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ELIMINATE THE NOISE OF WIND POWER PLANTS BY ANTIPHASE

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Abstract: *The basic issue of our solution is a noise generated by the transformer operation. If we ignore the constructional intervention into the transformers, we can proceed to the problem with active and passive solution. The passive solution can be covers, rubber silent blocks and elimination due to construction of the building. Our proposed solution for this problem is on active base by sending an identical acoustic signal turned to anti-phase, to the machinery causing an undesirable noise effects. During the optimal setting of this anti-phase there is a conflict of the wave and acoustic shunt fault which should cancel all noise activities expanding by the air during the optimum conditions.*

Key words: Anti-phase, transformer, noise, acoustic signal

1. INTRODUCTION

Currently, the health of human population in any activity is a priority of human pursuit. Indivisible factor having an adverse impact on the human organism is a parasitic noise around us. Human physiology is not adapted to deal with noise emissions, which currently man produces, therefore are issued orders, regulations and directives governing the noise level to human in various activities in various areas. The aim of designers is the parasitic noise as possible to eliminate.

2. PARASITIC NOISE OF ELECTRICAL DEVICE

Methods of elimination can be divided into three basic systems:

1) Constructional
2) Passive systems
3) Active systems

Ad1) Constructional: systems heading to basic essence of parasitic sounds for each electrical device. Interventions for eliminate itself relate to construction and development groups and projectors.
Ad2) Passive solutions are covered, the rubber dampers and elimination using the building structure. Machine noise can be reduced by consolidating all the proper parts, different coatings, insulation covers.
Ad3) Active systems are devices capable of eliminating noise, such as using anti-phase. (Chmelík at al., 2003)

3. ANTIPHASE

To understand the system is important to know basic, namely waves alone. Phase of the wave is a dimensionless quantity that determines the relation variable waves, (e.g. displacement noise) at that place and time and to the state variables characteristic waves in temporal and spatial origin. Dependence characteristic of variables determines the shape of „waves" regardless of its dissemination. Phase is a parameter, which depends on the timing characteristic values in a fixed location, which the wave passes, respectively spatial field characteristic values for a fixed moment in time. Noise so we can capture by the curve demonstrate displacement in time. Anti-phase is turning the current signal o 180°.

The result of the exact anti-phase is an absolute deduction of both signals and therefore their complete elimination. (Chu at al., 2001)

4. SYSTEM ELIMINATION OF NOISE USING PHASE OPPOSITION

System consists of measuring microphone that its high-quality electro-acoustical converter receives the noise signal and changing it to a sinusoidal voltage curve, it is received by the system, which inverts the signal. Inverted signal is moved exactly by half period. This part is the most important and also must be made with great accuracy because phase shift means the misoperation of equipment. This just turned and shifted signal is amplified by an amplifier and it is radiated to signal of noise, Fig.1. (Tomlinson at al., 2009)

Fig.1 The block diagram of noise-elimination by antiphase

5. ACOUSTIC EMISSIONS WIND POWER PLANTS

The causes of noise emitted from operating wind turbines can be divided into two categories: aerodynamic and mechanical. Aerodynamic noise is produced by the flow of air over the blades. The primary sources of mechanical noise are the gearbox and the generator. Mechanical noise is transmitted along the structure of the turbine and is radiated from its surfaces.

Aerodynamic noise originates from the flow of air around the blades. This type of noise generally increases with tip speed or tip speed ratio. It is broadband in character and is typically the largest source of wind turbine noise. When the wind is turbulent, the blades can emit low-frequency noise as they are buffeted by changing winds. If the wind is disturbed by flow around or through a tower before hitting the blades (on a downwind turbine design), the blade will create an impulsive noise every time it passes through the 'wind shadow' of the tower. (Manwell at al.;2002)

Mechanical noise originates from the relative motion of mechanical components and the dynamic response among them. The main sources of such noise include: Gearbox; Generator; Yaw drives; Cooling fans; Auxiliary equipment (e.g., hydraulics).

Since the emitted noise is associated with the rotation of mechanical and electrical equipment, it tends to be tonal (of a common frequency) in character, although it may have a broadband component. For example, pure tones can be emitted from the rotational frequencies of shafts and generators, and the meshing frequencies of the gears.

In addition, the hub, rotor, and tower may act as loudspeakers, transmitting the mechanical noise and radiating it. The transmission path of the noise can be air-borne or structure-borne. Air-borne means that the noise is directly propagated from the component surface or interior into the air. Structure-borne noise is transmitted

along other structural components before it is radiated into the air. (Manwell at al., 2002), (Krejčí at al.,2009)

5.1 The intention to eliminate the noise of wind power plants.

Eliminating the noise of wind power plants is much more complex than for electrical devices such as transformer already mentioned. Unlike a transformer which is roared by constant frequency and intensity noise in it does not markedly change, noise of wind power plant is variable. To the noise of wind power plant is reflected as a mechanical and aerodynamic components and pressure weather and other natural influence. Carry out such as elimination is much more complicated and will need to focus on a specific frequency area which is the worst for human. These frequencies are from previous physiological surveys already established and move especially on the field of infrasound and then in audible range of frequencies around 300 and 2000Hz. We split a possibility of elimination in the three basic solutions that can be combined and also to modify and expand. (Krejčí at al.,2009)

(1) Device to eliminate noise using antiphase placed besides houses

The intention is to create an acoustic wall that might be part of such farm buildings or garages which would be placed in facilities for parasitic signal and then broadcasts the identical signal in anti-phase to wind power. This device would be most energy-intensive, but it would be able to cover a larger number of objects.

