

Achievements of the KOMAG Institute in the field of environmental protection over the years 1950-2020

Published online: 07-10-2020

Aleksander Lutyński^{1a}, Małgorzata Malec¹, Dariusz Prostański¹

¹ KOMAG Institute of Mining Technology, Pszczyńska 37, 44-101 Gliwice, Poland

^a e-mail: alutyński@komag.eu

Keywords: environmental protection, research, noise, innovation

Słowa kluczowe: ochrona środowiska, prace badawcze, hałas, innowacja

Abstract:

Seventy years of research-and-development activities of the KOMAG Institute of Mining Technology in the field of environmental protection are presented in this article. Special attention is paid to the projects oriented onto reducing noise emissions. Technical solutions in the field of noise control, developed at KOMAG and oriented onto passive acoustic baffles and noise silencers are discussed in the article. Some examples of research projects results and their successful implementation in the industry are described. A review of several projects relating to widely understood environmental protection, including work environment, reflect an interdisciplinary approach of KOMAG researchers to the issues of reducing hazards and increasing safety. There is also some information about innovative technical solutions, which obtained awards and were distinguished by domestic and foreign experts at fairs, exhibitions and competitions in Poland and abroad.

Streszczenie:

W artykule przedstawiono siedemdziesiąt lat działań badawczo-rozwojowych Instytutu Techniki Górniczej KOMAG na rzecz ochrony środowiska. Szczególną uwagę zwrócono na projekty dotyczące redukcji emisji hałasu. W artykule omówiono rozwiązania techniczne dotyczące zwalczania hałasu, opracowane w Instytucie, które są ukierunkowane na ekrany akustyczne oraz tłumiki hałasu. Podano przykłady wyników projektów badawczych i ich wdrożeń przemysłowych. Przegląd różnych projektów dotyczących szeroko rozumianej ochrony środowiska, łącznie ze środowiskiem pracy, odzwierciedla interdyscyplinarne podejście pracowników badawczych KOMAG-u do zagadnień ograniczenia zagrożeń i zwiększenia bezpieczeństwa. W artykule zawarto informację o innowacyjnych rozwiązaniach technicznych, które uzyskały nagrody i zostały wyróżnione przez ekspertów krajowych i zagranicznych podczas targów, wystaw i konkursów organizowanych w Polsce i za granicą.

1. Introduction

This year the KOMAG Institute of Mining Technology celebrates the seventieth anniversary of its activity. Over the years it changed its name, but has always been oriented onto designing and testing of machinery and equipment for extracting as well as processing of minerals. In the past it was a scientific, research and development organization for all the factories of mining machines such as FAMUR, FAZOS, TAGOR, RYFAMA and GEORYT, where KOMAG had its design branches. At present KOMAG elaborates and implements research results contributing to an improvement of miners' work comfort and safety as well as to widely understood environmental protection, including post-mining sites and other areas badly affected by the industry. Since 1950 more than 1100 technical documentations of machines and equipment, applied in mines of minerals in Poland and abroad, have been generated. More than 4400 patents and utility patterns, obtained so far, confirm an innovative character of these technical solutions. As far as the subject-matter of environmental protection is concerned the following activities are realized:

- development of innovative solutions reducing hazards and increasing work safety,

- environmental management of industrial and urbanized areas according to the strategy of sustainable development,
- development of technologies and methods for environmental protection of post-mining sites and other areas badly affected by the industry,
- development of technologies of using and dumping waste,
- development of techniques and technologies for a management of natural heat sources – geothermics, hydrothermics and aerothermics,
- clean coal technologies ensuring security of energy supplies.

