Study on mechanics of bodies under the action of sound pollution in industrial halls. Part I: Setting away from local sources

I L Lăpuşan¹ and M Arghir²

¹ Department of Mechanical Engineering Systems, Technical University of Cluj-Napoca, Romania
² Department of Mechanical Engineering Systems, Technical University of Cluj-Napoca, Faculty of Building Machines, Cluj-Napoca, Romania

E-mail: ¹marghir@mep.utcluj.ro; marianaarghir@yahoo.com

Abstract. When they are generated in confined spaces (halls, meeting rooms, theatre, concert, lecture, etc.) the sounds of suffering typical wave phenomena: absorption, reflection, refraction, production of stationary wave phenomenon, beatings, diffraction. In this work, it is taking into account all these phenomena of sounds propagation in given space. Within the framework of the given research is a study in industrial park "Teraplast" from Bistriţa-Năsăud county. This is industrial products for pvc constructions. From the submissions made to the workshops of processing industrial park "Teraplast" has been found, that noise is produced mainly in the power pumps hall. The registrations were made during a normal working days. The recorders made, for one minute, with recorder type NL32 made by Japanese society RION, in the pump's hall 12 positions, and they were introduced in a high-capacity computer. Signal processing has been made by the use of Fourier series. Graphs resulting from recorders were processed in Matlab. By analyzing the results of measurements of pollution levels in the pump room from "Teraplast" proves the fact that at any frequency of operation of pump maximum acoustic pressure exceeds the admissible pressure inside the halls and is needed to reduce it in industrial application.

1. Introduction

The work starts with a few geometric requirements they need to fulfil an industrial Hall. Industrial hall, in which works people, provide the necessary volume of 6-8 m³ per person and about 30000 m³ per room. In order to avoid echo, is shown as the room height should be less than 10 m or, if it exceeds this value, then the ceiling must not be plane or concave with the outbreak in the floor plan. All to avoid stationary waves through multiple reflections and unwanted effects of acoustic ceilings must not be parallel to the floor, and the walls to be layered or make composite, with several layers of different materials, which to absorb or to deflect sound waves differently [1].

All geometric requirements listed in the previous paragraph are fulfilled by industrial Hall that investigations are made, and everything will be presented in this paper is accepted by the company management "Teraplast" in Bistriţa-Năsăud, they put at the disposal of investigators all construction documentation, field placement, positioning of the machinery inside the halls.

The result of the investigations was communicated to the company management, and that will take relevant measures, according to communicate data [3].

Content from this work may be used under the terms of the Creative Commons Attribution 3.0 licence. Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.

Published under licence by IOP Publishing Ltd.
2. Industrial park “Teraplast”
The study was conducted at the industrial park from “Teraplast”, Bistrița-Năsăud, a manufacturer of pipes and profiles made by PVC. The purpose of this study is to carry out the analysis of noise inside the halls of the industrial enterprise; the field is rendered location of figure 1.

![Image](image1.png)

Figure 1. In the field of industrial park “Teraplast”.

Workshops, for processing industrial park area, are bounded by the blue-roofed halls, which are also several which come into the middle-part of the figure 1. The workshops are divided [2]: 1. Hall feed pumps; 2. Hall line drawn PVC pipe; 3. Hall line drawn PVC profiles; 4. Workshop granule coated. From observations of the workshops processing industrial park "Teraplast" was found, that noise mainly produced in hall feed pumps, which although located in the south-west industrial park has the largest share in pollution sound and will therefore take account of hall space limited supply pumps in the study of pollution sound industrial.

![Image](image2.png)

Figure 2. Hall feed pumps positioned, with the notation from rectangle, thus: 1, 2, 3, 4, and 5 for Blower pumps; a, b, c, and d for Vacuum Blower pumps; x, y, and z for Coperion2 pump.
Registration noise was made by sound recorder, which has adequate controls (Figure 2). It was made simplifying assumption, through which the same type of pumps with reportophon was positioned in a certain place, it will behave in the same way for all the identical pumps.

3. Recording sound pollution supply pumps hall
Recording made, for one minute, with recorder type NL32 made by Japanese society RION, in the pump's warehouse positions appeared in Figure 2, were download in a high-capacity computer. Signal processing has been by the use of Fourier series. The graphs resulting from recording made were processed in Matlab and are playable in figures what follow [1].

Figure 3. Registration of point 1.

