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Lithuanian acousticians: activities and future plans

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Introduction

The most active Lithuanian acousticians are united under the Acoustical Society of Lithuania (LAS) that was established nine years ago. Lithuania, the first of the Baltic countries, declared the restoration of its Independence on March 11, 1990 and was the first to rally the Lithuanian acoustical scientists into the Acoustical Society of Lithuania (July 8, 1990). In the year 2000 the Lithuanian scientists will celebrate it's the first ten-year anniversary. During the said period the Lithuanian acoustical scholars not only managed to be in the vanguard, making attempts to break the ice through the years of stagnation years, but also are known world-wide as those who disseminated new creative ideas and inventions. Sound propagation in cylindrical pipes and the ways of its reduction have been investigated rather extensively. Ultrasound investigation systems and devices for their practical application are being created. The First Baltic-Acoustic Conference to be held on September 17-21 invites not only all acoustical scholars from the Baltic countries, but also the scientists from various countries of the world, who are interested in the science of acoustics and the generation of new ideas in this branch of science.

The conference will take place in the centre of Vilnius, capital of Lithuania, in the Congress House, with best hotels, other scientific and cultural sights, and museums, located nearby.

Paraphasing the commonly accepted saying, it is better to come once than to read hundred times. Therefore the acoustical scientists from the entire world are invited to the first Lithuanian International Conference “Baltic-Acoustic”, dedicated to the anniversary of the Acoustical Society of Lithuania.

Distribution of Acoustical Science by the Fields of Acoustics

In accordance with the LAS Statute the acousticions pursue their activities according to groups.

The LAS was established in 1990 after the reestablishment of Lithuania's independence and was named the Acoustical Society of Lithuania, rallying numerous Lithuanian scientists and practical specialists working in the sphere of acoustics. The main body consists of higher school lecturers and specialists from designing institutions. Vilnius University scientists-physicists are involved in solving acoustoelectronic problems. Here the acousto-resistant phenomenon was discovered, i.e., the change in semiconductor resistance under the action of an acoustical wave. The scientists of the Kaunas University of Technology have established the ultrasound laboratory, solving urgent problems relevant to ultrasound measurement and development of instruments and systems, e.g., measurement of impulsive ultrasonic fields generated by an electric discharge, etc.

Vilnius Technical University and Lithuanian Agricultural Academy solve issues pertaining to the reduction of production noise. Here special attention is accorded to the problems of sound insulation and noise reduction in pipes.

With a collapse of the Soviet system, the industry that was backward in terms of technology went bankrupt, new technologies have been created slowly, resulting in the diminishing number of noise control solutions. Quite many qualified scientists lost orders in the sphere of acoustics and shifted to other jobs, this causing a problem to the development of acoustical science and the improvement of qualification of specialists in the sphere of fight against noise.

This report deals with the above-mentioned and those issues that are pertaining to the works and problems of Lithuanian acoustical researchers. In 1997, the Lithuanian Acoustical Congress was held; the Statute and the name of the organization were changed.

Now the organization is named the Acoustical Society of Lithuania. Prof. D. Gužas, the author of this report has been elected its President. Our Society is a member of the European Acoustics Association. Currently, when the need exists to integrate into the Western acoustic science, our organization as never before expects the Western assistance in the preparation of new acoustical specialists and stimulation of the implementation of the science of acoustics.

Quite a number of Lithuanian acoustical experts feel frustrated, since they do not see any prospects in the science of acoustics. Therefore, much is needed to be done in the education and information areas. Without the assistance extended by the world acoustical scientists we will not be able to cope with the existing problems.

There are eight main groups in it. They are:

- Architectural and constructional acoustics.
- Physical acoustics and acoustical electronics.
- Ultrasound physics and technique.
- Ultrasound in medicine and biology.
- Electroacoustics.
- Musical and speech acoustics.
- Oscillation and industrial noise.
- Environmental noise.