2. KOMAG activities in the scope of reducing noise emissions to the environment

Noise emissions from industrial works or means of transport to the environment are a natural phenomenon, connected with production processes, conducted in these works and with a traffic of vehicles. Attempts of silencing production processes to create an acoustic comfort for workers do not always give required effects and they do not cause a reduction of imissions. Such a situation is described in [2], where it is shown on the example of one of hard coal mines, how the acoustic climate around this mine land is shaped. It was detected that there were higher noise levels in the environment than the permissible ones contained in the Minister's of Environment Order from 14th June 2007 [1] and revised in 2014. Thus inhabitants of houses, persons working in social or commercial-service objects are endangered to this imission which is not in accordance with the recommendation of 2002/49/EU Directive [2] which states that “no inhabitant of EU should be endangered to noise on the level hazardous to the quality and health of life”. As the above actions inside the works do not give the right effects, other activities are indispensable, to be taken outside the works, to improve the existing situation. To protect the housing areas and the lands protected acousticly different kinds of methods and means as well as preventive measures are used. It should be mentioned that a reduction of the noise level by 3-5 dB gives perceptible effects for inhabitants (small changes of noise level can cause feelings of different intensity). Due to these reasons, first of all, a professional, correct identification of the acoustic climate and then a selection of proper protections, which should take into consideration both the acoustic conditions as well as others, including environmental ones, is an important element of the acoustic protection.

Technical solutions, leading to a reduction of noise emissions to the environment, include different types of passive acoustic baffles and active acoustic silencers [3, 4].

The issues from this field are in the KOMAG research activity. In the scope of the research-and-development projects, conducted within the framework of the statute activity, several methods, computer software, innovative projects and conceptions were successfully implemented in the scientific and service-and-testing activity of the Institute and contributed to a development of the scientific staff.

Among the most important and interesting projects those presented below should be highlighted:

- an elaboration of a conception of constructing an active silencing system of noise emissions of high power transformers' assembly with external cooling systems,
- an elaboration of the modelling method of acoustic field distribution in closed spaces of diffusing character of the acoustic field to reduce noise emitted to the environment by industrial objects,
- an elaboration of the method for a determination of environment acoustic climate in the area of a large surface industrial object (patent application),
- an elaboration of a technical project of a passive means for reducing noise emitted by a unit transformer,
- a determination, on the basis of industrial tests, of an impact of technical condition and load changes of a power object on shaping the acoustic climate in the surrounding environment,
- a development of a conception project of an acoustic baffle to be installed in mining areas which belong to the III category of building suitability,
- an elaboration of methods and means for a reduction of over and above the standard noise emissions from typical coal loading stations,
- an elaboration of the method for acoustic analyses of airports – conducting acoustic measures and model tests to determine acoustic field distribution; within the doctorate grant from this

- scope a method for a determination of acoustic field distributions of airports and of areas endangered by air noise was developed,
- an elaboration of the author's method of reducing noise emissions in the power objects of a complex special structure,
 - an elaboration of innovation conceptions of sound-insulating screens of efficiency exceeding the level achieved in implementations so far, for coal tumbling and ball mills, whose acoustic power exceeds the level of 100 dB, and low frequencies dominate,
 - an elaboration, on the basis of conducted acoustic analyses with use of a numerical model of sound propagation, of two conceptions of an installation of acoustic tunnel for a reduction of over and above the standard sound emissions from A and S class roads; the final project result was a proposal of a technical solution enabling a significant protection improvement of many-story apartment buildings in relation to classical acoustic baffles used at present,
 - an elaboration of a detailed method of developing roads acoustic maps of traffic intensity over 3 million vehicles a year; the developed method included the stage of data processing for a numerical model and a correlation of the data and conducted calculations; the method was subjected to a validation on the base of developed acoustic maps of selected roads,
 - conducting acoustic tests for a railway section of permissible speed 160 km/h, being the basis of an analysis of problems resulting from an installation of sound-insulating screens for high speed trains and an elaboration of a sound-insulation screen to be used within the railway lines of this type,
 - an elaboration and an implementation of computer software enabling a significant speeding up of the analysis of measurement results of traffic noise and of a distribution of traffic intensity, which eliminates a possibility of making mistakes in the process of developing analyses in this scope,
 - an elaboration, on the basis of a multi-alternative numerical tests, of a conception of reducing over and above standard sound emissions of the mine central ventilation station consisting in an installation of two acoustic silencers effectively reducing the noise emissions generated by the diffusors of the central ventilation station,
 - an elaboration of an interface of 3D data distribution system in the internet viewer and a presentation of acoustic maps in it,
 - an elaboration and implementation of a visualization and 3D animations for a presentation of the results of roads' acoustic maps as 3D noise front maps, indispensable for a presentation of noise levels on individual stories of buildings,
 - an elaboration of the new method guidelines for obtaining the GIS data from photogrammetric activities conducted with use of unmanned aircraft; the basis for an elaboration of guidelines included taking photographs of the land from the unmanned aircraft and making inventory of this land using the equipment of Real Time Kinematic GPS which enabled an orthorectification of photographs from the unmanned aircraft and an elaboration of the land model,
 - an elaboration of assumptions for conducting tests aimed at an identification of the acoustic field in the objects of increased acoustic requirements,
 - a determination of V70 acoustic diffractors' efficiency enabling an efficient reduction of traffic noise in the area of apartment buildings,
 - an elaboration of RMR 2002 method for conducting numerical tests and 3D animations of the sound propagation emitted by rail vehicles; the requirements for a construction of the land numerical model and the land coverage were defined, simultaneously determining minimal conditions concerning an accuracy of mapping elements of site planning,
 - an elaboration of 3D data base enabling data addition and edition in the QGIS software environment and an interactive system for a distribution of 3D data,
 - an elaboration of a conception of fixing a noise baffle to a facade which solved a problem of protecting apartment buildings against traffic noise, in particular in the case of multi-family buildings; conducted acoustic numerical tests confirmed a high efficiency of sound level reduction in the building protected by the installed baffle,