Figure 4. Registration of point 2.
In figure 3 is played FFT processing of recording from the point of measuring range also exists in processing 1. According to its there are given four maximum, which values represented in table 1.

| Crt. No. | Frequency [Hz] | Amplitude [dB] | Moment [s] |
|----------|----------------|----------------|------------|
| 1.       | 374,1          | 94,04          | 3.071      |
| 2.       | 2140           | 95,23          | 1.181      |
| 3.       | 702,5          | 95,85          | 33.78      |
| 4.       | 1421           | 102,9          | 55.98      |

Table 1. Highs pollution sounds recorded in point 1.

In figure 4 is placed the processing in FFT to recording from the measurement point 2. According to its there are 4 processing maximum, the values shown in table 2.

Table 2. Highs pollution sounds recorded in point 2.

| Crt. No. | Frequency [Hz] | Amplitude [dB] | Moment [s] |
|----------|----------------|----------------|------------|
| 1.       | 236,9          | 94,4           | 10.16      |
| 2.       | 1424           | 104,7          | 11.57      |
| 3.       | 799,4          | 93,35          | 25.28      |
| 4.       | 1425           | 104            | 50.79      |

In figure 5 is placed the processing in FFT to recording from the measurement point 3. According to its there are 3 processing maximum, the values shown in table 3.

Figure 5. Registration of point 3.

Table 3. Highs pollution sounds recorded in point 3.

| Crt. No. | Frequency [Hz] | Amplitude [dB] | Moment [s] |
|----------|----------------|----------------|------------|
| 1.       | 236,9          | 97,16          | 3.307      |
| 2.       | 699,8          | 89,8           | 26.46      |
| 3.       | 1424           | 104            | 43.23      |
In figure 6 is placed the processing in FFT to recording from the measurement point 4. According to its there are 3 processing maximum, the values shown in table 4.

**Figure 6.** Registration of point 4.

| Crt. No. | Frequency [Hz] | Amplitude [dB] | Moment [s] |
|----------|----------------|----------------|------------|
| 1.       | 239,6          | 93,37          | 0,2362     |
| 2.       | 1424           | 103,8          | 29,53      |
| 3.       | 799,4          | 97,02          | 52,68      |

**Table 4.** Highs pollution sounds recorded in point 4.

In figure 7 is placed the processing in FFT to recording from the measurement point 5. According to its there are 5 processing maximum, the values shown in table 5.

**Figure 7.** Registration of point 5.
Table 5. Highs pollution sounds recorded in point 5.

| Crt. No. | Frequency [Hz] | Amplitude [dB] | Moment [s] |
|----------|----------------|----------------|------------|
| 1.       | 374,1          | 95,26          | 2,362      |
| 2.       | 1424           | 105,5          | 4,016      |
| 3.       | 374,1          | 98,7           | 30,47      |
| 4.       | 8476           | 78,91          | 1,654      |
| 5.       | 1421           | 103,3          | 58,82      |

In Figure 8 is placed the processing in FFT to recording from the measurement point a. According to its there are 4 processing maximum, the values shown in table 6.

Table 6. Highs pollution sounds recorded in point a.

| Crt. No. | Frequency [Hz] | Amplitude [dB] | Moment [s] |
|----------|----------------|----------------|------------|
| 1.       | 352,5          | 97,09          | 1,417      |
| 2.       | 1421           | 104,1          | 1,89       |
| 3.       | 1421           | 103,5          | 47,95      |
| 4.       | 376,8          | 99,14          | 58,35      |

In Figure 9 is placed the processing in FFT to recording from the measurement point b. According to its there are 3 processing maximum, the values shown in table 7.

Table 7. Highs pollution sounds recorded in point b.

| Crt. No. | Frequency [Hz] | Amplitude [dB] | Moment [s] |
|----------|----------------|----------------|------------|
| 1.       | 376,8          | 99,95          | 0,01       |
| 2.       | 355,3          | 94,17          | 23,15      |
| 3.       | 1421           | 104            | 59,29      |

In Figure 10 is placed the processing in FFT to recording from the measurement point c. According to its there are 2 processing maximum, the values shown in table 8.
Figure 9. Registration of point b.

Figure 10. Registration of point c.

