3. ANNEX to Application

Summary
Of scientific, research, organizational and didactic work achievements

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Rzeszow, April 2019

1. Name and surname

JUSTYNA ZAMORSKA

2. Held diplomas, degrees - with the name, place and year of acquisition and title of doctoral dissertation

1999, PhD in Earth Sciences, discipline: Geology, area: Hydrogeology

Council of Faculty of Geology, Geophysics and Environmental Protection, AGH University of Science and Technology in Kraków

Dissertation title: Prediction of selected water properties in the natural environment by image recognition method

Supervisor: Prof. dr hab.inż. Zdzisław Hippe
Kraków, November 1999

1990, master of Biology, area: environmental biology
University of Silesia in Katowice, Faculty of Biology and Environmental Protection
Topic of master thesis: Analysis of genetic variation of synthetic populations of spring barley

3. Information on previous employment in scientific institutions

1990-1991 - Assistant Trainee in Department of Water Supply and Wastewater Disposal, Faculty of Civil and Environmental Engineering and Architecture, Rzeszow University of Technology.
1991-1995 - Assistant Trainee in Department of Water Supply and Wastewater Disposal, Faculty of Civil and Environmental Engineering and Architecture, Rzeszow University of Technology.
1995-2000- Assistant Trainee in Department of Department of Water Purification and Protection, Faculty of Civil and Environmental Engineering and Architecture, Rzeszow University of Technology.
2000-to date - Assistant Trainee in Department of Water Supply and Wastewater Disposal, Faculty of Civil and Environmental Engineering and Architecture, Rzeszow University of Technology.
2014-2016 – academic teacher, The East European State Higher School in Przemysl

4. Indication of achievements according to Art. 16 Paragraph 2 of the Act of Laws from 14 March 2003 on Academic Degrees (Dz. U. nr 65, poz. 595):

a) Title of the academic achievement

Assessment of the microbiological quality of water using breeding methods, flow cytometry and luminometry, Publishing House of the Rzeszow University of Technology, Rzeszow 2019, ISBN 978-83-7934-296-9.

b) Author/authors, title/titles of publication/s, year of publication, name of the publisher:

The base for my application for a habilitation of technical sciences in the field of environmental engineering (my contribution is 100%) is: Zamorska J., Microbiological quality assessment of water using standard breeding techniques, cell counting and luminometry, Publishing House of the Rzeszow University of Technology, Rzeszow 2019.

c) Description of the scientific research of this work and achieved results and their potential use in practice

In the monography submitted for assessment entitled 'microbiological quality assessment of water with the use of breeding techniques, cell counting and luminometry' various methods of microbiological quality assessment of surface water, rainwater, groundwater, tap water and pool water were compared. A small piece of research presented in the monography, which focuses on single results of chosen kinds of water has been published earlier in three works (according to annex 4: II E.5., II E.9. i II E.10.). In case of every of the aforementioned articles the results made <10% of the whole article. A significant contribution to environmental engineering of the mentioned achievement concerns the microbiological quality assessment of water using traditional breeding techniques, luminometry and cell counting.

Introduction

Microorganisms in water environments are represented by numerous viruses, bacteria, cyanophyta, algae and protozoa. Some of them form the autochthon microflora, which is harmless to people. Apart from them, there is also the allochthonous microflora, which may be formed by pathogenic microorganisms, therefore microbiological quality assessment plays such an important role in water quality assessment. The appearance or permanent presence of pathogenic microorganisms in drinking water causes the danger of dissemination of many communicable diseases. For this reason permanent monitoring of microbiological water quality is necessary. The problem concerns mainly sources which provide drinking water for people, but also pool water or rainwater, which are more frequently considered as alternative water sources. Accurate and fast detection of microorganism cells remains a

constant challenge in the wide spectrum of research and fields of application. This challenge includes such various issues as obtaining quantitative information on certain populations of microorganisms in natural source water, monitoring the quality of fluids used in food and pharmaceutic industry or fast detection of danger in drinking water. Methods of water microbiological quality assessment can be divided into traditional (breeding techniques) and those which use modern technologies. Traditional methods have been used for many years, while methods using cell counting and luminometry are somewhat new in microbiological quality assessment.

