



Centrul de Cercetare Avansată pentru Calitatea Ambientală
și Fizica Clădirilor
Departamentul Sisteme Termo - Hidraulice și Protecția Atmosferei
Facultatea de Inginerie a Instalațiilor

NOISE LEVEL PREDICTION INSIDE TECHNICAL SPACES

Thesis SUMARRY

Scientific coordinator,

Phd. Eng. Iordache Vlad

Student,

Eng. Bailescu Catalin

CONTENTS

Chapter 1. Introduction	Error! Bookmark not defined.
1.1 The importance and topicality of the subject	Error! Bookmark not defined.
1.2 Research objectives	Error! Bookmark not defined.
1.3 Content of work.....	Error! Bookmark not defined.
Chapter 2. Bibliografy study	Error! Bookmark not defined.
2.1 Introduction	Error! Bookmark not defined.
2.2 Introduction in building acoustics	Error! Bookmark not defined.
2.2.1 Acoustic wave lenght equation	Error! Bookmark not defined.
2.2.2 Acoustic levels	Error! Bookmark not defined.
2.2.3 Reverberation time	Error! Bookmark not defined.
2.2.4 Equivalent noise level	Error! Bookmark not defined.
2.4 Noise generating thermal plant equipment.....	Error! Bookmark not defined.
2.5 Noise level prediction.....	Error! Bookmark not defined.
2.5.1 Noise level prediction - Cyssau.....	Error! Bookmark not defined.
2.5.2 Noise level prediction - Hamayon.....	Error! Bookmark not defined.
2.5.3 Noise level prediction - Malcolm J. Crocker și David A. Bies	Error! Bookmark not defined.
2.5.4 Noise level prediction - Stanislav Ziaran	Error! Bookmark not defined.
2.5.5 Noise level prediction - INCON INSTITUTE – HRSG software...	Error! Bookmark not defined.
2.5.6 Prediction of the noise level produced by other equipment in the thermal plant.....	Error! Bookmark not defined.
2.6. Noise protection solution	Error! Bookmark not defined.
Chapter 3. Experimental study	Error! Bookmark not defined.
3.1 Introduction	Error! Bookmark not defined.
3.2 Experimental study method.....	Error! Bookmark not defined.
3.3 Experimental campaign. Description	Error! Bookmark not defined.
3.3.1 CT VEOLIA Bucov Ploiești Analysis	Error! Bookmark not defined.

3.4 Creating data base**Error! Bookmark not defined.**

Chapter 4. Preliminary analysis of the experimental database experimentale
.....**Error! Bookmark not defined.**

