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POSSIBILITIES OF USING THE COMBINED SENSOR OF PARTICLE VELOCITY AND ACOUSTICS PRESSURE

The increase in noise causes problems in recent years especially for people in mental health. This article discusses about sensor of Microflown, which is used to measure the speed of particles. Currently Microflown technology offers a breakthrough for noise and vibration testing, which are based on the speed of the acoustic sensor Microflown particles and also on measurement of temperature difference in cross-section.

Key words: *acoustics, noise, Microflown, sensor, particle velocity*

1. INTRODUCTION

The problem of noise as nuisance factor is in the last decades much discussed topic. The result is a rise in human population associated with economic growth and of use of equipment producing sound. The effects of noise pollution in urban areas have impact on human health and their comfort, what is the important reason to minimize all forms of noise pollution. [1] [4].

The sound is defined as acoustic percept caused by small pressure variations that are propagated in space or other elastic medium.

Microflown is acoustic sensor, which except for the sound pressure measured the speed of the particles in a flexible environment.

It is suitable for measuring direct unidirectional flows, which are used at particle velocity from 0 Hz. [2]

2. MEASURING PROBES OF MICROFLOWN

PU regular

Any sound field is described by two complementary acoustic properties, the scalar value 'sound pressure' and the vector value 'particle velocity'. The PU regular – Fig.1, can be used for a variety of applications such as the determination of sound intensity, sound power, acoustic absorption, sound leakages etc. The sensors are applicable to use in reverberant conditions and can be used within closed cavities, such as a car interior, the sensor is not having P/I (pressure over intensity) index problems. [3]

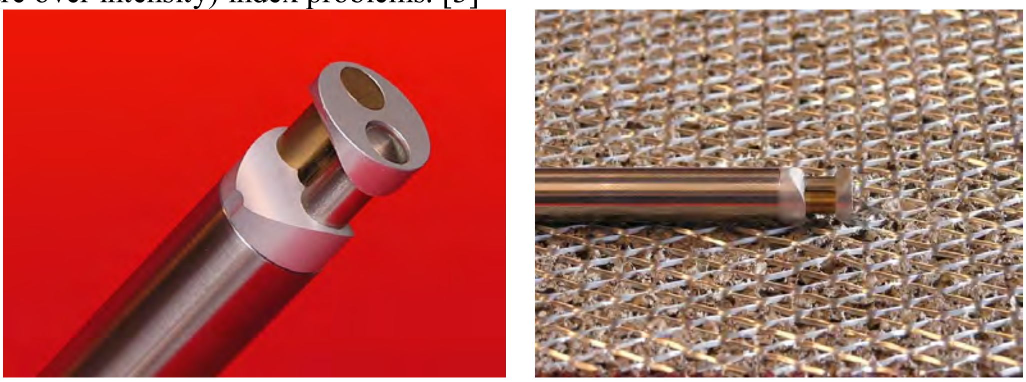

Fig. 1 PU regular [3]

PU mini

The PU mini – Fig. 2 can be used for a variety of applications but is mainly used in array applications such as scattered arrays for Panel Noise Contribution Analysis, free or fixed grid arrays for the Near Field Acoustic Camera etc. Also the determination of sound intensity, sound power, acoustic absorption can be done with the PU mini. [3]

Fig. 2 PU mini [3]

USP mini

The actual sensor configuration without its cap is less than 5×5×5mm³. Any sound field is described by two complementary acoustic properties, the scalar value 'sound pressure' and the vector value 'particle velocity'. The USP mini – Fig.3, probe is mainly used as an AVS (Acoustic Vector Sensor). Acoustic vector sensors have come to play an increasingly significant role in this technology with application focus on border control, harbor protection, gunshot localization, and situation awareness. Acoustic vector sensors have come to play an increasingly significant role in this technology with application focus on border control, harbor protection, gunshot localization, and situation awareness. It can also be used in the near field for 3D sound intensity, energy, power and acoustic impedance. [3]