Architectural and constructional acoustics applies known theoretical methods into practice. Since 1960 Vilnius State University is engaged in physical acoustics and acoustoelectronics. Acoustic-electronical phenomena in semi-conductors have been developed in the laboratory of molecular acoustics headed by academician Povilas Brazdžiūnas by using high frequency ultra sound and hypersound waves. Surface acoustical waves have been used for the research work carried out by the University scientists. Great results have been achieved in the investigation of Seignette electrical materials by acoustical waves and in the analysis of integral acoustooptical phenomena. The application of these results in micro and optical electronics are well known all over the world. The initiator of acoustic-electronical investigations in Lithuania is the doctor of sciences Prof. Evaldas Garška. At present there is a great number of his followers. Their scientific achievements are applied in microelectronics and optical electronics as well as in development of various devices.

The third group deals with ultrasound physics and technics. This group includes the scientists of Kaunas Technological University. In 1960 by the initiative of Prof. K. Baršauskas the Ultrasound Laboratory was established in the former Kaunas Politechnical Institute. The main trend of this laboratory at present is to improve the methods and technics of ultrasound spectrometry. At present this laboratory is named Prof. K. Baršauskas Ultrasound Research Center and is headed by Prof. R.J. Kažys.

The group of ultrasound in medicine and biology investigates the use of ultrasound means in medicine and biology. Special devices are constructed.

Musical and speech acoustics is being investigated by the scientists of Lithuanian Music Academy and by some scientific industrial enterprises. Training appliances are prepared, musical instruments are constructed and made in the Music Academy. Computer music is created, musical programs and technical means for computer music are designed.

Much is being done in the sphere of oscillation and industrial noise reduction. Some trends are seen here. There is a Research Centre "Vibrotechnika" headed by Prof. V. Snitka under the leadership of Prof. K. Ragulskis at Kaunas Technological University. In 1964 first experiments in the field of sound reduction in Lithuania were carried out there. At present this scientific sector "Vibrotechniques" is busy in the field of precise vibrotechnics, noise reduction problems are being analysed parallelly too. There is an occupational safety department and scientific laboratory at the University too. Industrial noise and oscillation reduction problems are being investigated and practical questions ordered by enterprises are being solved.

Vilnius Technical University and Lithuanian Agricultural University deals with the perfection of environmental noise reduction methods. Some departments are dealing with this problem. I would like to give a more detail description of the scientific department, which I am heading. Our scientific group investigates theoretical and experimental problems of noise reduction of transportation systems run by gas, air and other materials, compressors, pipes and their elements. There are some works on sound insulation by limited plates. This problem deals with plane wave passing through a limited plate with hinge fastened edges, located in a rigid screen. The problem of sound insulation by multilayer barriers is solved too.

Sound wave propagation of cylindrical shell, sound insulation of cylindrical duct and shells having different fastenings have been studied.

It is to be noted, nevertheless, that at present especially active are two fields of science, namely ultrasound and noise and vibration control.

The spheres of the development of ultrasound science

The science of ultrasound is developed at Vilnius University and Kaunas Technological University. The scientific trend of acoustoelectronics was developed at Vilnius University, where Prof. E. Garška and co-workers achieved significant results. The said group of scientists succeeded in discovering an acousto-resistant phenomenon, i.e., the change in semiconductor receptivity under the effect of an acoustical wave. The development of acoustical research covers the following areas:

– research of semiconductor properties by acoustical methods;

– stimulation of catalytic chemical reactions by acoustical waves;

– investigation of acoustical photoelectrons and super sonic properties of crystals;

– investigation of acoustooptical phenomena in integral optical compounds.

To-date new areas of activity are being developed: investigation of acoustical properties of non-homogeneous and biological compounds, acoustic spectroscopy of porous and granular materials, simulation of architectural acoustics, ultrasound adaptation in non-traditional energetics.

Kaunas Technological University is involved in investigating ultrasound processes and in creating instruments and systems for investigating these processes, for example:

- ultrasound non-destruction testing;
- acoustic imaging;
- acoustic transducers (theory and practice), and
- ultrasonic measurements in industry and science.

Some of these instruments are more perfect than in Western countries, others are of entirely new construction.

The Ultrasound Biomedical Engineering Laboratory of the Kaunas Technological University conducts works in ultrasound diagnostics and carries out investigations of precise ultrasound measuring in medicine. The aforementioned laboratory jointly with the Universities from Germany and Denmark participated in the Tempo Project No. JEP-4949-95, intended for preparing curricula in physiology. This laboratory is headed by prof. A. Lukoševičius.

