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FAKULTA STROJNÍ

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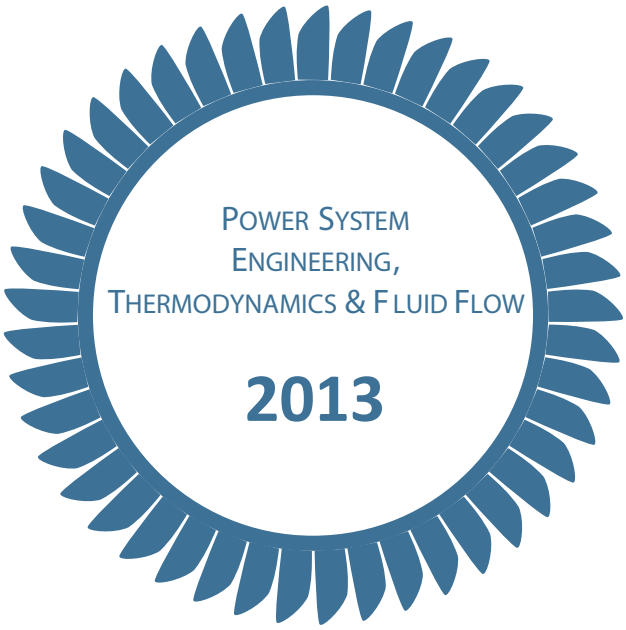

JEDNOTLIVÝ PŘÍSPĚVEK ZE SBORNÍKU

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MONITORING OF EXHAUST FAN CONTROL PARAMETERS

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This article is focused on description our experience with off line monitoring basic control parameters of exhaust fan. This monitoring is targeted on assembly keys data in weekly period and its analysis. We collect data which are connected with continuously adjustment of fan blades. The monitoring solves collection of data about running of fan: position of blades, acting forces and value of bearings vibrations. Regularly is recorded requested and really position of rotors blades. Acting forces are calculated from measuring of acting pressures of hydraulic oil before and behind of piston in hydraulic valve. Vibrations of bearings are measure through the accelerometers fixed of supporting box. This monitoring makes trends of fan reliability and is able easily planning of service period.

Keywords: axial exhaust fan, monitoring, reliability

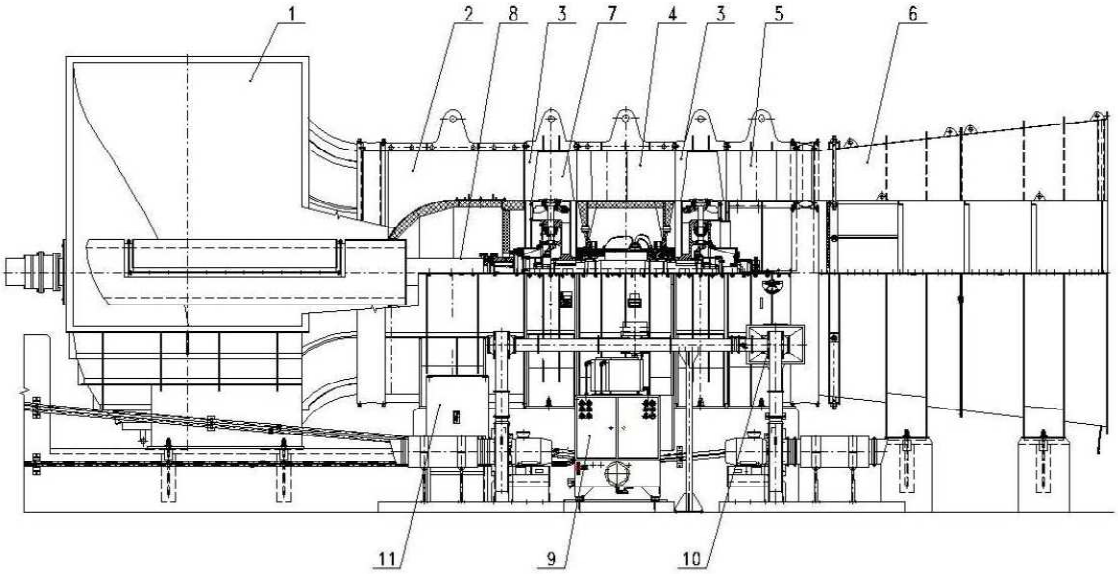
1. Introduction

Company ZVVZ MACHINERY, a.s. is a big producer of specialized devices for power plants. One type of these devices is an axial overpressure fan with single stage or double stages. Adjustment of gas-handling parameters is made by adjusting the impeller blades angle during fan operation. The fan is designed as horizontal type for the transport of air and flue gases, and for overcoming pressure losses of connected technologies and the piping system up to the value of the maximum.