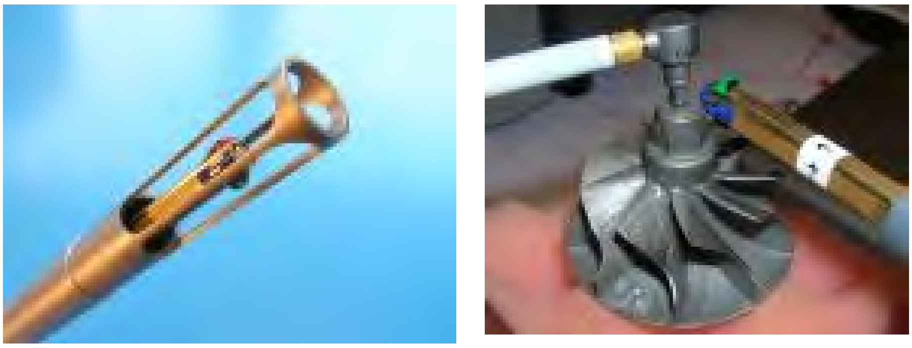

Fig. 3 USP mini [3]

3. ARRAYS

Technology of Microflown includes the arrays for performing acoustic measurements.

Hand held array

The hand held array – Fig. 4. is standard delivered with a 12 PU mini array for the purpose acoustic camera. The acoustic camera enables you to visualize sound as an acoustic pictures or video, displaying a color overlay as representation of the sound level. The acoustic camera can even visualize the sound pressure, particle velocity and sound intensity in real time [5].

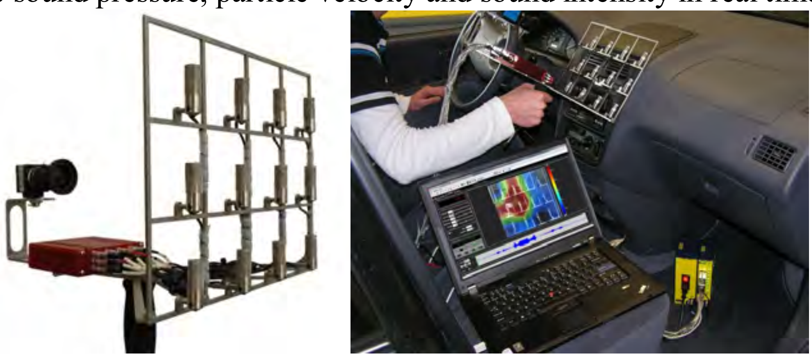

Fig. 4 Hand held array [5]

PU match array

If a high spatial resolution is an important criteria even on small objects, the sensor size and sensor spacing become critical. The PU match array – Fig.5 will be the suitable solution for these criteria. Acoustic pictures of small objects like miniature pumps, electric motors and many more can be generated easily and quickly. [5]

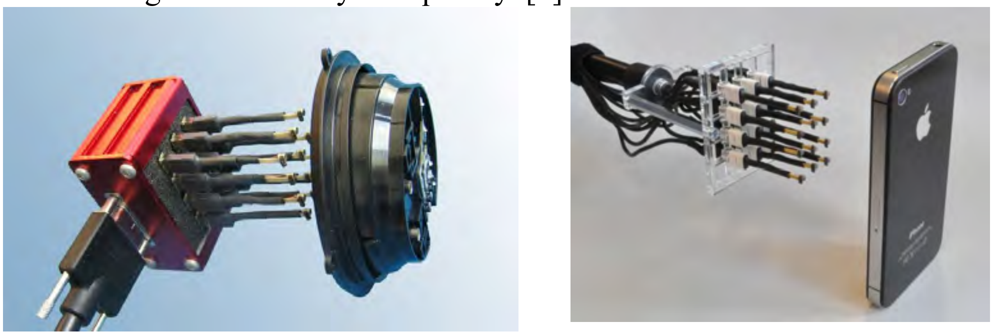

Fig. 5 PU match array [5]

Configurable array

The PU probe methodology allows a completely free configuration of the measurement point positions in the measurement grid. A finer mesh of PU probes can be placed at the position of interest, e.g. an expected acoustic hot spot, providing high resolution information [5]

