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The Proposal for a Knowledge Center for Support of a Knowledge Base for the objectification of Environmental Factor

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BIOGRAPHICAL NOTES

Ervin Lumnitzer, prof. Ing. PhD. He is graduated at Technical University of Košice in the field of „Robototechniques" in 1985. In 1995 he defended his dissertation thesis in field of „Mechanical Technologies" and in 2002 habilitated in the field of „Automation and Control". Nowadays he works as a university teacher. He is the head of the Environmental Engineering Department, authorized person for noise measurements in living and working environment, referee of bachelor stud ies in field of Environmental Management, chairman and also member of board of state examiners. Lately he is focused on the field of noise measurements and assessment, protection against industrial noise, noise mapping, noise visualization, assessment of the working environment quality.

Monika Biľová, Ing. PhD. She is graduated in „Environmental Conservation Techniques" at Technical University of Košice in 2003. She became an internal PhD. student at the Department of Environmental Studies and Information Engineering after her graduation. In 2007 she defended her dissertation thesis in field Environmental Engineering. Nowadays she works as a lecturer at the above mentioned department. At the present she focuses on acoustic issues and noise mapping.

Lenka Rusinová, Ing. She graduated at Technical University of Košice in the field of „environmental engineering" in 2009. In 2010 she was admitted to postgradual studies at the Department of Environmentalistics, where she currently is in the 2nd year of studies focusing on chemical analysis of the environment.

KEY WORDS

Measurement, analysis, evaluation, environment, chemical factors, physical factors

ABSTRACT

The paper deals with the research of the project "Centre for Management Research of Technical, Environmental and Human Risks for Continuous Development Production and Products in Mechanical Engineering", namely the phase 1.2 " The Proposal for a Knowledge Center for Support of a Knowledge Base for the Objectification of Environmental Factors". It presents the latest results, equipment and software tools of the center and its application.

1. Introduction

The concept of quality of the environment today is directly related to the concept of objectification. Objectification of environmental factors can be defined as the process of obtaining a result by any method, which can be considered for objective. The basic methods of objectification include measurement and calculation.

Parts of the developed knowledge center are two areas of objectification - objectification of selected physical and chemical factors. In the field of physical factors is the knowledge center focused on completing the laboratories of the Department of Environmentalistics in field of noise, vibration and electromagnetic field. In the field of chemical factors the knowledge center is focused on the construction of laboratories for assessment of chemical factors.

2. The laboratory of objektification of chemical factors of environment

This laboratory is designed as:

- *Educational Laboratory for students' education in field of "Technology of environmental protection", where they performe the basic chemical analysis. Students learn how to of work in chemical laboratories and perform simple, standard analysis for the detection of environmental quality.*
- *Laboratory for the research of methods of objectification of chemical factors in environment. The laboratory is mainly intended to PhD. students and young researchers. We expect also research in field of the mineralization of soil samples, plastic composite materials, and in the field of the spectrograph with inductively coupled plasma.*

The teaching laboratory will perform the following activities:

- *Basic chemistry (weighing, precipitation, filtration, decantation, crystallization, drying, firing, annealing, etc.).*
- *Evidence of cations, anions.*
- *Gravimetric analysis of samples (gravimetry).*
- *Measuring sample analysis (titration - alkalimetry, acidimetry).*
- *Qualitative analysis of samples.*
- *Quantitative analysis of samples.*
- *Organoleptic properties of water.*
- *Measuring of pH.*
- *Measuring of conductivity.*
- *Measurement of absorbance, transmittance.*

In the laboratory for research methods of objectification of chemical factors in environment the range of activities will gradually expand. It is designed in away, that will make possible to perform the following activities:

- *collection, preparation and microwave digestion of samples,*
- *analysis of chemical factors of samples of environment (water, soil, air),*
- *qualitative and quantitative analysis of chemical elements in components of the environment using spectrophotometry and spectroscopy.*

There are enliven and gradually tested the following devices:

2.1 Microwave Digestion System

Microwave decomposition belongs to the group of wet breakdown methods. For microwave decomposition of biological and other samples mineralization devices are used – microwave mineralizators – which use the microwave radiation to destroy the matrix at a high pressure and temperature. Using this microwave decomposition of sample, the time of the decomposition is reduced and a perfect disruption of the matrix can be achieved, which will result in a more suitable consistency, lower viscosity and increased homogeneity of the sample for further analysis. This efficiency of the decomposition is given by the direct absorption of microwave energy by the sample.

The chemical decomposition of samples using a mineralization device Speedwave 2 takes place under high pressure (max 75 bar) and temperature (up to 240°C) using a suitable decomposition agents to which are the following acids: 65% HNO_3, HCl, HF a H_2SO_4. [4]

Samples that have been decomposed using this method are ready for further analysis, which can be for example analysis using the emission spectrometer ICPE 9000. This method is used for qualitative assessment of the samples - that means the presence of each individual element that was sampled when the measurement was done on places with high density of the samples.