Kaunas Technological University established the Ultrasound Research centre, investigating ultrasound measurement and development of instruments.

Here three scientific groups work:

1. Scientific group – Ultrasound measurement technology and non-destructive control. Head – prof. R. J. Kažys.

The group carries out research in the sphere of ultrasound industrial measurement, non-destructive control, fundamental research measurement and signal processing [1]. Now most attention is devoted to the development of computerized non-destructive control systems, intended for nuclear power plants and chemical industry. The work currently carried out by the group:

Development and investigation of ultrasonic measurement systems.

Modelling and processing of ultrasonic signals.

Development of high diversity ultrasound methods for analysis of the structure of biological.

Development of the system of express-analysis for zirconium tube diameter and wall thickness of the nuclear fuel channels.

Development of smart ultrasonic sensors for navigation of mobile robots (INCO-COPERNICUS project).

2. Scientific group – Development of acoustical methods and electronic devices for investigation of physical-mechanical properties of materials. Head – Dr. A.Petrauskas.

2.1. Investigation and application of the properties of propagation of quasi-surface and quasi-Lamb waves.

2.2. Development and investigation of acoustical measuring systems for control of technological processes of the food industry.

2.3. Investigation of inhomogeneous ultrasound wave propagation at the boundary of two-phase structure.

2.4. Ultrasound level meters for reservoirs.

3. Scientific group – Flow diagnostics. Head – Dr. J.Butkus.

The journal "Ultrasound" has been revived, and the Prof. K. Baršauskas Ultrasound Research Center under Prof. R.J. Kažys started its regular publication. Prof. R.J. Kažys improved his qualifications in France and Sweden, where he was recognized as an active scientist with innovative ideas. These ideas receive their implementation in the said Ultrasound Research Center. The material on the implementation of his ideas you will find in this report and the issues of the journal "Ultrasound", where you can also find reports on other trends of acoustical science, including noise and vibration control.

Noise and vibration control

Noise is one of the main factors, having a harmful effect on human health. A prolonged effect of intensive noise on main is the cause of partial or complete loss of his hearing. Noise, affecting the central nervous system, is the cause of fatigue, insomnia, it increases nervous tension, inhibits the creative activity, reduces the efficiency of work as well as the intensity of recreation.

As the contemporary investigations evidence, the high level of noise, having an impact on man, is the cause of numerous cardiovascular, stomach and nervous diseases.

The noise of industrial and agricultural enterprises as well as urban noise have a tendency towards increasing, since new technological processes that are put into production are not so perfect as not to make noise. The capacity of machines, the number of their rotation and the level of mechanization are increasing both in towns and in the countryside. All that augments the level of industrial noise. New technologies will be implemented at the agricultural enterprises of the Republic of Lithuania, the level of their mechanization will increase. To date in agriculture ventilators of various purposes, pumps, compressors, technological pipings are in operation, they propagate additional technological noise to the environment and increase the general level of noise in agricultural production. Under such circumstances the necessity arose to conduct quite a number of field research and to steer the preparation of technical measures to the tackling of problems concerning the protection of man from noise.

Noise may be reduced in many ways. The most effective method of noise abatement is its reduction in the source of its rise. However, due to technical and economic difficulties the application of this method is impossible in many cases.

Issues related to noise reduction of technological equipment and noise control at industrial and agricultural enterprises cannot be solved without creating and developing new means and methods for control noise.

Many scientists in the sphere of acoustics and other branches are involved in noise and vibration control problems.

In the Lithuanian Agricultural University, professors and associate professors, including Prof. P. Ilgakojis, Ass.-Prof. J. Deikus, S. Merkevičius and others, work successfully in this sphere.

In Vilnius Gediminas Technical University work is undertaken in environmental noise control and acoustics of buildings. Many chairs and laboratories have done considerable work in this trend. One of the main chairs where the science of acoustics has been developed is the Professional Improvement Center and by the staff of the Research Center "Vibrotechnika".