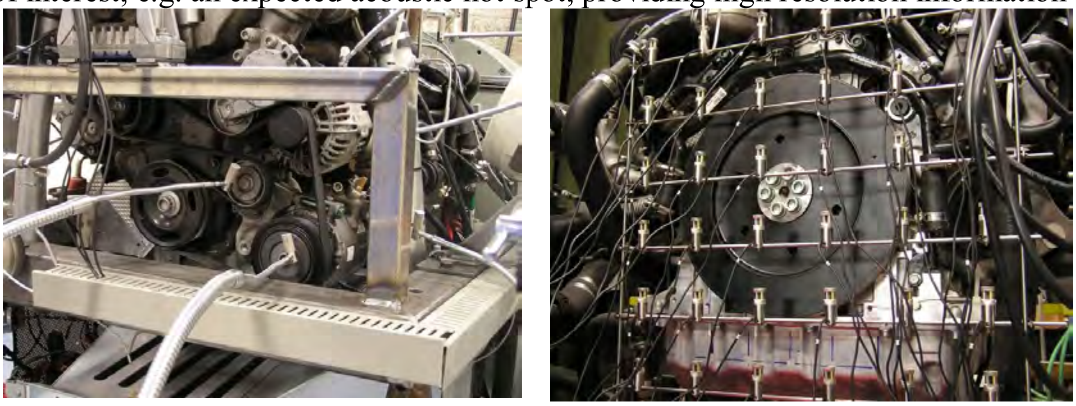

Fig. 6 Configurable array [5]

Scattered array

A scattered array is not like the other arrays, probes fixed on a grid, but the probes are mounted directly on the structure. This sometimes is needed because the shape of the object that needs to be measured is very curvy. A good example of the use for a scattered array is measurements inside a car so called panel noise contribution analysis. The mounting for the scattered array is designed in the way the PU mini probe is mounted vibration less from the to be measured surface so it doesn't move cohinside with the structure. This technique cans also being applied on other applications such as measuring sound intensity on very big structures. [5]

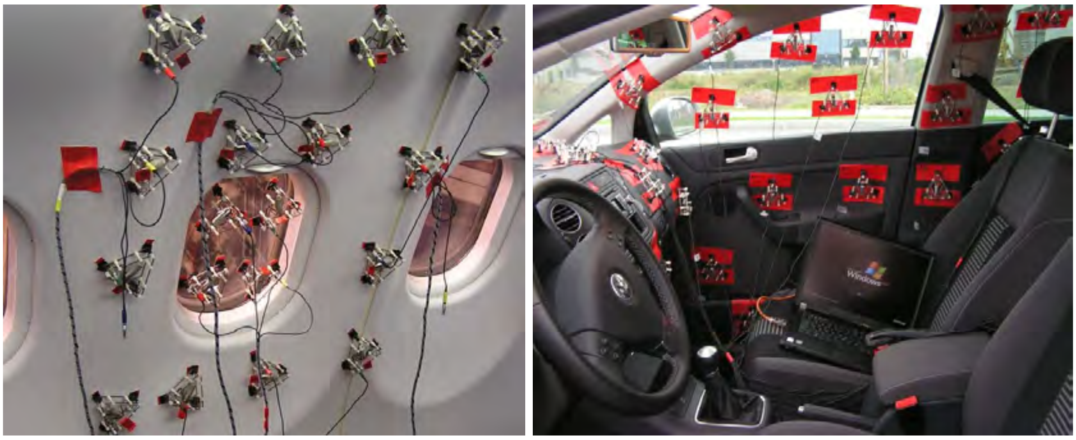

Fig. 7 Scattered array [5]

Cage array

An cilindrical cage array can be used with PU mini probes and USP mini probes. A special metal mesh is covering the probe for protection and also used as a wind shield. [5]