2.2 Emission Spectrometer ICPE 9000

Plasma induced optical emission spectroscopy is the measurement of light emitted by elements in sample, witch is fed into the ICP source (plasma). Measured emission intensity is then compared with the intensity of standards of known concentration, with them is than possible to detect concentrations of elements in the unknown sample.

Emission spectrometer ICEP 9000 with inductively coupled plasma facilitate by the qualitative analysis of all elements in selected samples. With the analysis is also provided a concentration range for the calibration curve used for a quantitative analysis.

In Fig. 1-3 is presented the construction of the laboratory. The laboratory has been completely renovated from the former classroom. There have been established new distribution of power, fulfilling the highest existing criteria for a top laboratory, the water and waste distributions. There was created a new, chemical-resistant floor. The laboratory is furnished with tailor-made furniture. It is in process of finalization and installation of new equipments and about to start the experimental research.

Fig. 1: *The chemical laboratory at Department of Environmentalistics.*

Fig. 2: *Sample preparation.*

In the field of physical factors the designed knowledge center focuses on:

- *Visualization of noise in the near field of the source swith Microflow method.*
- *Visualization of the sound insulation properties of materials.*
- *Visualization of the soundintensity.*

Fig. 3: *Application of autosampler in chemical analysis.*

- *Post-processing and data evaluation.*
- *Frequency analysis of electromagnetic fields.*
- *Assessment of low levels of vibration acceleration (geofon).*
- *Measurement of dust in outdoor with equipment based on infrared radiation.*

All equipments are determined to research activities. We have started working on drafting the application methodologies of individual equipments. These are non-standard devices, without traditional standardized methodologies of they use.

3. The laboratory of objectification of physical factors of environment

For this laboratory were purchased top technical and software equipments.

Mainly it goes about:

- *3D equipment for visualization of near acoustic fields (Fig. 4),*

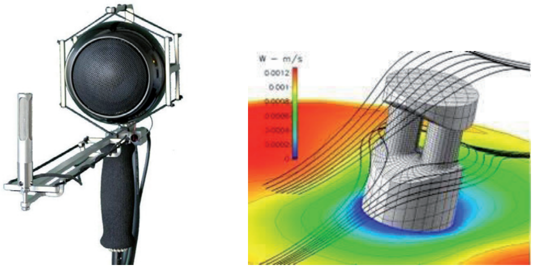

Fig. 4: *The 3D equipment for visualization of near acoustic fields.*

- *the equipment „scan and listen" subject for identification of noise sources,*
- *the seismic sensor for sensing of low values of vibration acceleration,*

- the thermovision camera which is applied in field of maintenance.

Since these are unique equipments, resulting from research the world's top workplaces, there are not methods for their application in practice. These need to be developed. The following section describes the identification and visualization of acoustic intensity and determination of sound power of a chosen source:

3.1 Sound power determination of a chosen sound source by P-U technique

The measurement system used for sound power determination is shown on Fig. 5 and Fig. 6. This system consists of:

- *PU sound intensity probe which can be thought of as an acoustic "multi-meter", measuring both sound pressure and acoustic particle velocity in a single point. The Microflown sensor working principle uses two extremely sensitive heated platinum wires that have very little heat capacity. If airflow occurs around these wires, heat transfer will take place, causing the upstream wire to be cooled down and the air picking up some heat. As a consequence, the downstream wire is cooled down just a little bit less. The temperature difference that will arise in the cross section happens to be a direct measure for the acoustic particle velocity. The sensor is linear and provides output in Voltage.*
- *MFSC-2 - Signal conditioner - is a 2 channel signal conditioner and has three main functions, powering, pre-amplification and the option to correct the amplitude and phase of the signals electronically.*
- *MFDAQ-2 - Data acquisition - is a 2 channel sound card based frontend. The MFDAQ-2 can read in two analogue channels, usually sound pressure and particle velocity, labeled as P (pressure) and U (velocity) inputs. The MFDAQ-2 is connected to the MFSC-2 by two BNC cables. The interface to the computer is by USB. The MFDAQ-2 converts the signal from Analog to Digital, so that it can be processed in the software. Next to the two inputs the MFDAQ-2 has also one dedicated output channel.*
- *Digital camera.*
- *Scan & Paint software.*

In Fig. 7 the chosen sound source – a vacuum cleaner – is shown. It also shows the PU probe trajectory in the near field of the source. The probe was swept over the surface of the source with constant speed.