All of them have their own special field of activities, therefore we may focus our attention on the work carried out by the author of this report. One of his last major works is the monograph in the English Language "Noise Propagation by Cylindrical Pipes and Means of Its Reduction". This is the first monograph in English that was published after the reestablishment of an independent Lithuania. It deals with production noise control problems. The author has been working in the sphere of noise control for 35 years and for 25 years he is involved in researching of sound insulation of shells, duct walls and coverings.

The further study of the theory of sound insulation of cylindrical surfaces and its application in practice open broad possibilities for noise damping at the rate of low frequencies, where on applying other means of sound reduction considerable economic expences are needed.

When solving urgent issues of present-day science it is necessary to have in mind the industrial and production needs of the Republic.

Theoretical solutions of the author that are given in the monograph are applied in practice when preparing real projects of noise abatement. These projects were implemented in 1988–1993 at the Vilnius City plants. Unique noise dampers suppressing noise of compressors and powerful ventilators were devised and implemented, in these noise dampers the theory of sound damping going over to pipings of different diameters and joints was applied.

The aim of the work conducted was the creation of the complex of research methods and sound insulation designing means in machine-building and building industry. These comprehensive means were of help in solving the problem of the reduction of noise in industry, working places and the surrounding environment which is harmful to human health.

The works conducted enabled the author to establish in Lithuania the school of this trend and unite Lithuanian acousticians into the society, engaged in solving topical acoustical issues. This society and the school are aimed at expanding scientific works of the indicated trend to satisfy the needs of the Republic of Lithuania, to integrate the acoustical science into the structure of the world science and achieve the level of the world science. The monograph covers the following issues: The

– sound propagation through duct;

– sound insulation of cylindrical pipes and shells;

– sound insulation of cylindrical and semi-cylindrical housings;

– insulation of sound propagating through a pipe of variable cross-section;

– methods of engineering calculations and designing recommendations of sound insulation constructions.

The whole complex of the work may be characterized as the generalization of sound insulation theory and the scientific solution of the problem of noise reduction in machine-building, construction and transport which is of social importance;

– the theory of sound insulation of various constructions was further developed by applying impedance methods and solving boundary conditions of wave equations;

– a broad spectrum of various concrete theoretical problems was considered, evaluating sound insulation of cylindrical and semi-cylindrical constructions;

– physical regularity of the main dependences, characterizing the efficiency of sound insulation of various structures, and fields of practical application were defined;

– methods of reliable evaluation and prediction of sound insulation were obtained, they may be used in designing and control;

– dependences between sound insulation construction parameters and their acoustical efficiency at the broad range of frequencies were obtained;

– mathematical models of sound insulation of cylindrical and semi-cylindrical housing were created, with the help of which engineering calculations methods were developed;

– the theory of insulation of sound propagation of variable cross-section with various laws of cross-section change was formulated.

Scientific theoretical and experimental investigations conducted, as well as calculation methods created made it possible to select effective means of noise reduction in various branches of industry, e.g., gas industry, machine-building and light industry enterprises.

Basing on our suggestions and recommendations noise reduction means were designed in Belarus and Lithuania, and they reduced industrial noise additionally from 5 to 30 dB at the range of frequency of 16-10,000 Hz.

Our measures, implemented in Lithuania (Alytus "Snaigė" Refrigerator Plant, Ukmergė "Vienybė" Plant, Dvarčionys "Dvarčionys" Ceramics and Brick Plant, "Venta", "Kartonas", "Velga" and other plants of Vilnius), made it possible to decrease noise in working places and environmental noise in residential areas until the permissible sanitary norms.

Further, mention should be made of the book, published by the Publishers "Mashonostroenye" in 1990 a book "Sound insulation in machine building" in co-author with L. Borisov has been written. Chapters and paragraphs written by the author and their analysis are given.

Unfortunately theoretical and practical sound insulation issues are not sufficiently developed in scientific works. The sound insulation theory for different designs is practically not being developed yet, except for separate papers dealing with some particular tasks. Our book "Sound-Insulation in Machine Building" fills in this gap and contains new important theoretical matter for practical engineering.

Insufficient development of this problem is related to sophisticated solution of boundary-value problems of a wave equation. Such precise solutions are practically not available and preliminary study of technical aspects become difficult due to lack of dependable calculation methods.