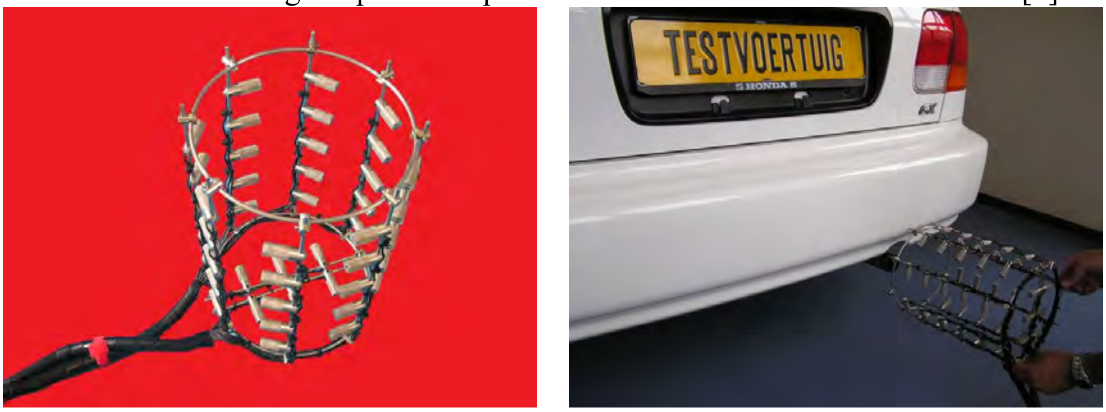

Fig. 8 Cage array [5]

4. APPLICATION POSSIBILITIES OF USING OF MICROFLOWN SENSORS

The techniques of surface impedance of free field can be used combined sensor of acoustic pressure and particle velocity (PU). Both sensors are located in one sheath, and in the measurement need to be placed in close proximity of the material being measured. Hand-held device for measuring the coefficient of sound absorption principle of sound pressure and particle velocity is shown in Fig.9. [6]

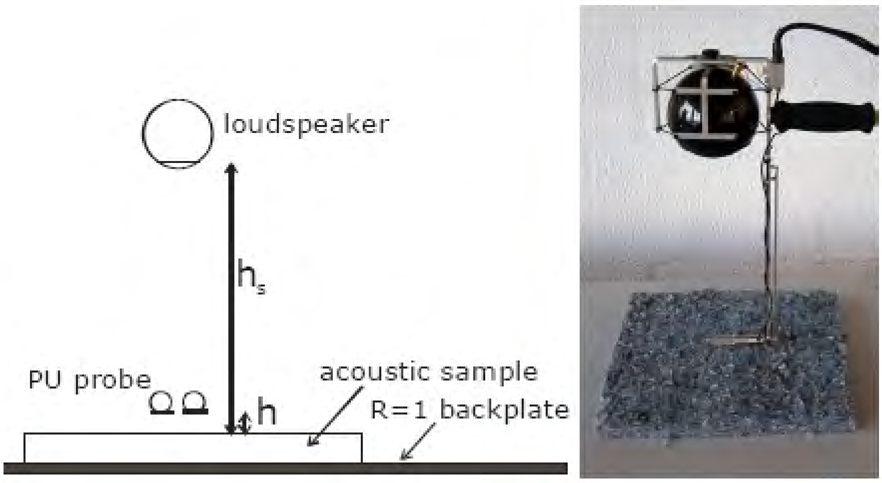

Fig. 9 PU probes and equipment [7]

The result of such measurements is the frequency dependence of the coefficient of sound absorption (α). Fig.10 shows the course of the α sound sample material which is used as the sound-absorbing lining of the appliances such as washing machines, driers or dishwashers. The measured dependence of sensor Microflown which was located 2,5 cm from the sample of material, is graphically compared with the mathematically calculated by simulation and measurement using Impedance (Kundt) tube with sensors to measure the sound pressure, thus a conventional microphone. Measuring the impedance tube may in this case as reference, because this method of measurement and evaluation of sound absorption coefficient considered more accurate. [6]