4.1 Graphic representation of points in database**Error! Bookmark not defined.**

4.1.1 Graphic representation of volume and thermal power**Error! Bookmark not defined.**

4.1.2 Graphic representation of reverberation time T30kHz and thermal power **Error! Bookmark not defined.**

4.1.3 Graphic representation of reverberation time T30kHz and volume **Error! Bookmark not defined.**

4.1.4 Graphic representation of thermal power and reverberation time... **Error! Bookmark not defined.**

4.2 Preliminary observations.....**Error! Bookmark not defined.**

4.2.1 Verification of CZ80**Error! Bookmark not defined.**

4.2.2 Verification of the permissible limit of the internal equivalent noise level **Error! Bookmark not defined.**

4.3 Distribution of measurements**Error! Bookmark not defined.**

4.4. Clases of thermal power plants**Error! Bookmark not defined.**

4.4.1 Full database.....**Error! Bookmark not defined.**

4.4.2 Burner AI with/without case**Error! Bookmark not defined.**

4.4.3 Burner AI with/without acoustic treatment of the wall.....**Error! Bookmark not defined.**

4.4.4 Burner AI with/without desolidarisation.....**Error! Bookmark not defined.**

4.4.5 Burner AI with/without desolidarisation with foundation **Error! Bookmark not defined.**

4.4.6 Burner AI with/without external pumps**Error! Bookmark not defined.**

4.4.7 Burner AI with/without flexible gas duct.....**Error! Bookmark not defined.**

4.4.8 Burner AI with/without desolidarisation with elastic methal **Error! Bookmark not defined.**

Chapter 5. Statistical analysis.....**Error! Bookmark not defined.**

5.1 Database adimensionalisation**Error! Bookmark not defined.**

5.1 Full database.....**Error! Bookmark not defined.**

5.1.1 Compare reliminary statistical value and the Smirnov – Kolmogorov normality test	Error! Bookmark not defined.
5.1.2 Correlation between the output and input parameters.....	Error! Bookmark not defined.
5.2 Small thermal plant - CM.....	Error! Bookmark not defined.
5.2.1 Compare preliminary statistical value and the Smirnov – Kolmogorov normality test	Error! Bookmark not defined.
5.2.2 Correlation.....	Error! Bookmark not defined.
5.3 Athmosferic burner database - AA.....	Error! Bookmark not defined.
5.3.1 Compare preliminary statistical value and the Smirnov – Kolmogorov normality test	Error! Bookmark not defined.
5.3.2 Correlation.....	Error! Bookmark not defined.
5.4 Force air intake burner database - AI.....	Error! Bookmark not defined.
5.4. Compare preliminary statistical value and the Smirnov – Kolmogorov normality test	Error! Bookmark not defined.
5.4.2 Correlation.....	Error! Bookmark not defined.
5.5 Force air intake burner databa, without case - AI FC	Error! Bookmark not defined.
5.5.1 Compare preliminary statistical value and the Smirnov – Kolmogorov normality test	Error! Bookmark not defined.
5.5.2 Correlation.....	Error! Bookmark not defined.
5.6 Force air intake burner databa, with case - AI CC	Error! Bookmark not defined.
5.6.1 Compare preliminary statistical value and the Smirnov – Kolmogorov normality test	Error! Bookmark not defined.
5.5.2 Correlation.....	Error! Bookmark not defined.
Chapter 6. Mathematical modelling	Error! Bookmark not defined.
6.1 Mathematical modeelling of full databsae BD.....	Error! Bookmark not defined.
6.1.1 Linear regression - Model 1	Error! Bookmark not defined.
Residue analysis.....	Error! Bookmark not defined.
Testing model 1 on testing database	Error! Bookmark not defined.
6.1.2 Linear regression - Model 2	Error! Bookmark not defined.
6.1.3 Multiple linear regression.....	Error! Bookmark not defined.

6.1.4 Comparations of 3 models.....	Error! Bookmark not defined.
6.2 Regressions – BD AI (CC+FC) modelling	Error! Bookmark not defined.
6.2.1 Linear regression - Model 1	Error! Bookmark not defined.
Testing model 2 on testing database	Error! Bookmark not defined.
6.2.2 Multiple linear regression - Model 2.....	Error! Bookmark not defined.
6.2.3 Multiple linear regression - Model 3.....	Error! Bookmark not defined.
6.2.4 Comparations of 3 models.....	Error! Bookmark not defined.
6.3. Regressions – BD AI FC modelling.....	Error! Bookmark not defined.
6.3.1 Linear regression - Model 1	Error! Bookmark not defined.
Testing model 3 on testing database	Error! Bookmark not defined.
6.3.2 Multiple linear regression - Model 2.....	Error! Bookmark not defined.
6.3.3 Multitple linear regression - Model 3.....	Error! Bookmark not defined.
6.3.4 Comparation of 3 models	Error! Bookmark not defined.
6.4 Compare different model clases	Error! Bookmark not defined.
6.4.1 Compare complexity of the model	Error! Bookmark not defined.
6.4.2 Compare clases of the model	Error! Bookmark not defined.
6.4.2 Compare with existing prediction models in literature.	Error! Bookmark not defined.
Capitolul 7. Contribution in assessing the influence of acoustic treatment inside thermal power plant and the positioning of measurements point in tehnical spaces	Error! Bookmark not defined.
7.1 Acoustic map of CASA PRESEI	Error! Bookmark not defined.
7.1.1. Location.....	Error! Bookmark not defined.
7.1.2. Architectural presentation of the tehnical space	Error! Bookmark not defined.
7.1.3. Thermal power plant equipment	Error! Bookmark not defined.
7.1.4. Acoustic protection	Error! Bookmark not defined.
7.1.5 Experimental part and data processing.....	Error! Bookmark not defined.
7.1.6 Conclusions	Error! Bookmark not defined.
7.2 Influence of the position of acoustic insulation on the reverberation time and noise level in a large classroom.....	Error! Bookmark not defined.