The boundary-value problem related with sound energy passing through cylindrical thin-wall shell to the equipment is given for solutions of wave equations determining pressure in the wave field beyond the housing p_2 and in the space between the housing and solid internal body (equipment) p_1.

The above equations are considered together with the corresponding equations of the elasticity theory for the shell located on the boundary surface between outside and filling in the cylindrical layer medium between the shell and the solid body. The major peculiarity of the sound field analysis is related with necessity to apply the methods of the random function theory. The matter is that behaviour of the elements in real designs under the influence of acoustic disturbances depends on a series of random factors. On the one hand, it represents random character of the noise itself, on the other hand – the deviation of the design parameter from ideal due to manufacturing errors is also of random character.

Thus, specific class of interaction problems is approached starting with the assumption that "medium-design-medium" represents essentially integral nonconservative system, and the relevant mathematical mechanism is required to reflect the above peculiarities. Our book [4] contains many useful solutions of wave equations applicable to specific technical sound insulation tasks. But the number of those solutions is limited, also qualitative and quantitative evaluations of different sound insulating devices (designs) and items is still insufficient.

The book should be considered as the first rather new investigation but, of course, requiring development both in the theoretical aspect and in the achievement of theoretical and practical adequacy. This rather valuable and practically important matter requires further development. This submitted work presents new solutions and developments of the problem investigated by the author.

The following is brief consideration of individual chapters of the book written only by the author or together with L. Borisov.

Chapter 1. The Fundamentals of Acoustics. It presents basic concepts of the technical acoustics (definition of sound, characteristic parameters of this physical phenomenon, etc.), statistical characteristics of sound processes, mathematical mechanism for space-time description, the laws of mechanics governing sound processes.

Chapter 2. Sound Radiation by the Sources. It describes the sources of noise (random sound waves) accompanying mechanical motion in machine-building and methods of mathematical simulation describing the sources of noise accompanying mechanical and gas-dynamic processes in production and media transportation. In particular, it has been determined sound pressure p radiated into a pipe by the piston oscillating at V_o velocity

$$p=\frac{2\rho_1\omega V_0}{a}\sum_{n=0}^{\infty}\frac{J_1(\mu_n a)J_1(\mu_n r)e^{i\sqrt{\frac{\omega^2}{c_0^2}-\mu_n^2}z}}{\mu_n\sqrt{k^2-\mu_n^2}J_0^2(\mu_n a)\left[1+\frac{F^2}{\mu_n^2}\right]}$$

where

ω – circular frequency,

a – pipe radius,

$J_1(x)$ – Bessel's functions

$\mu_n a$ – roots of Bessel function

$J(\mu_n a) = 0$, c_0 – acoustic velocity,

$$F=\frac{-i\rho\omega}{Z_{об}+Z_{изл}};$$

ρ – density of medium,

$Z_{об}$ – pipe surface impedance,

$Z_{изл}$ – radiation impedance

$$Z_{изл}=\frac{-i\rho_2\omega}{\mu_2}\frac{H_0^{(1)}(\mu_2 a)}{H_1^{(1)}(\mu_2 a)},$$

$H_0^{(1)}(x)$ – Henkel functions

It presents main methods of noise level normalization based on sanitary safety requirements.

Chapter 3-4. Sound Insulation of Double-and Multilayer Constructions. They present definition of sound insulation for specific technical problems related to protection methods of one or another part of space by means of providing soundproofing protection. In particular, for monochromatic wave passing through an elastic plate with surface density equal to $m = p \cdot h$ a sound insulation value R is given in the form of

$$R=10\lg\left[1+\left(\frac{\omega m}{2\rho c}\cos\Theta\right)^2\left(1-\frac{\omega^2}{\omega_{kp}^2}\sin^4\Theta\right)^2\right]$$

where Θ – wave drop declination angle

ω_{kp} – critical frequency

$\omega_{kp}=1{,}1\pi c^2/c_0 h$,

R for diffusion sound

$$R=10\lg\left(\frac{2\beta}{\pi}\right)+10\lg\left(\gamma^2\sqrt{1-\frac{1}{\gamma}}\right)+10\lg\left[1+\eta\beta\gamma\sqrt{1-\frac{1}{\gamma}}\right]$$

where $\beta\gamma=\frac{\omega m}{2\rho c}$, $\gamma=\frac{\omega}{\omega_{kp}}$

Sound insulation has been determined for elastic barriers in an extended space (waveguide) by means of the series containing finite number of terms corresponding to propagating normal waves.