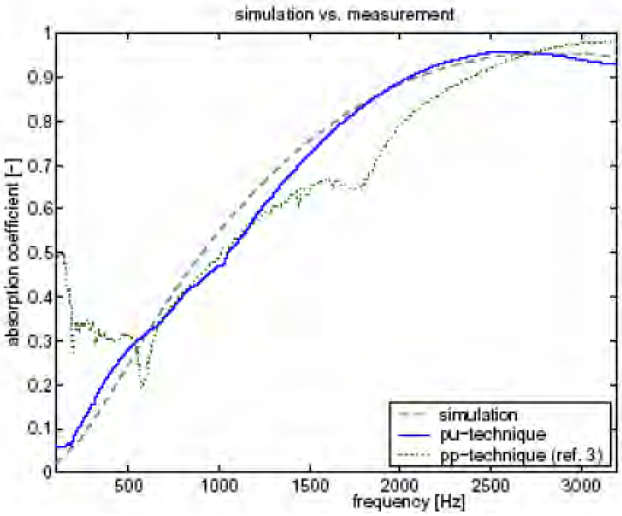

Fig. 10 Comparison of the results of measurements of sound absorption coefficient [7]

The results show that the technology is Microflown practically, suitable for determining the coefficient of sound absorption of acoustic materials in the frequency range of approximately 300 to 400 Hz to 10 kHz.

The next use of sensors Microflown the measurement and visualization of sound intensity, sound pressure and particle velocity.

In the Fig. 11 and 12 are shown the acoustic images of the vacuum cleaner. Acoustic images are created for sound pressure level (dB) and particle velocity recalculated to a dB. The biggest source of noise on vacuum cleaner is intake and exhaust air.

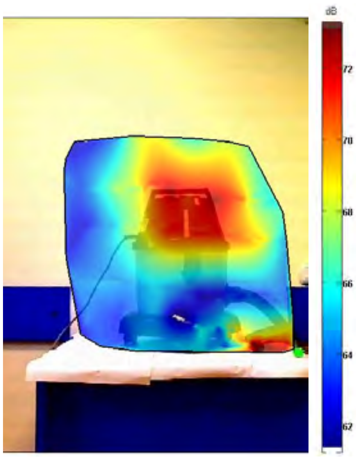

Fig. 11 The acoustic image wich represent sound pressure level (in dB) at frequency 4000 Hz

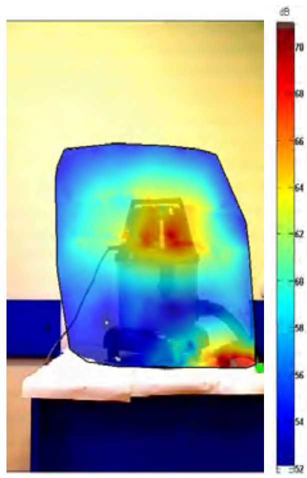

Fig. 12 The acoustic image wich represent particle velocity (in dB) at frequency 4000 Hz

In the figures, A, B and C are shown the acoustic images of the nozzle of vacuum cleaner. Acoustic images are created for sound pressure level (Pa) and particle velocity recalculated to a dB and sound intensity (W/m^2). It is clear that the largest source of noise is the air-intake to the nozzle.

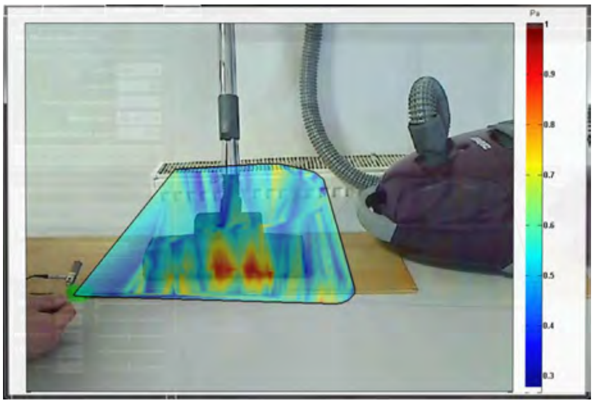

Fig. 13 The acoustic image wich represents sound pressure (in Pa) at frequency range 20 - 20000 Hz

