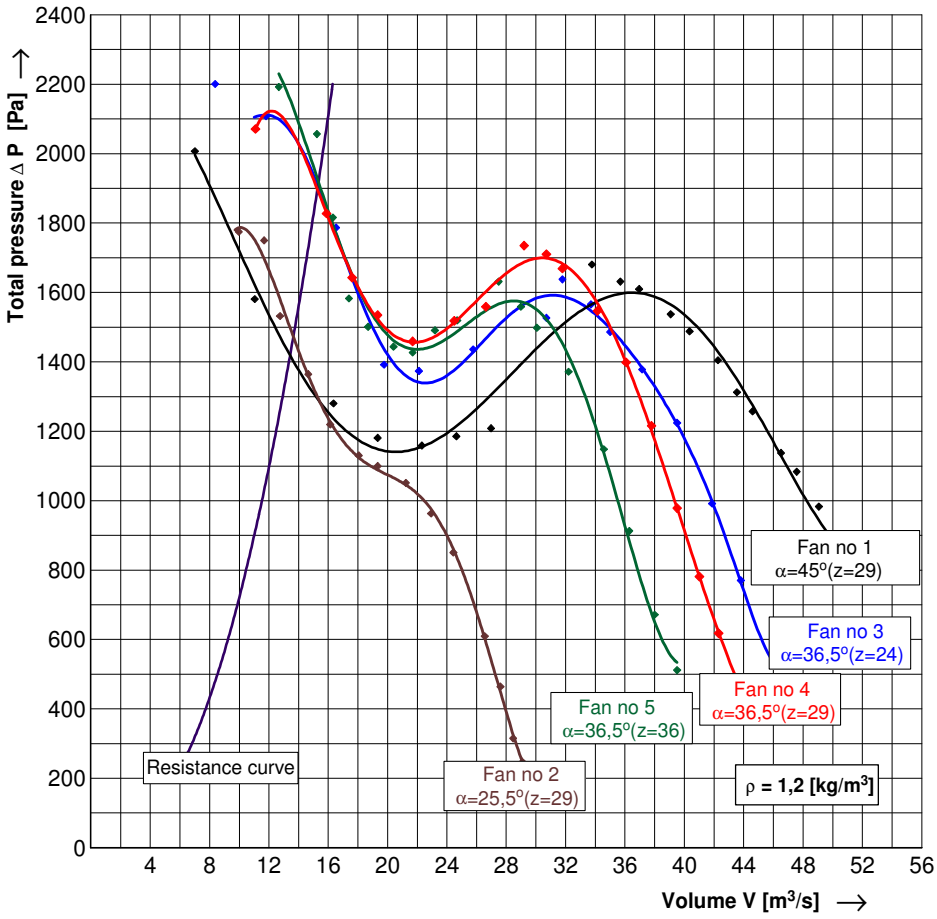

Fig. 7. Performance curves of the original and new fan

5. CONCLUSIONS

1. Carried out flow researches of all fans (and recounting of characteristics) shows that the optimal fan for TWW generator is fan no 3, with B blade, blade number z=24 and blade angle setting α =25°.
2. Working point parameters of optimal fan are:
   - volume V=15.6 m^3/s
   - total pressure Δp_c=1900 Pa
3. Working point parameters of original fan are:
   - volume V=13.3 m^3/s
   - total pressure Δp_c=1425 Pa

4. After comparison of flow characteristics of original and optimal fans we can say that optimal fan has higher volume (about 17%) than original fan.
5. Optimal fan has stable characteristic in area of working point (smooth flow), original fan doesn't have stable characteristic in this area (turbulent flow).
6. After comparison of efficiencies of both fans we can say that optimal fan has higher efficiency (about 15 %).
7. Geometrical features of modernized blade have been applied to patent office.
8. Modernized fans have been applied to production in second half of 2007 for TWW-320-2Y3 generator (Fig. 8).

Fig. 8. Rotor of TWW-320-2Y3 generator with modernized fans with blade angle setting.

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