- a preparation of numerical situational - height map and of numerical models of the land and of an orthomap for mining sites together with adjacent land,
- an elaboration of a method for a generation of digital land maps for industrial areas on the base of photogrammetric data,
- an elaboration of a conception of anti-noise protections limiting the over and above standard noise emissions from the area of the water conditioning technological line; the basis of the elaboration contained measurements conducted in the area which incorporated acoustic measurements of identified sound sources, geodesic measurements and measurements of water flow, which enabled an elaboration of a numerical model of sound propagation and an implementation of noise reducing means,
- an elaboration of geometric and acoustic models consisting of architectural objects with use of ODEON models and the method of defining materials for the layers imported from the AutoCAD software,
- an elaboration of a universal geo-information system using the internet map application for which a visualization of 3D maps indispensable for analyses of sound propagation in the area was developed and started,
- an elaboration of new guidelines for modelling an acoustic field distribution for a determined category of aircrafts, in particular of military type which enabled to establish grounds for a limited use area in vicinity of airports,
- a development of the method for numerical tests of acoustic parameters in interiors of rail and wheel mounted vehicles, which enables to assess acoustic conditions of the interiors of these vehicles,
- an elaboration of a new solution of the silencing base of a roof mechanical fan, enabling a significant reduction of noise generated by the fan,
- an elaboration of a conception of an industrial sound insulating cabin, improving the acoustic comfort of the interior and protecting against mechanical vibrations at the work-place; basing on tests and analyses, including numerical ones, optimal material design features of individual barriers were selected and a transmission of mechanical vibrations by the cabin floor was reduced,
- an elaboration and an implementation of the Robot Structural Analysis Software for designing support constructions of silencers and acoustic enclosures,
- an elaboration of a conception of a light, mobile acoustic baffle for a reduction of noise generated during repairs of urban road infrastructure and of the underground one as well as during open-air events; the features of the suggested acoustic baffle were identified and standard conditions for designing solutions in the scope of environmental protection were determined,
- an elaboration of the method for assessing the hazard of inhabitants of buildings as regards mechanical vibrations generated by means of public transport; after having conducted the measurements verifying the developed method, the means of reducing this impact were suggested,
- a realization of an analysis of an impact of simplifications, used at developing numerical models of the land coverage on the acoustic field distribution around apartment buildings and in the area of the buildings protected acoustically,
- a development of the method for conducting tests of a cumulated acoustic impact of roads and railway lines,
- a determination of the conditions which should be met by the buildings in the scope of an acoustic insulation of external walls, flat roofs and windows; a numerical model of apartment buildings enabling a determination of an acoustic field distribution inside rooms, generated by the sources situated outside the building as well as assumptions of the testing method of sound penetration from the open space to the building, were formulated,
- an elaboration of a conception and a construction of a sound-insulating enclosure for an oil compressor, reducing noise emissions to the environment,
- an elaboration of the method for selecting vibration isolators of water pumps for the Warsaw University of Technology.