These fans are mainly used for blasting of air into boiler combustion chamber and exhaustion of flue gases. The axial overpressure fans with standard diameter of impeller 3550 mm are situated on a lot of power plants. The fan is suitable for the transport of air masses avec the maximum temperature of +220°C (by short-time emergency 235/310°C), at the ambient temperature from -20°C to +40°C.

There is short description of fan. The fan has double stage with performance control by rotor blades adjustment during rotation of impellers. The fan is delivered in horizontal orientation; the position of the inlet chamber is +30°. (See Fig. 1.). The impellers are freely seated on both ends of the shaft and comprise mechanical parts enabling the adjustment of the blades. The blade bearings are seated in sliding and roller bearings. Radial bearings have a permanent grease filling. Axial bearings have a permanent common oil filling. The bodies of the impellers are welded from steel parts and machined.

Main bearings of the fan rotor are lubricated with oil, whose circulation and cooling is assured by the lubricating part of the hydraulic unit. They are seated in a special bearing box. For the needs of diagnostics and control, the box is equipped with Pt 100 resistance thermometers and vibration sensors. The temperature of the bearings of +80°C means an increased temperature of the bearing, at +100°C, the fan must be shut-down and corresponding measures in the linked technology must be taken.



1. Suction box
2. Inlet box
3. Impeller box
4. Distribution box of 1 stage
5. Distribution box of 2 stage
6. Diffuser
7. Rotor
8. Shaft coupling
9. Hydraulic unit
10. Sealing air tubing
11. Electric box

Fig. 1: APJC 3550 - Description of exhaust fan parts

The diffuser and the inlet chamber are provided with manholes enabling access inside the fan. The diffuser manhole is located at the end of its core, and it enables access to the hydraulic mechanism of the impeller blade adjustment control. The manhole to the inlet chamber is in its side wall, and enables the access to the space in front of the impeller and through the manhole on the inlet box core to the bearing.

Hydraulic control of the power regulation is composed of a hydraulic cylinder and a rotary converter (distribution head). The power control is made by controlling the proportional valve of the hydraulic unit. The position of the blades is captured by an electric position sensor (inclinometer), whose output of 4 - 20 mA is transmitted to the control system. The blade adjustment is also visualized by a mechanical indicator, located on the outer casing cover of the fan. You can see the control range and blade angle range in Fig. 2.

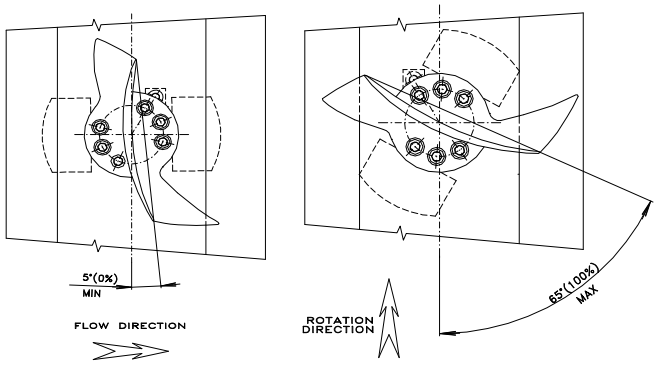


Fig. 2: Control range – blade angle range

2. Description of data monitoring

The main reason for installing monitoring of recording operating data position rotor blades of exhaust fan was the fact that it occurred several times around the switch off the block of power station due to large deviations between the set point and the actual position of fan blades. The primary cause of fan stopping was the increasing of passive resistance in control mechanism and acting force was not able turn the blades to right position. Subsequent checks on-line records in the control room of power station, it was found that it was always a long-term process (several weeks) often accelerated operational downtime.