A significant progress has been noted in the field of microflora research in many environments. A significant technological progress, including the appearance of molecular microbiology, revealed the complex and abundant presence of microorganisms in almost every water environment. This new approach has highlighted the vast underestimation of bacteria detected by conventional methods compared to bacteria detected by cultivation-independent methods - this phenomenon is classically described as the “great anomaly of dish counting” Flow cytometry (FCM) is defined as cell counting and many applied cytometric techniques are compared. Compared to breeding techniques, luminometry also presents high accuracy of measurement and sensitivity, as well as low machinery cost. It allows to accurately and quickly measure the biomass quantity and the metabolic activity of microorganisms.

Description of the scientific research

The aim of the conducted research was the assessment of microbiological quality of waters of different microbiological characteristics, and therefore of a different level of microbiological contamination:

- surface water,
- rainwater,
- underground water,
- tap water and
- pool water.

The assessment was carried out using traditional breeding techniques and quick instrumental methods: cell counting and luminometry.

The analyses of the microbiological parameters were used for carrying out statistical analyses to answer the question: If quick methods of assessing microbiological quality, like luminometric ATP tagging or cell counting will give such a credible result, that it will allow their routine application.

The traditional assessment of microorganisms quantity on different bases was made to answer the question if the applied reference methods (breeding techniques with reference culture medium - agar A) give credible results for all examined typed of water.

Scope of work

The realisation of the scientific research required literature study, as well as carrying out laboratory research.

The laboratory research included microbiological quality assessment of waters of different microbiological characteristics: surface water, rainwater, groundwater, tap water and pool water.

The scope of the conducted laboratory research included labelling:

1. The general number of psychrophilic bacteria, general number of mesophilic bacteria. These signs were carried out on two kinds of agar media: Reference agar - agar A and agar R2A,
2. The number of particles in water using cell counting with the application of two pigments: SYBR green I and propidium iodide,
3. Luminometric ATP concentration labelling - the RLU amount is mentioned in the paper.

The obtained database was used for statistical calculation, in order to determine a Pearson's correlation between the obtained results.

Discussion of obtained results

The microbiological quality of water is the main aspect determining life and health of the person using it. This problem concerns every kind of water presented and analyzed in the research. Surface waters are a source of drinking water for about 50 per cent of the population of Poland. Currently surface waters are assessed according to classification of ecological status, ecological potential and chemical state. microbiological quality is not assessed, but sadly it is bad. Quantitative values of bacteria in the tested samples of surface water are very diversified and depend mostly on season. By analyzing the values of correlation coefficient for the evaluated parameters of surface water we can see very strong correlations. This concerns the number of psychrophilic bacteria labeled on agar A and agar R2A.

However, strong dependencies were observed for:

- The number of mesophilic bacteria on both agars,
- RLU values, and psychrophilic bacteria on agar A and R2A,
- The sum of all labeled bacteria and RLU value.

It might suggest the application of luminometric ATP tagging for quick microbiological quality assessment of surface water. Unfortunately there was no Pearson's correlation between cytometric labelling and the remaining tested microbiological parameters of water. The correlation coefficient values after considering autofluorescence increased insignificantly. A significant correlation could not be observed in any case.

Water supplies in Poland come mainly from atmospheric rain, which is characterized by differentiation in time and space. There is increasing talk of using rainwater, even as drinking water. Rainwater is characterized by different quality and its composition is shaped by many factors. The source of contamination of rainwater is usually the atmosphere, but the greatest

contamination occurs during flow on surface, roofs, or pipeline systems. After such contact the stored rainwater can be microbiologically contaminated. Even in this case quick methods of quality assessment can be very helpful. Little thorough research aimed at determining the physicochemical and microbiological quality of rainwater. The microbiological quality of rainwater results presented in the paper present its huge variety dependent on the season.
In case of rainwater very strong Pearson correlations between the examined parameters have been noticed. There is a very strong relation between:

- The sum of all bacteria and psychrophilic bacteria on agar R2A
- The sum of all bacteria and mesophilic bacteria on agar R2A
- The number of psychrophilic bacteria on agar A and agar R2A,
- The number of psychrophilic bacteria on agar A with the number of mesophilic bacteria on agar R2A,
- The number of mesophilic bacteria on agar A and R2A,

A very strong relation exists for:

- The RLU value and the number of particles measured using SYBR Green I, and
- The number of particles using both fluorochromes - SYBR Green and propidium iodide.

In case of rainwater no correlation between the results obtained using standard methods and quick methods has been found.

