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SOUND VISUALISATION METHODS – IDENTIFICATION AND LOCALIZATION OF INDUSTRIAL NOISE SOURCES

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Abstract: The noise pollution of the population is currently one of the major environmental quality problems, especially near industrial noise sources. For this reason, noise source operators seek to reduce noise emissions from industrial plants. Various types of noise reduction measures can be applied in industrial plants. Comprehensive knowledge of noise sources and implementation of noise measurements is a first step in applying noise abatement measures. Noise visualization tools can be used for comprehensive knowledge of noise sources. Noise visualization tools allow the identification and location of noise sources and serve as a basis for designing noise abatement measures. Afterwards, these tools can be subsequently used to verify the effectiveness of the measures implemented.
Keywords: noise, visualization, measurements

INTRODUCTION

Noise visualization allows you to find the connection between the sighted and the heard. The result of noise visualization is acoustic images, where the colored fields show noise emission from individual parts of the visualized object. Noise visualization is carried out using noise visualization tools [2].

The basic design elements of these devices are sensors, especially microphones. The microphones are arranged in microphone arrays and together with the sensing device it create microphone field.

Noise visualization tools currently use different principles. The basic principles of noise visualization are beamforming, acoustic holography, focalization and direct methods.

These basic principles of noise visualization have their advantages and limitations. Manufacturers apply these methods to noise visualization tools. The design of these tools varies depending on the visualization principle used. The main differences between these devices are the frequency ranges, the measuring distances and the size of the object under investigation [2].

The fields of application of these devices are diverse and apply in different areas of industry.

The basic task of these visualization tools is to identify and locate partial noise sources. The results are presented by acoustic images and audio videos. The result of noise visualization allows a comprehensive knowledge of the source and consequently creates a suitable basis for noise reduction measures. Other tools for understanding the acoustic properties of noise sources are psychoacoustic methods and subjective noise assessment methods. These methods make it possible to assess sound quality parameters [1].

NOISE VISUALIZATION MEASUREMENTS

Noise visualization tools are nowadays available from different producers. Noise visualizations tools are often also called acoustic cameras. Noise visualization tools consist of three basic components (Figure 1):

- microphone array,
- data recorder unit,
- notebook with post processing software.

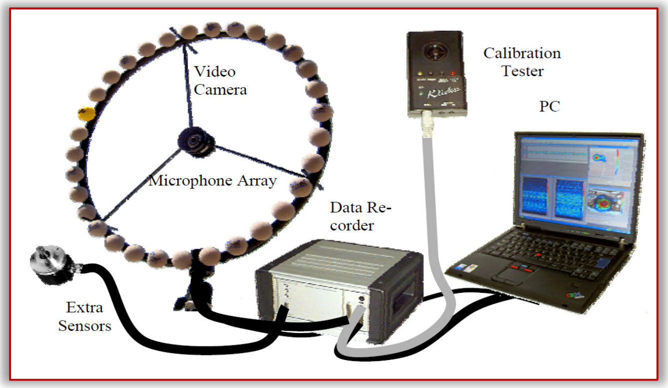

Figure 1. Basic component of noise visualization tools [11]

Noise visualization tools that are using beamforming principle are suitable for measurement distances from 1 m up to 300 m and frequency range from 300 Hz – 10 000 Hz. The measuring distance depends on the design of the microphone array. Figure 2 present different construction of beamforming microphone arrays [8].

Figure 2. Microphone arrays of noise visualization tools [11]

Measurements for visualization of industrial plant noise sources were made by acoustic camera. This device visualized all the most important noise sources of this facility. Spectral analysis was also performed to better understand the nature and nature of the transient noise.

Measurements were made to identify and locate dominant noise sources of stone mining facility. Measurements were also made to identify dominant sources and their impact on the nearest residential areas. Acoustic camera is installed during measurements (Figure 3).

Figure 3. Installed acoustic camera

RESULTS OF THE NOISE VISUALIZATION MEASUREMENTS

First series of noise visualizations measurements was realized measurements from living areas close to family houses in nearest village. Target of these measurements was to identify most critical areas in industrial site. Measurements was realized from two directions from distances 250 - 300 m. Results of the measurements presents Figure 4 and Figure 5.