The consideration has been given to a wide spectrum of specific theoretical problems for evaluation of sound insulation applicable to practical solution of industrial noise localization by means of flat barriers.

Chapter 5. Sound Insulation of Cylindrical Shell. It presents theory of sound insulation in thin-wall cylindrical shells based on solution of the equation for shell displacement under the influence of sound pressure which is expressed in the form of:

$$L_{ik}U_k=\delta_{i3}f_3,$$

where L_{ik} – differential operators for a thin cylindrical shell,

f_3 – pressure differential in the medium on the shell surface.

Thus the sound insulation value has been obtained for axially symmetrical wave of a q number

$$R=20\lg\left|1-\frac{\omega m\cos\Theta_{2_{q0}}H_1(k_2 a\cos\Theta_{2_q})}{\rho_2 c_2 H_0(k_2 a\cos\Theta_{2_q})}\left(\frac{f_\Pi^2}{f^2}+\frac{f^2}{f_{kp}^2}\sin^4\Theta_{1_q}-1\right)\right|$$

where f_{kp} – critical frequency of shell,

Θ_{2_q}, Θ_{1_q} – inclination angles of wave vectors to the shell axis under the shell and beyond the shell.

Here the wave equations have been considered in the cylindrical coordinate system.

These equations are supplemented by boundary conditions, which are reflected by the corresponding equations of the dynamic theory of elasticity for a thin wall housing.

$$\left[-\frac{1}{c^2}\frac{\partial^2}{\partial t^2}+\frac{\partial^2}{\partial z^2}+\frac{1-\nu}{2r^2}\frac{\partial^2}{\partial\varphi^2}\right]u_2+\left[\frac{1+\nu}{2r}\frac{\partial^2}{\partial z\partial\varphi^2}\right]u_2-\left[\frac{\nu}{r}\frac{\partial}{\partial z}\right]u_3=0,$$

$$\left[\frac{1+\nu}{2r}\frac{\partial^2}{\partial z\partial\varphi}\right]u_1+\left[-\frac{1}{c^2}\frac{\partial^2}{\partial t^2}+\frac{1-\nu}{2}\frac{\partial^2}{\partial z^2}+\frac{1}{r^2}\frac{\partial^2}{\partial\varphi^2}\right]u_2-\left[\frac{1}{r^2}\frac{\partial}{\partial\varphi}\right]u_3=0,$$

$$\left[\frac{\nu}{r}\frac{\partial}{\partial z}\right]u_1+\left[\frac{1}{r^2}\frac{\partial}{\partial\varphi}\right]u_2-\left[\frac{1}{c^2}\frac{\partial^2}{\partial t^2}+\frac{1}{r^2}+\frac{h^2}{12}\left(\frac{\partial^2}{\partial z^2}+\frac{1}{r^2}\frac{\partial^2}{\partial\varphi^2}\right)^2\right]u_3=\frac{p_2-p_1}{\rho hc^2},$$

where u_1, u_2, u_3 – represent vector components of shell surface displacement (as indicated in Fig. 1); r, h, ν, c – shell parameters; radius, thickness, Poissons ratio and longitudinal wave propagation velocity, respectively.

Chapter 6. Sound Insulation by Sound Propagation in pipes. It presents theory of sound energy reflection at sound propagation in pipeline systems and the methods of sound reduction – by way of application of sound absorbing materials. Sound insulation R is expressed by the equation

$$R = 201g\left|1 - \frac{Z_{об}\pi\mu^2 a_2}{4\rho\omega}\left[H_1(\mu a_2)\right]^2 \times \left[\frac{H_1^{(1)}(\mu a_2)H_1^{(2)}(\mu a_1)}{H_1^{(2)}(\mu a_2)H_1^{(1)}(\mu a_1)} - 1\right]\right|$$

where $Z_{об}$ represents impedance on the surface of the shell, used as a casing;

$\mu = \sqrt{k^2 - k_z^2}$ – the radial wave number of the wave under the shell a_1 and a_2 – radii of a pipeline and a casing;

ω – angular frequency,

ρ – density of the medium.