According to the rule that water supplies of the highest quality should be used as a source of drinking water, there is an increase of the number of groundwater sources that are used to massively supply people with water in Poland. In many cases the quality of these waters is so good that they don't require disinfection. In Poland almost 70 per cent tap water come from groundwater, but holding in tanks and distribution in elaborate piping and water systems changes the quality of this water. It implies to use disinfection processes of even groundwater. Local contamination of groundwater also occur, as well as secondary contamination, caused often by the faulty technical and sanitary condition of water installations inside buildings, which provides end users with water. In emergency cases microbiological danger might emerge and then quick labelling methods can inform us about it. The values of psychrophilic and mesophilic bacteria quantity were examined in 24 samples of groundwater. The maximum numbers of bacteria in this water, labelled by breeding techniques on agar A, were for psychrophilic and mesophilic bacteria 27 and 16 cfu/ml respectively, whereas on agar R2A - 84 and 52 cfu/ml. In some samples no bacteria could be found on agar A, bacteria were always found on agar R2A (a minimum value is 4 and 2 cfu/ml respectively for psychrophilic and mesophilic). No bacteria which might indicate faecial water contamination - coliforms or enterococci were found in any of the examined samples of groundwater.

By analyzing the Pearson correlation coefficients a strong correlation between the number of psychrophilic bacteria on agar R2A and the sum of all bacteria obtained by breeding methods can be seen.

A very strong Pearson correlation can be seen between:

- The number of psychrophilic and mesophilic bacteria on both agars,

- The number of mesophilic bactteria and the sum of all bacteria,
- The RLU value, and the number of mesophilic bacteria on agar A,
- The RLU value, and the number of mesophilic bacteria on agar R2A,
- The RLU value and the sum of all bacteria.

In case of groundwater the obtained results indicate luminometric ATP labelling as a quick and credible method of quality assessment.

The quality of tap water depends on the its source, method of withdrawal and purification, the sanitary state of the intakes and storage tanks, the piping system, connections and internal piping installations. There are many factors which determine the quality of water, which is finally used. Many times the quality of water produced and introduced into the water supply network is not the same with the water receiver by the end user. Disruptions of water supply and storing in tanks result in bacteriological contamination. Pressure variations in the system can lead to contamination by other waters sucked into the water system. Drinking water for people should meet certain standards and is systematically monitored. Physicochemical parameters are more often verified by quick tests. But the problem of assessing microbiological contamination is still being solved using traditional, labor and time consuming breeding methods. It takes 24 hours from the moment of labeling to obtaining the first results. This is why searching for labelling methods which are quick, reliable and give repetitive results is essential nowadays. It should be noted, that these quick methods - luminometric ATP labelling and cell counting will not replace breeding methods today. Traditional methods, as stated in the paper are not reliable. The presented research clearly show how big is the difference between the results obtained with using different culture media. Agar A - referencial, depending on the kind of examined water, detects only a small number of bacteria. Is this result satisfactory in case of water we use on a daily basis? Luminometric ATP labelling is a very quick and relatively cheap method to assess the microbiological quality of water. It is a general indicator. Constant ATP labelling would let us identify dangers and could be used in many kinds of waters. Surface waters are used as drinking water sources. The changing microbiological quality, quickly detected, would allow, inter alia, to quickly correct the unitary processes, for example to correct the dosage of disinfectants, to detect incidental contamination and therefore a quick reaction of the services.

In the conducted research, the microbiological quality in 29 samples of tap water has been assessed. Multiple times, the number of bacteria detected in the samples of tap water exceeded the standards stated in the regulation concerning the quality of drinking water [Journal of Laws 2017, item 2294]. Statistical parameters indicate large differences in values of individual indicators on both used agars. In all tested samples a considerably higher number of bacteria was observed in cultures on agar R2A.

By analyzing the Pearson correlations we can see there is a strong linear correlation between:

- The number of psychrophilic bacteria on agar R2A and the sum of all bacteria,
- The number of mesophilic bacteria on agar R2A and the sum of all bacteria.

A very strong correlation was achieved between the number of particles measured using cytometry using SYBR Green I and propidium iodide. Unfortunately the correlation cofactor values indicate lack of Pearson correlation between the results of the number of bacteria achieved using breeding techniques and RLU values and the number of particles measured by cell counting. It concerns both the values of numbers of certain physiological bacteria groups, as well as their sum.