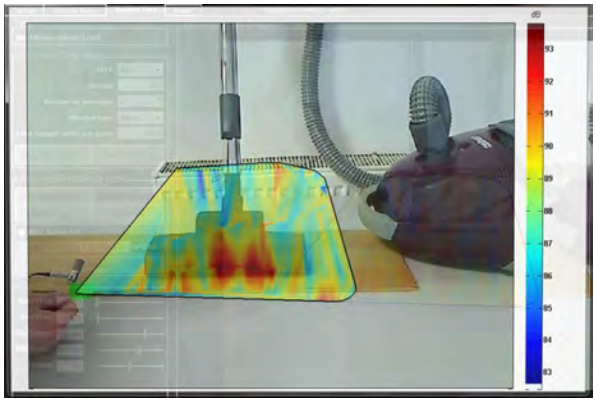

Fig. 14 The acoustic image wich represents particle velocity (in dB) at frequency range 20 - 20000 Hz

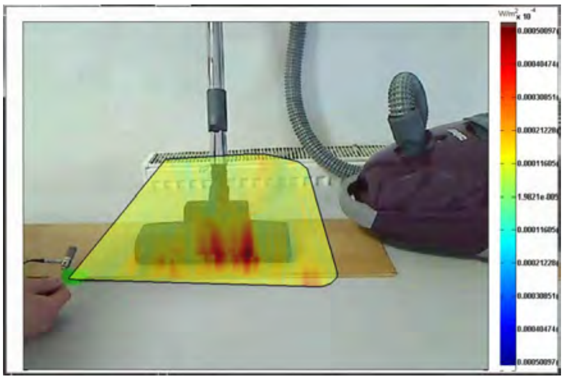

Fig. 15 The acoustic image wich represents sound intensity (in W/m2) at frequency range 20 - 20000 Hz

The frequency spectrum of the nozzle of vacuum cleaner calculated for sound intensity is shown on the fig. 16.

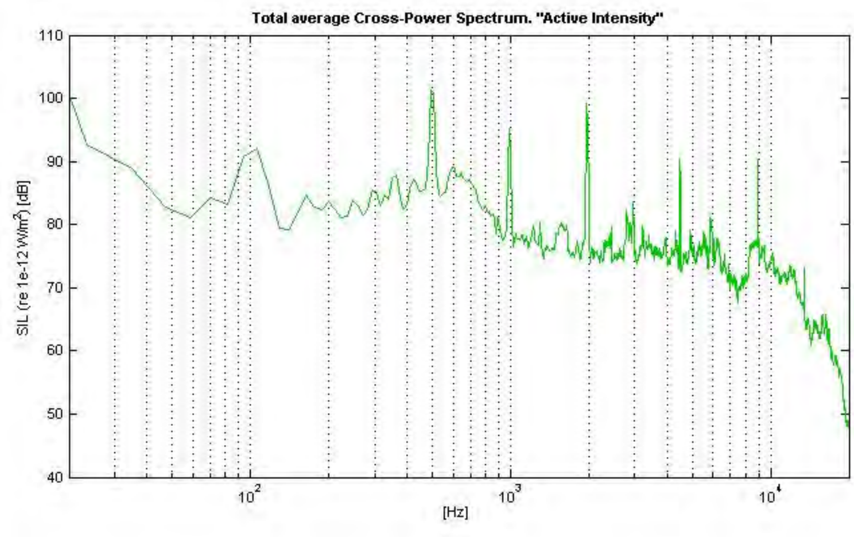

Fig. 16 Frequency spectrum of the nozzle of vacuum cleaner

5. CONCLUSIONS

Microflown is the sensor, which creates new opportunities in the field of acoustics. It is resistant to extreme conditions in the area that it generates no resonance because have not moving parts. Microflown is mainly used in an environment which is the conventional sensors greatly troubled. The article includes a practical part, which deals with the practical use of this sensor for measuring the coefficient of sound absorption materials and visualization of acoustic parameters for example sound intensity, particle velocity and acoustic pressure.

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Acknowledgements

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