$Z_{об} = i\omega m\left(\frac{f_{\Pi}^2}{f^2} + \frac{f^2}{f_{kp}^2}\sin^4\Theta - 1\right)$, $f_{\Pi} = c/(2\pi a)$ – frequency of longitudinal resonance

$\omega = 2\pi f$; Θ – angle of incidence $\left(\sin\Theta = \frac{k_z}{k}\right)$, $f_{kp} 0{,}55c^2/(c_0 h)$, c – sound velocity in the material of enclosure; c_0 – sound velocity in medium; m – superficial mass of enclosure

$m = \rho \cdot h$

Sound propagation factor τ through a joint (smooth connection) of the pipes of different radius having a smooth connection with the insertion featuring exponential cross-section expansion law $s = s_1 \exp^{\beta x}$ is expressed as follows:

$\tau = |D|^2 e^{\beta l}$,

where

$$|D| = \left|\frac{e^{-\frac{\beta l}{2}}}{\cos\sqrt{\left(\frac{\omega}{c}\right)^2 - \left(\frac{\beta}{2}\right)^2}\, l - \frac{i\left(\frac{\omega}{c_0}\right)}{\sqrt{\left(\frac{\omega}{c_0}\right)^2 - \left(\frac{\beta}{2}\right)^2}}\sin\sqrt{\left(\frac{\omega}{c_0}\right)^2 - \left(\frac{\beta}{2}\right)^2}\, l}\right|$$

here l – length of the insertion,

ω – angular frequency in an arriving wave,

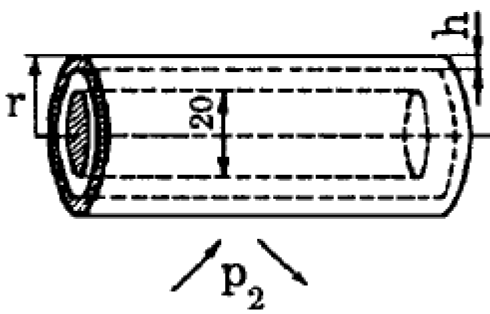

Fig. 1**. Calculation model of noise passage through thin-walled shell**

c_0 – sound velocity in a filling medium.

Similar results have been also received for a conical transient diffuser. Based on the solution of the wave equation with variable factor the following sound insulation R value for this case have been obtained:

$$R = 101g\left[1 + \frac{(kd)^2 + \left(1 + 4k^2 x_0 h\right)\sin^2 kd - 2kd\sin kd\cos kd}{4k^4 x_0^2 h^2}\right]$$

where $h = x_0 = d$ – length of a conical diffuser,

$k = \frac{\omega}{c_0}$ – wave number,

x_0 and h – origin and end coordinates of the diffuser.

Chapter 7. Designing of Soundproofing Constructions. This chapter describes qualitative specifications and quantitative evaluation of the efficiency of the soundproofing designs used in machine-building based on the author's skill gained in implementing his designs into production.

Chapter 8. Soundproofing Casings, Cabins and Screens.

Chapter 9. Sound Insulation of Cylindrical Casing for Pipelines. The methods of pipeline sound insulation by means of coaxial casing have been developed based on the theory of thin-wall circular cylindrical shells. Detailed study related to sound insulation of cylindrical casings is presented in this work by the author.

Chapter 10. Sound Insulation of Cylindrical and Semicylindrical Casing at the Limited Sound Source. It presents precise theory of sound insulation in the limited cylindrical shells located within the space between two impermeable surfaces and other similar problems allowing to build up theoretical models with self-matching boundary conditions (for sound field and for shell displacement).

Chapter 11. Materials for Soundproofing Constructions. It describes materials used for soundproofing and soundabsorbing in modern industrial noise protectors.

Chapter 12. Means of Individual Protection against Noise. It presents brief reference data on the means of individual protection used in industrial premises with noise levels. Sound insulation have been defined for ear protectors.