Continuous data record (set points, actual values of position of blades, vibration on front and rear bearings and controls hydraulic pressure to operate before and behind the piston of hydraulic cylinder) is performed periodically every 30 seconds. The change of control commands from the control system from the control room power station is occurs more frequently, but to reducing the data transmission to us it is this value appears to be sufficient. The limits of maximum pressure in front and behind the piston are set in collecting the data logger. The period data record is during exceeded these values decreased on 5 seconds.

Information about the set point position of the blades is scanned from the input signal 4-20 mA, which is send from the control room to the hydraulic control valve. This information is converted to value 0-100%, which corresponds with the set point angle blades on the impeller of fan. This data are in Fig. 3.

Information about actual position of the blades is derived from the piston position of hydraulic cylinder, which control positions of blades and following mechanism. This mechanism transformed actual position into a rotary movement and this is scanned installed inclinometer. The inclinometer provides a signal of turning vanes again in 4-20mA signal. This information is also converted to 0-100% and corresponds to the angle of blades on the impeller of fan. This data are in Fig. 3 too.

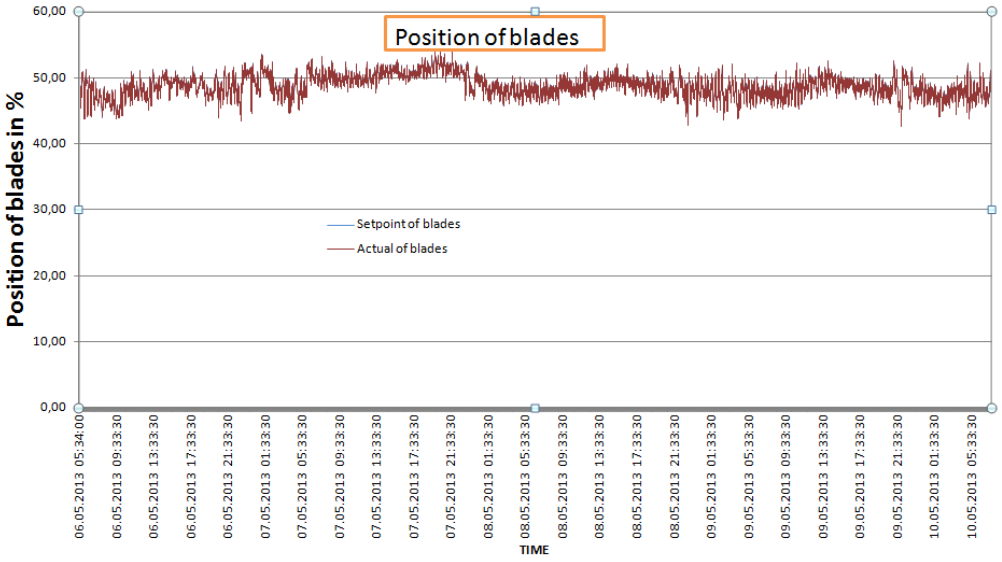


Fig. 3: Weekly record of set point and actual position of the blades

Two pressure sensors are placed in the hydraulic oil pipelines supplying pressure oil before and behind the piston of hydraulic cylinder. The output variable is again a signal 4-20 mA. Current operating force in kN is calculated from these measured pressures. The force impacts in mechanism of blades positioning. This data are in Fig. 4.