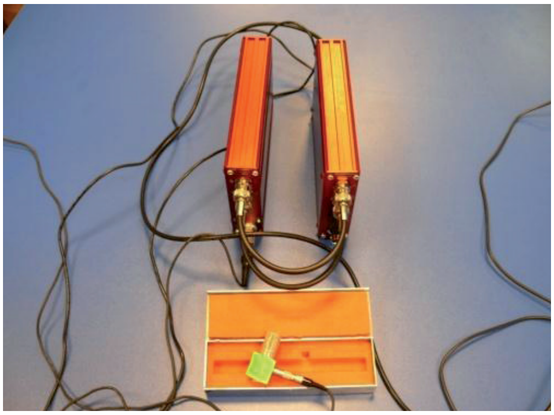

Fig. 5: *PU probe and MFSC-2 - Signal conditioner.*

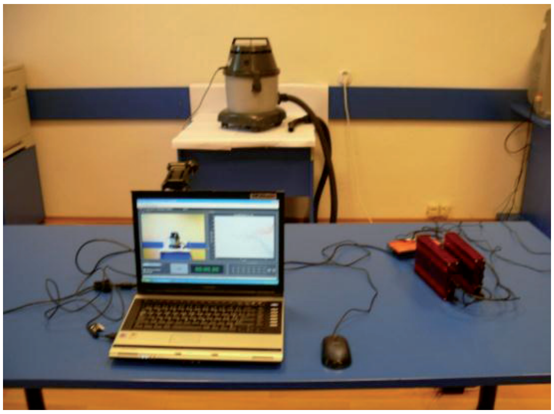

Fig. 6: *Camera, MFSC-2 - Signal conditioner, Scan & Paint software.*

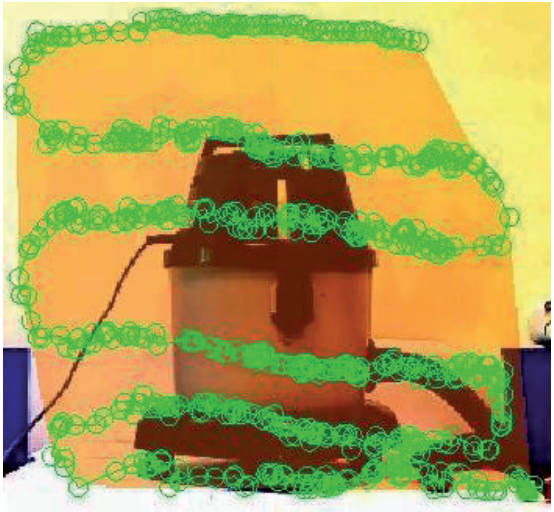

Fig. 7: *The chosen noise source and the measurement trajectory.*

Below some of the results of performed measurements are shown. The monitored parameters at critical frequency 4000 Hz were the followings:

- the sound pressure (Fig. 8),
- the particle velocity (Fig. 9),
- the sound intensity (Fig. 10).

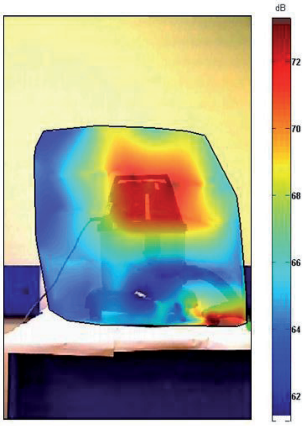

Fig. 8: *Sound Pressure at 4000 Hz.*

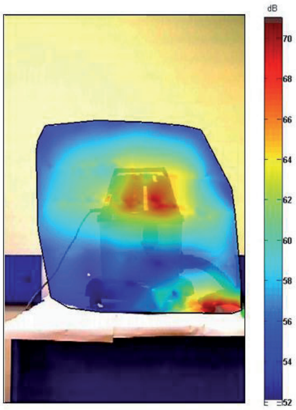

Fig. 9: *Particle Velocity at 4000 Hz.*

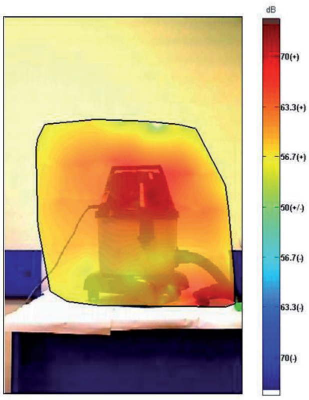

Fig. 10: *Active Sound Intensity at 4000 Hz.*

Giving the software a spatial reference it makes possible to calculate the sound power of a selected area or the total measurement. Instead of the intensity the program displays the sound power spectra (Fig. 11).

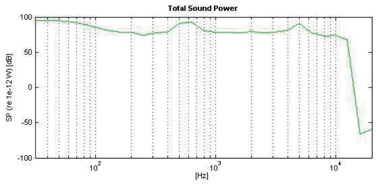

Fig. 11: *The Total Sound Power.*

4. Conclusions

Every noise control problem is first of all a problem of localization and identification of the source. Sound intensity measurement offers several ways of doing this which have considerable advantages over older techniques.

We can summarize the benefits by measurement of acoustic intensity for determination of acoustic power of noise sources in these points:

- *simple localization and identification of sound sources,*
- *independence from sound field,*
- *possibility of measurements in near field,*
- *possibility of in-situ measurement,*
- *possibility of determination of the sound power from the components of a machine,*
- *total sound power can be found simply by adding the partial sound powers from all the noise radiating components,*
- *the chosen measurement distance doesn't influence the results,*
- *steady background noise doesn't influence the results,*
- *straightforward and effective technique.*

5. Acknowledge

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