Future plans in this sphere

Lithuanian higher schools do not specially prepare the specialists in the sphere of acoustics, such important subjects like sound theory and vibration theory (except separate subjects, when these problems are dealt with in short), are not taught. In Soviet times, due to the centralized development of science, specialists in this sphere were not prepared and from inertia this branch of science as a whole has been neglected. Therefore today we cannot design concert and theatre halls without the assistance from foreign countries; we even hire specialists for prediction and evaluation of street noise. In the future, with the industry and new technologies being developed, the need for such projects will increase. The Government will be forced to invest considerable funds in designing by foreign specialists and could not allocate more funds to the development of the science of acoustics. We will find ourselves in the vicious circle and no way out of it could be found for a long time. Therefore it is high time to plan the preparation of such specialists in Lithuania.

To train highly professional specialists in the sphere of acoustics today, the sufficiently well-prepared teaching staff is needed to satisfy the afore-mentioned needs. In the main universities, like KTU, Vilnius University, LAA and VGTU the initial base exists for preparation of such specialists. Not only specialists of narrow profile are needed to be prepared but also universal experts who will have the firm knowledge of the fundamental acoustics in each sphere of construction or technology. Therefore when teaching bachelors it would be necessary to establish the optional courses in acoustical specialities. In addition, at the special chairs and laboratories masters for the acoustic specialities should be prepared. Here in the study programme should be included the fundamentals and projects of sound and vibration theory, special areas of acoustics, psychological and physiological acoustics, electroacoustics, architectural acoustics, methods and measures of sound control, the fundamentals of sound and noise measurement, etc.

Another important area in preparing highly professional specialists is the preparation of textbooks, the legalization of Lithuanian terms. Today we have methodical teaching aids and lecture synopsis of some higher schools, but we lack a uniform textbook on acoustical science. Moreover, one textbook will not be sufficient. Separate books, it may translations for study of sound and vibration theory, research of methods and means of noise control. Special importance should be given to architectural acoustics, namely, hall and room acoustics.

Possessing the existing potential in the sphere of acoustics, this work could carried out within the short period. For this purpose it is necessary to coordinate the work between the acoustic experts in universities and make common plans and projects.

Conclusions

Information concerning the trends of scientific work conducted by Lithuanian acousticians as well as the establishment and activities of the Lithuanian Acoustical Society is provided. A description of the problems concerning the study of sound insulation of cylindrical pipes and cylindrical housing, of various shapes is given.

Theory and application of the case of sound insulation and exploratory results and analyses of separate cases are provided.

The pape deals with the problems of the development and improvement of acoustical science, including acoustical research financing, the preparation of high-quality acoustical specialists, publishing of textbooks and other national literature in the sphere of acoustics.

The role of the Acoustical Society of Lithuania in solving these problems is indicated.

The report deals with acoustical works and problems. When integrating into the Western acoustical science, support is needed in the preparation of new acoustical specialists and in encouraging the development of acoustical science. Many Lithuanian specialists are frustrated since they do not see any prospects for them in acoustical science. Therefore the enormous educational and informative work is ahead. Support of the world acoustical scientists will be of great benefit to Lithuanian acousticians.

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D. Gužas

Lietuvos akustikai, jų veikla ir ateities darbų planai

Reziumė

Darbo tikslas – apžvelgti įvairias Lietuvos akustikų veiklos sritis, jų atliekamus darbus ir ateities planus.

Darbe smulkiai aptariami ultragarso moksliniai tyrimai ir jų atlikėjai bei triukšmo mažinimo srityje pasiekti rezultatai. Dėl ribotos straipsnio apimties ir informacijos stokos liko nepaminėti ne mažiau svarbūs akustikų atlikti darbai ir jų veikla. Kadangi savas darbas yra geriausiai žinomas ir suprantamas, todėl daugiau vietos skiriama autoriaus atliktiems darbams ir jų analizei. Iškeltos akustikos specialistų rengimo Lietuvoje problemos. Numatoma 2000 m. rugsėjo 17-21 dienomis surengti Vilniuje pirmąją tarptautinę akustikų konferenciją "Baltic – Acoustic".