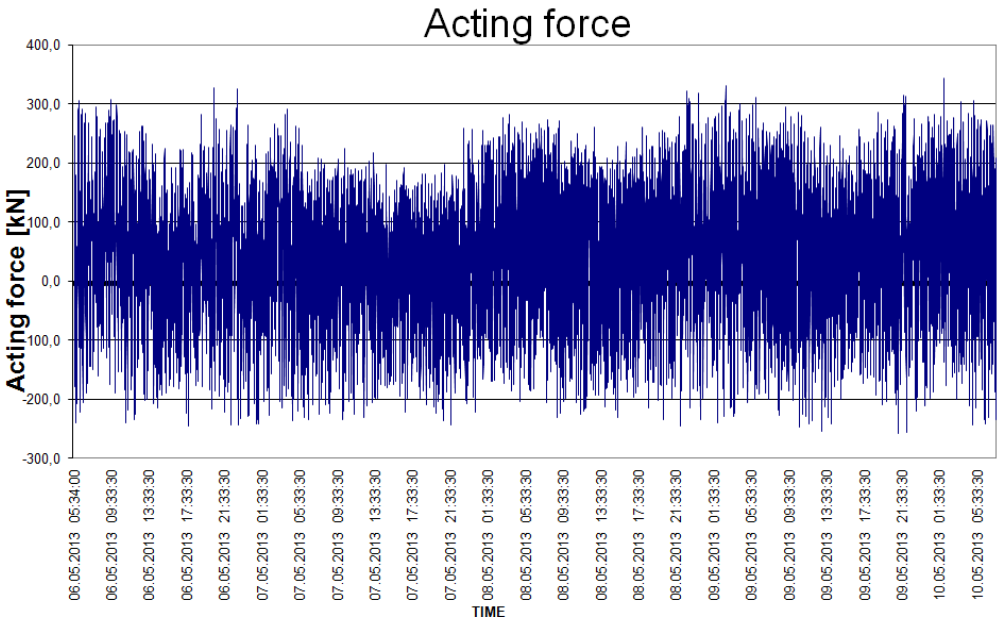


Fig. 4: Weekly record of acting force in positioning mechanism of the blades

The actual values of mechanical vibrations are measured on the front and rear bearings fan rotor. Relevant accelerometers are used for radial direction and these signals are transferred to the level 4-20 mA. This information is stored again after conversion in values of vibration velocity in mm/s. This data are in Fig. 5.

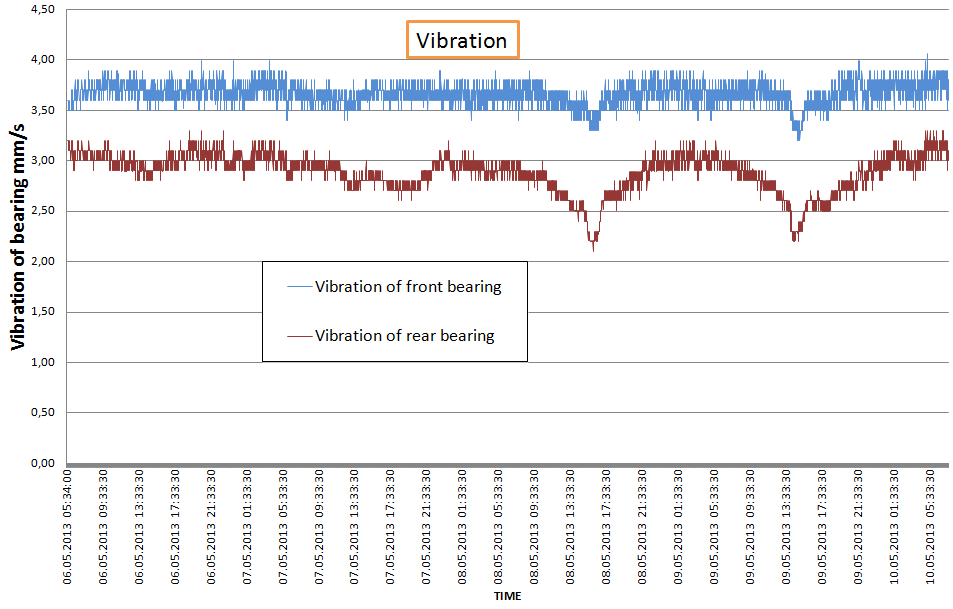


Fig. 5: Weekly record of front and rear bearing vibrations

3. Evaluation of measured data

The recorded data are stored on internal hard disk of data loggers and this file is regularly transferred one times per week from the fan data loggers to the service centre of our company. Transfer takes place between GSM module of fan data loggers and GSM module in PC on the service centre. Here is made data check and it's evaluating. The resulting values are saved in the trends of vibration, position and acting forces. We evaluate the maximum value and the average

from 50 biggest values. These trends are plotted in charts Fig. 6 for acting force and in charts Fig.7 for vibrations of front and rear bearing in weeks