3. Examples of research projects oriented onto environmental protection

Besides, a three-year research project, financed by the Ministry of Science and Higher Education was realized. Within the framework of the project the method of hybrid reduction of noise level from the equipment transmitting out the power of turbine sets was developed. The basis for a development of this method was an identification of an impact of the most important equipment in the engine room in the area of the power transmission from a turbine set and an elaboration of a numerical model of the area under testing. A numerical representation of machines and equipment was conducted with use of a model of point sources, taking into consideration their characteristics, i.e. a small surface of sound emissions, versatile character of emissions and a significant acoustic power of machines and equipment under testing.

Within the framework of the COST Action a three-year project COST-EST 356 “Activities in the direction of measurable transport defining at a sustainable environmental impact”, coordinated by the INRETS Institute of Transport Safety from France, was realized. Within the project KOMAG researchers conducted environmental measurements of air-suspended dust as well as of noise generated by industrial objects and motor transport. They realized acoustic analyses and assessed an impact of harmful factors on the environment. The final result of the project included a construction of models of air pollutants’ propagation and of noise propagation in the environment [5].

The subject: “Activities in the direction of a measurable definition of transport at a sustainable environmental impact” was financed with the means of the Special Research Programme. It enabled to conduct tests of ventilation efficiency of lungs of a selected group of Gliwice inhabitants of defined places of residence. Simultaneously tests of air samples in the defined locations, analyzing a propagation of pollutants from linear sources, were conducted. Obtained results of tests of the inhabitants’ lungs ventilation efficiencies and of the levels of environmental pollution were compared.

The research project i-Protect “System of smart means of personal protection for the personnel working in complex environments of high risk” was realized within the Seventh Framework Programme of the European Union [6].

The results of the presented research as well as research-and-development projects were implemented in the industry, and the knowledge and abilities gained during their realization formed the basis for publications of the KOMAG researchers and for a realization of collaboration within scientific as well as scientific-and-industrial consortia.

One of good implementation examples of a KOMAG technical solution in the industrial practice is a sound-insulating enclosure of the WOK 1.5 centrifuge commonly used in preparation plants of mines [7]. A sound-insulating enclosure is made of sound absorbing panels of an assumed acoustic insulation R_w on the level of 40 dB for the frequencies 125–8000 Hz. The requirements of the acoustic insulation meets the mineral wool of density 150 kg/m^3 and of thickness at least 100 mm. The design project of the developed conception of the centrifuge sound-insulating enclosure is shown in Fig. 1 and a visualization of this technical solution – in Fig. 2. However, in Fig. 3 a practical realization of this solution on the real object is shown.

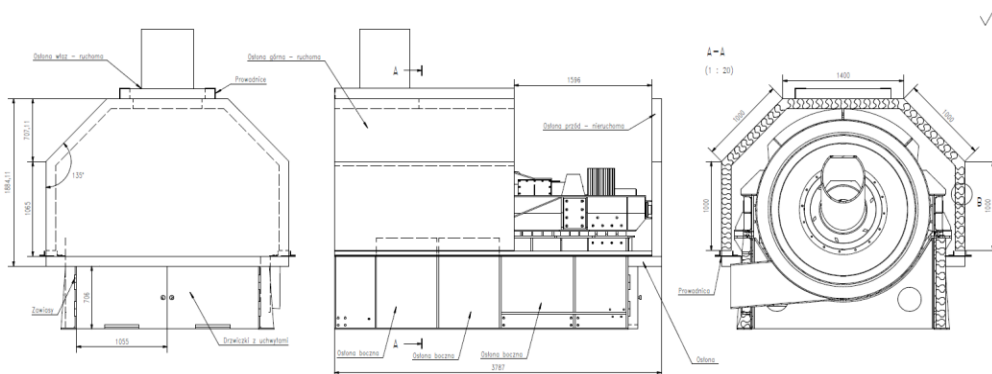


Fig. 1. Design conception project of WOK 1.5 sound-insulating enclosure [7, 8]