(2) Device to eliminate the noise by a counterweight located directly in the construction of power wind plant

In this solution is intended to be placed directly into antiphase eliminator walls of the building. This solution is less energy intensive and does not interfere with other construction in the countryside, but it most economically. It would thus need to equip all homes affected by the incident noise of wind power plant.

(3) Installations for the elimination of noise with phase opposition incorporated into the constraction of wind power plant

Certainly the most interesting and also most complex solution is to equip anti-phase eliminator directly in the manufacture. This idea includes for example equipment rotor blades grooves, which were phase opposition, for example, the mechanics of power plant. With narrowing of grooves would be offset by differences in the frequency and the rotor rotation. Another possibility is tuned bearings. This means that the contact surface of rolling elements and inner ring bearings deliberately created a groove, which would in turn generate the same sound the rest of the mechanism. The question remains how to comply with the phase shift by 180°. Such a system would most thrifty and most economical.

6. MEASUREMENT AND ACOUSTIC TESTING

Simulations were carried out in anti-phase action in software environment. The entire test consisted of a two mono tracks which were imported into the audio signals with frequency of 1kHz.

It was necessary to select the signal from which the following measurements will be read. Because dB is the relative unit and the signal was measured by standard acoustic VU meter, we chose a baseline -6dB. Signal to stop was import as data, as well as all subsequent transactions are made only as a software step, than the signal could be distorted by electronic components or external interference. This signal has been enlarged so that it was possible to make precise displacement signal half period, thus achieving absolute anti-phase. The initial tests were carried out intentionally, but only a partial shifting. Thus the first test was conducted with the shifting of quarter-period, this situation in this artificial environment cause a decrease by 3 dB so to 9dB.

In current practice, the status was inadvertent, because it would not only have no effect, but the speaker would produce the same negative noise.

Fig. 2 shows basic devices for measurement of noise and testing system of anti-phase generation.

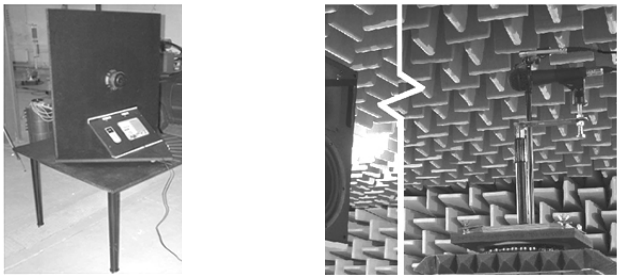

Fig. 2 Measurement and testing system for anti-phase

Final and most important test was complete, turn signal and the absolute anti-phase. The proof is the absolute phase opposition VU meter which reached the level – 78dB, Fig 3.

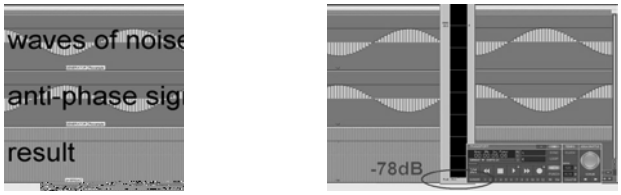

Fig. 3 Decrease of noise to -78db

Now we perform tests in laboratory and computer environment. We developed many devices that provide precise measurements and acoustic tests.

7. CONCLUSION

This researching leads to improve the system for eliminate noise of wind power plant by using of anti-phase system at the level of practical use. Now we are testing that anti-phase system at small wind turbine which is located at VSB-TU Ostrava campus.

Our proposed solution to this problem is on an active basis. With the broadcast identical sound signal rotated to anti-phase in the equipment causing unwanted noise effects. With optimal settings for this anti-phase there is a conflict of wave and so-called acoustic short, which would distraction in optimum conditions noise exposuring airborne.

8. ACKNOWLEDGMENT

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9. REFERENCES

Chmelík, K.. (2003*) DC and commutator electrical machinery, general machinery*, VŠB – Technical University of Ostrava., ISBN 80-248-0314-3

Manwell J.F ;McGowan J.G & Rogers A.L, (2002) *Wind energy explained, design and application,* University of Massachusetts, Amberst, USA., ISBN 13: 978-0-471-49972-5 (H/B)

Krejci, P.; Prokop, L. & Misak, S.(2009) *Analysis of Long Time WPP Power Flows Measurement. In RUSEK, Stanislav, GONO, Radomir (ed.).*10th International Scientific Conference Electric Power Engineering 2009., ISBN 978-80-248-1947-1, p. 373-378

Tomlinson H.; (2009) http://www.mefeedia.com/– Anti-noise by Tomlinson Holman, *Accessed on: 2010-05-15*

Chu M.; (2001) http://gilmore2.chem.northwestern.edu/tech/anr_tech.htm, *Accessed on: 2010-04-19*