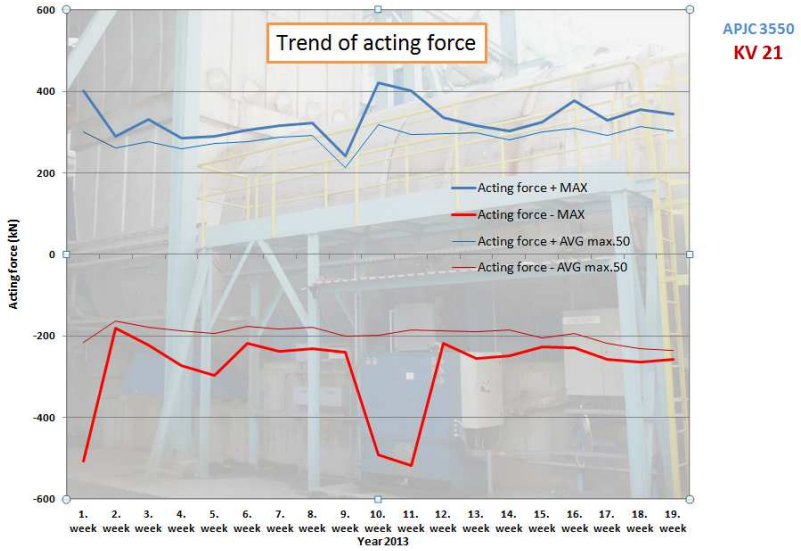


Fig. 6: Trends of acting force values in weeks

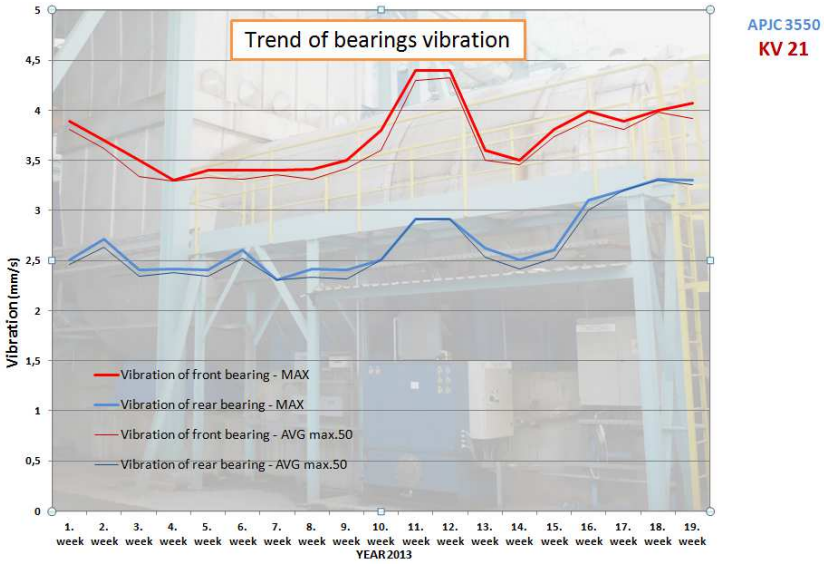


Fig. 7: Trends of vibrations for front and rear bearing in weeks

These trends are archived and compared regularly for each exhaust fan. These trends have got big role in planning service checks a repair. This analysis reduce cost on site of fan producer and on opposite site by customer too. We have got very positive experience with direct focusing our working capacities in during very short planed checking period on the fan with expected problems.

Conclusion

Monitoring of operating parameters (set point and actual position of blades, acting force in control mechanism, vibration on front and rear bearing) of fan provides for us important predictive information about condition of the exhaust fan. We are able to predict how and where will be lead the situation to a shutdown of the fan. We were able clearly demonstrate from

recorded data a causal link between value of acting force in control mechanism and the numbers of stops (crossings through dew point) which is caused by condensation with residual particles of exhaust gas and water in space between flange the blade and the hub hole.

The process of hardening of condensate starts immediately. The flue gas with solid parts and water dry up in small space and this effect to lead in increasing the frictional resistance in a mechanism for blades positioning.

We would like to use this monitoring system on other new power plants too. We have got a plan in next application used for monitoring other signals which are located or measured on the exhaust fan. It means for example pressure of flue gas, temperature of flue gas and temperature of bearings. The predicting of problems with devices is very usefully for service planning and reducing cost on the repairing.

Literature

[1] Internal reports about run monitoring of exhaust fans on power plants.

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