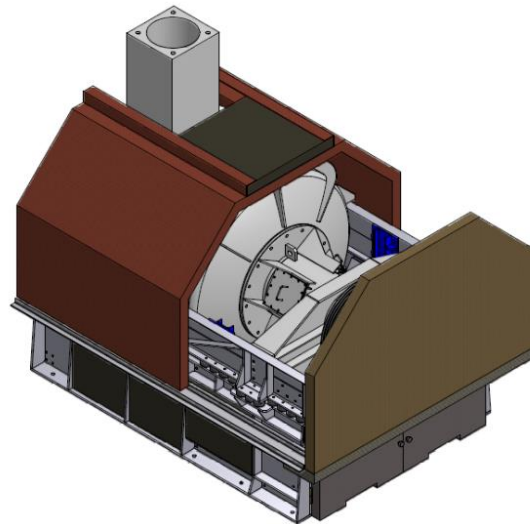


Fig. 2. Visualization of WOK 1.5 centrifuge sound-insulating enclosure [7, 8]



Fig. 3. WOK 1.5 centrifuge in sound-insulating enclosure [7]

Another example of a design solution reducing noise in the work environment, which was realized at the KOMAG Institute is a reflexive silencer of TG type, protected by the patent PL 215380 B1 [7], which is visualized in Fig. 4. An example of its application in the mine mechanical preparation plant is shown in Fig. 5 [9]. This silencer meets the requirements for this type of solutions. It reduces the energy of acoustic waves transmitted along the axes of pipes and holes, through which air or gas flows (ventilation installations, inlet and outlet systems of turbo-machines e.g. compressors, blowers, turbines, diesel engines), but it does not reduce a flow of working medium along the pipes.

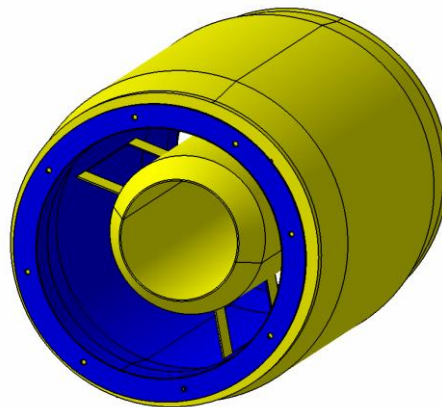


Fig. 4. Visualization of noise silencer of TG type designed at the KOMAG Institute [9, 10]



Fig. 5. View of noise silencer of TG type operated in the dust control installation at the coal mechanical preparation plant [9]

Executed research as well as research-and-development projects formed grounds for a broad service-and-testing activity of the KOMAG Institute of Mining Technology in the field of activities oriented onto acoustic climate and a reduction of noise emissions to the environment. A few examples, selected from many projects made in this scope, are given below:

- Environmental protection programmes against noise for Lubelskie and Kujawsko-Pomorskie Provinces,
- Documentation of anti-noise protections installation along the S1 express road at the section from the Brzeczkwocze Junction to the Dzieckowice Junction in Myslowice,
- Acoustic maps of areas situated in the vicinity of province roads of traffic intensity exceeding 3 million vehicles a year for the provinces: Podkarpackie, Lubelskie, Kujawsko-Pomorskie and for towns: Żory, Jelenia Góra, Gdańsk, Słupsk, Działdowo, Iława, Kętrzyn, Lidzbark Warmiński, Lubawa, Morąg, Mrągowo, Nidzica, Orneto and Pasłęk,
- Acoustic map of an impact of a military shooting-range situated in the Gliwice quarter called Wójtowa Wieś on the basis of environmental measurements of impulse noise emissions,
- Environmental impact reports and environmental protection programmes for the thermal-electric power station in Białystok, Godów Commune, technological system of beneficiating raw slurry at Knurów Mine,
- Hydro-legal assessment documents for towns: Piotrków Trybunalski, Łódź and also waste management plans,
- Projects of noise emission reduction at the area of the production plant FERROLI Poland Ltd., at the area of Shaft IV at Piast Mine, at the headframe of Shaft VII at Jankowice Mine, at the crushing node in the Czatkowice Limestone Mine, for the project offices: EKOSOUND s.c. and ATMOTERM Ltd.,
- Design project documentation for improving acoustics, dewatering and anti-humidity protection of the gym hall building in the Elementary School No. 29 in Katowice,
- Design projects of acoustic baffles E1 and E2 for WTB Konin – World Acoustic Group S.A. and of acoustic baffles for EUROMETAL Company,
- Complex project of assembly of noise eliminators of TS2 and TS4 turbocompressors for TAURON CIEPŁO S.A.,
- Conception of vibro-acoustic protections in work-places and in the rooms where the workers stay for the KGHM Polska Miedź S.A., Department of Ores' Beneficiation.