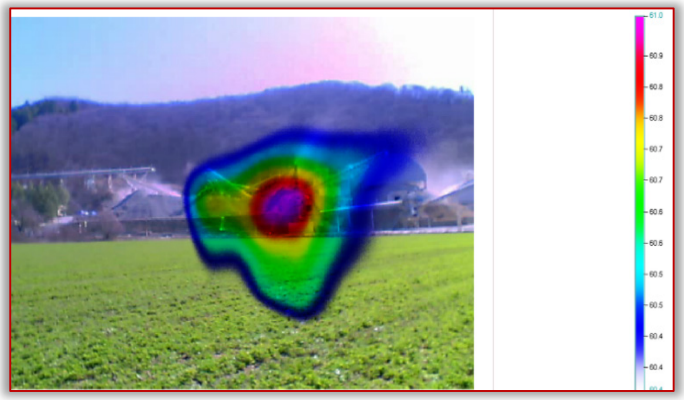

Figure 4. Noise visualization measurement of entire industrial area – south view

Figure 5. Noise visualization measurement of entire industrial area - west view

Results of these measurements clearly shows that the most critical parts of industrial area are secondary line - crushing and sorting lines.

Second series of noise visualizations measurements was focused to secondary line. These series of the measurement were realized from distances 50-70 m from the secondary line. Figures 6 - 8 show the noise emission of the visualized object over the entire frequency band. The presented acoustic images show the location of the integrated noise source

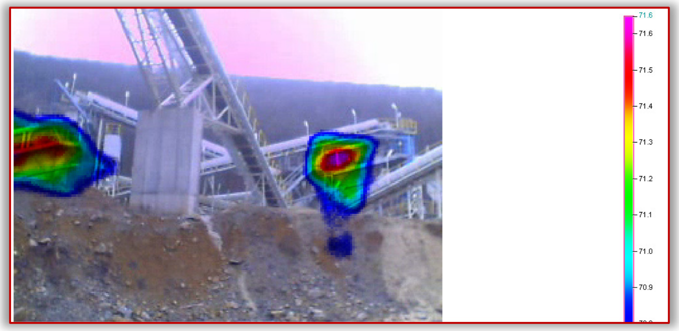

Figure 6. Noise visualization measurement of secondary line

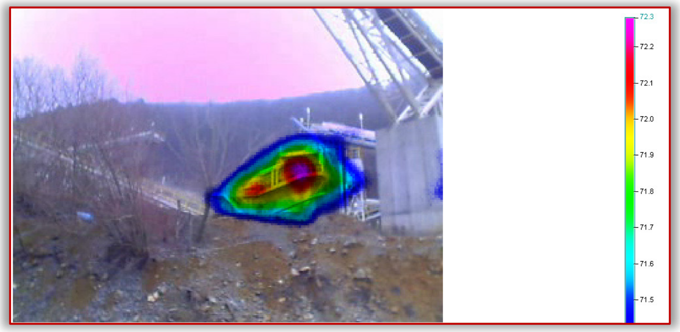

Figure 7. Noise visualization measurement of secondary line

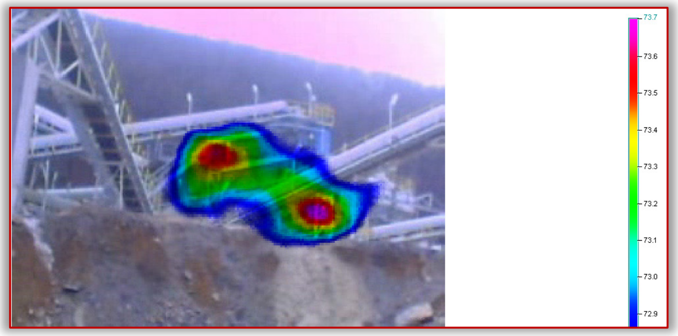

Figure 8. Noise visualization measurement of secondary line

Results of these measurements shows that the most critical of secondary line are crusher and sorter.

Third series of noise visualizations measurements was focused to individual parts of secondary line mainly (sorters and crushers). These series of the measurement were realized from distances 20-30 m from the secondary line. Figures 9-11 show the noise emission of the visualized object over the entire frequency band. The presented acoustic images show the location of the integrated noise source.