Table 8. Highs pollution sounds recorded in point c.

| Crt. No. | Frequency [Hz] | Amplitude [dB] | Moment [s] |
|----------|----------------|----------------|------------|
| 1.       | 355,3          | 97,68          | 1,181      |
| 2.       | 1424           | 102,9          | 56,46      |

Table 9. Highs pollution sounds recorded in point d.

| Crt. No. | Frequency [Hz] | Amplitude [dB] | Moment [s] |
|----------|----------------|----------------|------------|
| 1.       | 352,6          | 95,68          | 2,362      |
| 2.       | 3566           | 85,49          | 12,76      |
| 3.       | 355,3          | 91,26          | 48,9       |
| 4.       | 1424           | 105,4          | 59,29      |

In Figure 11 is placed the processing in FFT to recording from the measurement point d. According to its there are 4 processing maximum, the values shown in table 9.
In figure 12 is placed the processing in FFT to recording from the measurement point x. According to its there are 5 processing maximum, the values shown in table 10.

| Crt. No. | Frequency [Hz] | Amplitude [dB] | Moment [s] |
|----------|----------------|----------------|------------|
| 1.       | 374,4          | 95,26          | 2,362      |
| 2.       | 1424           | 104,5          | 4,016      |
| 3.       | 374,1          | 98,7           | 30,47      |
| 4.       | 4876           | 78,91          | 10,654     |
| 5.       | 1421           | 105,3          | 58,82      |

In figure 13 is placed the processing in FFT to recording from the measurement point y. According to its there are 4 processing maximum, the values shown in table 11.
Figure 13. Registration of point y.

Table 11. Highs pollution sounds recorded in point y.

| Crt. No. | Frequency [Hz] | Amplitude [dB] | Moment [s] |
|----------|----------------|----------------|------------|
| 1.       | 374,1          | 95,26          | 2,362      |
| 2.       | 1424           | 105,5          | 4,016      |
| 3.       | 374,1          | 98,7           | 30,47      |
| 4.       | 1421           | 103,3          | 58,82      |

In figure 14 is placed the processing in FFT to recording from the measurement point z. According to its there are 4 processing maximum, the values shown in table 12.

Figure 14. Registration of point z.
Table 12. Highs pollution sounds recorded in point z.

| Crt. No. | Frequency [Hz] | Amplitude [dB] | Moment [s] |
|----------|---------------|----------------|------------|
| 1.       | 234.2         | 92.06          | 1.181      |
| 2.       | 1424          | 105.3          | 1.184      |
| 3.       | 718.7         | 90.93          | 34.49      |
| 4.       | 2145          | 92             | 40.16      |

4. Conclusions regarding indoor sound pressure in pump supply hall

In this paper sets out the action of sound pressure produced by supply pumps into the Hall the 10 pumps within the enterprise "Teraplast". This is a processing factory for plastics materials, which realises contestants’ pipe dimensions and different profiles.

The enterprise is in the immediate neighbourhood of Bistrita municipality, why it was needed in the evaluation of noise pollution on this undertaking particularly factory of plastics, it produces in near the area of residential district.

With a tape recorder was marked the noise in the hall of power supply pumps, with which it was conducted analysis in the frequency of registrations, from which resulted the frequencies, which have maximum amplitudes during pumps activity.

From the tables shown results in the following any frequency operating the fuel pump pressure acoustic maximum playing escapes pressure acoustic admissible inside industrial plants (which you had to exceed 85dB) as European standardization, which is applied in Romania as a national standard.

5. References

[1] Lăpușan I L and Arghir M 2013 Studii şi cercetări privind poluarea fonică în mediul industrial Știință și Inginerie 24 pp 267 – 272
[2] Lăpușan I L and Arghir M 2014 Studii şi cercetări privind poluarea sonoră în mediul industrial Știință și Inginerie 26 pp 161-168
[3] Lăpușan I L and Arghir M 2014 The Present Stage of Noise Pollution in Industrial Environment Acta Technica Napocensis: Applied Mathematics, Mechanics, and Engineering 57(II) pp 239-244
[4] Lăpușan I L and Arghir M 2015 Contributions to the Experimental Study on the Sound Pollution in Industrial Environment – Theoretical Justification Acta Technica Napocensis: Applied Mathematics, Mechanics, and Engineering 58(IV) pp 597-600
[5] Lăpușan I L and Arghir M 2015 Contributions to the Experimental Study on the Sound Pollution in Industrial Environment – Measurements Acta Technica Napocensis: Applied Mathematics, Mechanics, and Engineering 58(IV) pp 601-604