The prizes and distinctions, obtained by KOMAG and its researchers at different kinds of exhibitions and competitions, confirm an innovative character of technical solutions. One of the most interesting research work results was the silencer of noise of air draw and chute for a collaboration with high-power fans. This technical solution was announced to be the Mining Success of the year 2010. Apart from that prize the technical solution obtained:

- Gold medal with distinction at the International Warsaw Exhibition of Inventions IWIS 2009,
- Prize of I Degree at the Polish Competition of Work Conditions Improvement in 2009,
- Gold medal at the Poznań International Fair 2009,
- Silver medal at the World Exhibition of Innovations, Scientific Research and Novel Technology, Brussels Innova in 2010,
- Bronze medal at the 109. International Fair of Inventions, Concours Lepine, France, in 2010,
- Silver medal at the 62. International Exhibition "Ideas, Inventions, New Products iENA 2010", in Nürnberg, in 2010,
- Diploma and Statuette as well as Congratulations Letter from the Minister of Science and Higher Education in 2010.

Other interesting technical solutions from this field include a system of fan acoustic screens, which received a gold medal at the International Poznań Fair in 2010 and also an acoustically low-emission system of ventilating objects, which obtained a special distinction at the 110. Fair Concours Lepine – Medal of French Inventors and Producers – AIFF. In the thematic field of acoustic climate two successful doctoral procedures were conducted.

4. Other KOMAG activities in the scope of environmental protection

The activity in the scope of environmental protection, described above, were not the only ones which concerned the projects realized at the KOMAG Institute of Mining Technology. Analyzing the results of individual projects, financed from the KOMAG sources as well as service-and-research projects, the following examples should be highlighted:

- an energy and ecological analysis of aspects of hard coal combustion with waste fuels; in the project physical-and-chemical properties of mixes generated on the basis of hard coal and wastes of car tyre rubber were determined and the subject-matter was continued in the doctoral thesis, in which optimal conditions of burning hard coal and rubber wastes were presented,
- an assessment of general population hazard caused by aerosol and nitrogen dioxide from traffic, basing on routine measurements realized at monitoring stations,
- an assessment of geotechnical possibilities of dumping wastes in the LGOM rock-salt deposit (grant financed by the Ministry of Science and Higher Education),
- a conception project of an ecological building in the aspect of heat economy, in particular a preparation of heat balance of large-surface industrial objects,
- an elaboration of conception of water sterilizer with use of UVC rays which can be used for a treatment of water in private houses and in systems of urban water supply systems,
- an elaboration of technical documentation of a novel design solution of special mixers in tanks for making biogas,
- an elaboration of the method of assessing dynamic impacts of road infrastructure on selected architectural objects,
- an analysis of possibilities of using wet dust control equipment for a removal of ash from fine gas emitted from coal fired boilers in power plants and on this basis a preparation and testing of a dust controller model of a new design,
- an analysis of possibilities of modernizing useful warm water installation of the power about 1 MW for heating, using the solar installation system,
- a development of methods and testing technologies enabling a preparation of the system of recovery and conversion of heat energy into electric energy; possibilities of constructing thermoelectric cells were analyzed and a programme of rig tests of recuperation and conversion of heat energy into electric energy was developed,