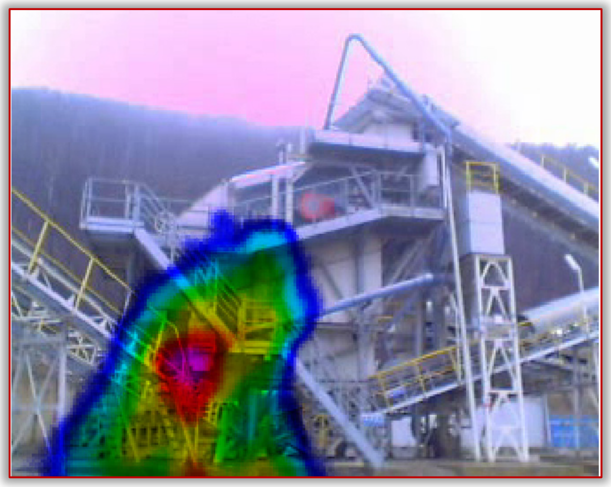

Figure 9. Noise visualization measurement of sorter 1

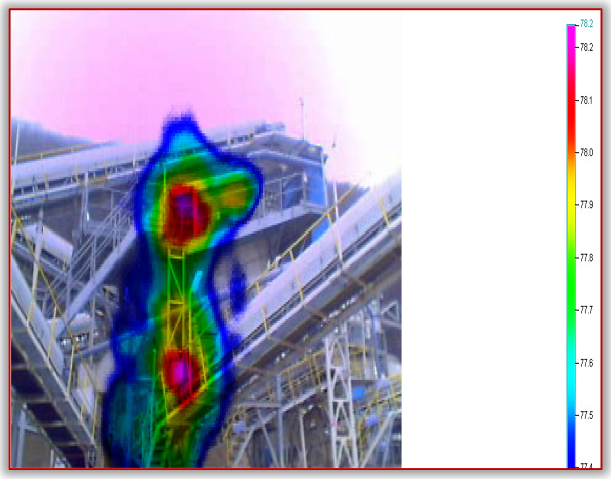

Figure 10. Noise visualization measurement of sorter 2

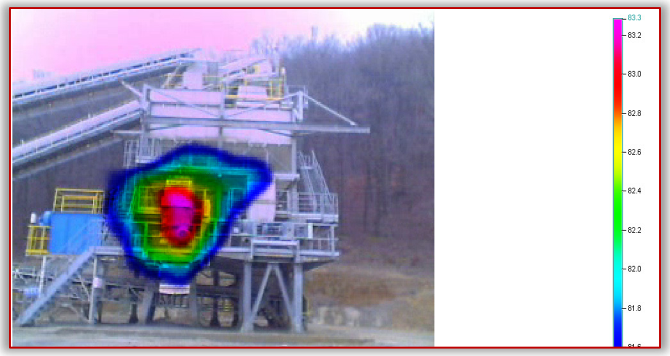

Figure 11. Noise visualization measurement of crusher

For better knowledge of noise character was generated spectrogram. Spectrogram shows dominant frequency bands of emitted noise (Figure 12).

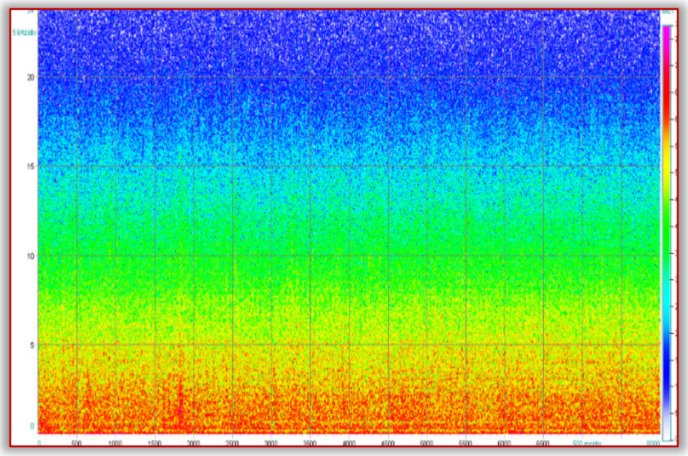

Figure 12. Noise spectrogram

CONCLUSIONS

Based on measurements of visualization of noise sources of the industrial site and secondary line we can state the following facts:

- for identification and localization of dominant noise source were realized progressive measurements from different distances,
- it has been confirmed that the secondary is the dominant source of noise due to the impact on the nearest residential zones,
- dominant noise sources (crushers and sorters) have been identified,
- specific critical points in terms of noise emissions are visualized and identified on individual objects,
- identified noise sources on these objects were confirmed by repeated measurements also from longer distances towards family houses,
- For all noise sources examined, the dominant frequency band is the frequency range from 20 - 2500 Hz, which is important in selecting suitable acoustically absorbing materials when implementing noise abatement measures.

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