7.2.1 Introduction	Error! Bookmark not defined.
7.2.3 Acoustic simulation.....	Error! Bookmark not defined.
3. Results	Error! Bookmark not defined.
7.2.4 Results of reverberation time without acoustic insulation	Error! Bookmark not defined.
7.2.5 Acoustic insulation treatment result	Error! Bookmark not defined.
7.2.6. Conclusions	Error! Bookmark not defined.
8. Conclusions chapter. Personal contributions and the future research directins	Error! Bookmark not defined.
8.1 General conclusions	Error! Bookmark not defined.
8.2 Personal contribtuion.....	Error! Bookmark not defined.
8.3 Future research direction	Error! Bookmark not defined.
BIBLIOGRAFY	Error! Bookmark not defined.

The purpose of this paper is to predict the noise level inside the central heating from the design phase using a simple calculation, available for every engineer. this model was determined from a database created from experimental campaigns, spread over several years and several seasons. The novelty brought by this prediction model, different from the other models from literature , is given by the fact that the database, which is the base of the model, was created by analizing some modern central heating, and the error given by the new model is lower and clearly explained than the existent models.

This paper consists of 5 main chapters, precedeed by am introductory chapter and the final chapter of conclusions.

Chapter 2 is represented by a bibliographic study in which were presented basic accoustic concepts noise standards from Romania and other countries, the prediction models of noise from the inside of the technical spaces, noise-making equipaments in central heating and the noise protection solutions applicable in such spaces.

In the third chapter, dedicated to the experimental part, were evidentiatiated the methodes used in the making of these measurement, the description of how the experiments worked, the creation of the database and, ultimately, the interpretation of this database.

This chapter presents the way in which worked the experiments in the technical spaces, how the measurement were made and which were the measured parameters. Also, the equipments and the softwares used were presented, the punctual notes of the influence of parameters on the others' determination. Next, this chapter contains a description of the experimental campaign and its components, as: the inspections made in each and every space, the period and the season in which these were made, the description of the measurement sequel, and in the and the result- the database and its interpretation.

In chapter 4, was studied the created database ,graphically represented and interpreted the values of the weighted global equivalent noise- $L_{Aeq}[dBA]$ compares to the measured parameters – P_{ar} [kW], V [m³] si $T_{30}[s]$, and then the measured values of L_{Aeq} will be compared to the predicted values with models from the literature. The next step is represented by studing the created database, it was graphically represented the values of the weighted global equivalent noise level. The static analysis begun with chapter 5, respectively by the normality test Smirnof Kolmogorov, and for the normally distributed models were analyzed the correlation coefficients..

Analiza statistică a debutat prin capitolul 5, respectiv prin testul de normalitate Smirnof Kolmogorov, iar pentru modelele normal distribuite s-au analizat coeficienții de corelație.

The statistical analysis started with chapter 5, respectively with the Smirnof Kolmogorov normality test, and for the normally distributed models the correlation coefficients were analyzed. In this chapter we will present the statistical analysis of the databases for the classes of thermal power plants presented in the previous chapter. For each class, using the statistical analysis software - SPSS, the preliminary statistical values, the deviations between the cumulative and the measured distributions for the L_{Aeq} parameter, and then the correlations of the measured parameters were calculated. The classes of thermal power plants presented in Chapter 4 were statistically analyzed

Chapter 6 is represented by mathematical models, after which new models were obtained and subsequently tested. This chapter will present the mathematical modeling of the databases for the boiler clases obtained from the experiments: the complete database, the blown air burner database and the blown air burner database without housing.

The last chapter is dedicated to the influence of acoustic treatments inside thermal power plants and the position of measuring points inside technical spaces. It is the answer of the observations received following the claims of the Research Report 2, it was considered the presentation of an action at a thermal power plant, from which to show the way of distributing the noise inside.