- a modification of the method of assessing suitability of underground mining wastes for road construction which was directed towards hydrochemical modelling, characterizing ground-water environmental hazard as regards a migration of heavy metals,
- an elaboration of the method of shaping safe environment of children's life and development by specifying standard requirements, concerning testing the safety of products for children and an identification and analysis of hazards resulting from their use; this subject-matter was developed within a successful assistant professor's procedure,
- an elaboration of a model project of assumptions concerning the plan of the commune supply of heat, electric energy and gas fuels as grounds of the commune plan of land development, development plans of power enterprises and plans of heat, electric energy and gas fuels supplies,
- an elaboration of a multi-alternative conception of a turbine construction and a construction of the wind turbine tower of rated power 1.8-2.5 MW,
- an elaboration of the container technology for composting organic wastes consisting in conducting composting in oxygen conditions; it requires an introduction of air into the container, using a unique technical solution with its own system controlling the whole process,
- an elaboration of the thermal method of utilizing polyolefine wastes consisting in cracking in the temperature 400-500⁰C in oxygen – free atmosphere, of the conception and preliminary design of the installation and reactor for a utilization of these materials together with the control and visualization system,
- an elaboration of a design solution of the bioreactor closure for making stabilat using a membrane made of cloth of specific properties,
- an elaboration of a technical conception of the installation for the technology of organic waste gasification, in particular plastics with a share of biomass and the factor supplying oxygen,
- an elaboration of a quick costing method of an investment from the scope of environmental protection, in particular as regards steel constructions,
- an elaboration of the conception of a station for producing ash-water emulsion of increased resistance to pressures, a transport system of thickened emulsion and portable shutters for making large-size pillars in mine workings as technologies of waste use and location,
- an elaboration of assumptions and detailed guidelines for generating solar potential maps as the basis of conducting profitability analyses of photovoltaic cells assembly; research tools used for a generation of this potential maps were analyzed and a map of a solar potential for a selected area, according to accepted assumptions, was developed,
- an elaboration of a conception of a small-size electro-filter used for purifying exhaust gases, mainly from house furnaces as an efficient tool of reducing low emissions (the solution is the subject of patent application),
- a development of a half-dry method of sulfur removal from exhaust gases in a reactor with an external circulation of the deposit,
- an elaboration of a technical documentation of a self-cleaning filter with a function of water treatment and a protection against big fractions of pollutants,
- an elaboration of a conception of hazing equipment, which effectively reduces thermal arduousnesses,
- an elaboration of the method for a dust neutralization in timber processing plants,
- an elaboration of a conception of the installation using geothermal heat from underground mines with an application of a heat pump and a co-generation system,
- an elaboration of a conception of equipment for a measurement of a geothermal potential,
- an elaboration of a conception of a network of air composition individual monitoring,
- an elaboration of a filter conception, basing on a zeolite, removing salt particles from the air supplied to diesel engines,
- an elaboration of a conception of a hydraulic system of a device for a thermoplastic processing of plastics, in particular polyethylene granulated product and from milling.

It should be mentioned that one of the above research project results, i.e. "Half-dry method of sulfur removal from exhaust gases in a reactor with an external circulation of the deposit" received a gold medal at the IV International Warsaw Exhibition of Innovations – IWIS 2010.

5. Summary

The subject-matter and scope of research-and development projects, concerning widely understood environmental protection with special attention paid to work-places and housing areas, are presented in this article. Over the period of its seventy-year lasting activity the KOMAG Institute realized many projects which enabled to commercialize the research results. Some of them are oriented onto controlling noise emissions from industrial objects, from road traffic, from aeroplanes and from railway lines. The authors of this paper undertook a task of giving a review of many different projects of innovative character, aimed at a development of novel solutions reducing hazards and increasing work safety as well as at a development of technologies and methods for environmental protection of post-mining sites and other areas badly affected by the industry. Special attention was given to the KOMAG achievements in the scope of reducing noise emissions to the environment, including acoustic baffles and active acoustic silences.

One of implementation examples of a KOMAG technical solution in the industrial practice is a sound-insulating enclosure of the WOK 1.5 centrifuge commonly used in preparation plants of mines. Other successful examples of design solutions reducing noise in the environment, which were realized at the KOMAG Institute, include a reflexive silencer of TG type which reduces the energy of acoustic waves transmitted along the axes of pipes and holes, through which air or gas flows as well as a noise silencer of air draw and chute for an operation with high power fans. The awards and distinctions, obtained by KOMAG and its researchers at different kinds of exhibitions and competitions, confirm an innovative character of these technical solutions [11].

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