Pool water is vulnerable to all sorts of contamination every day. These are mostly external contamination, that is allochthonous, which are introduced to the pool by each person who is using the pool. These contaminations can be divided into microbiological and physiochemical. Microbiological contamination is a danger for people using this water, whereas physiochemical contamination is often the factor which decides of the survivability of the microbiological contamination introduced to the pool. The presented research for pool water indicated how big is the difference in quality assessment of this kind of water by different methods. Constant control and constant dosing chemical disinfectants do not make this water completely safe.

The number of both psychrophilic as well as mesophilic bacteria specified in the tested samples of pool water on agar A was very low or presence of these bacteria was not noted. The maximum values were 6 cfu/ml (psychrophilic bacteria) and 8 cfu/ml (mesophilic bacteria). On agar R2A the population values were considerably high (256 cfu/ml - psychrophilic, 496 cfu/ml - mesophilic). The minimal amounts were 11 cfu/ml and 46 cfu/ml for psychrophilic and mesophilic respectively. The volume of the remaining water chlorine was from 0.3-0.8 mg/dm^3.

Analyzing the statistical parameters by a strong Pearson's correlation was observed for the following measured a parameters:

- The number of psychrophilic bacteria on agar A and mesophilic on agar A,
- The number of psychrophilic bacteria on agar R2A and mesophilic on agar R2A,

A considerably strong correlation was noted for:

- The number of particles measured using propidium iodide and the number pf psychrophilic bacteria on agar R2A,
- The number of particles measured using propidium iodide with the sum of all the bacteria measured with breeding techniques,
- The number of particles measured using propidium iodide and the RLU value.

Also in the case of pool water the cell counting method using propidium iodide as a dye is the methods which can be used to quickly determine its quality.

In the presented research the sign were made according to the number of microorganisms and correlations obtained by using different methods. The innovation in this work is the comparison of microbiological quality assessment of water using different methods. Every water sample was tested using the breeding method (using the reference agar - agar A and agar R2A) and cell counting and luminometry methods. Creating such a database has let us make a statistical assessment of the obtained results of the quality of

different kinds of water. The analysis has let us make the following conclusions according to the proposed theses of the work:

1. The population of bacteria on agar R2A for all kinds of analyzed waters was higher compared to the reference agar A. The lowest values of the standard deviation for 4 groups of bacteria (psychrophilic and mesophilic bacteria on both agars) in waters of little bacteriologic contamination was obtained in groundwater.
2. The general number of bacteria strongly correlated with the RLU values for surface water and groundwater. It might suggest the application of luminometric ATP tagging for quick microbiological quality assessment of this kind of water.
3. The general number of bacteria strongly correlates with the number of particles labeled cytometrically with the use of propidium iodide only for pool water.
4. A strong correlation between the RLU values and cytometrically labeled number of particles using both the applied fluorochromes was observed for rainwater.
5. Strong and enough strong linear dependencies for the examined microbiological parameters differ in every of the assessed waters.

   The research and statistical analysis also let us make extra points concerning each kind of water.

   - In case of surface water the microbiological quality depended strongly on the season of the research. Low Pearson's correlation coefficients indicate no Pearson's correlation between cytometric labelling and the remaining tested microbiological parameters of water. In case of cytometric labelling we need to correlate the obtained result with autofluorescence. However, the methodology of autofluorescence labeling needs to be improved, because using measurement in water samples only slightly raised the values of correlation coefficient.
   - The microbiological quality of rainwater is very changeable. A very strong Pearson correlation has been noted for labels of bacteria numbers found using breeding methods. On the other hand low values of linear correlation were obtained for values of bacteria population, and values obtained by citometric and luminometric methods.
   - In the case of uninfected groundwater of very high microbiological quality a quick measurement and microbiological quality assessment using the luminometric ATP labelling method is suggested.
   - For tap water a lack of Pearson correlation between the values of the number of bacteria achieved using breeding techniques and RLU values and the number of particles measured by cell counting has been noted. A very strong correlation was achieved between the number of particles measured using SYBR Green and propidium iodide. Such a result indicated the presence of a uniform microflora of the examined waters. What might have influenced the results of luminometric

measurements was the extracellular ATP, which was released from the microorganisms cells while labelling. It indicates the necessity of assessing the concentration of extracellular ATP for the disinfected tap water.

- By analyzing the statistical parameters of pool water a high correlation value of the number of cells measured using propidium iodide with the value of the sum of all bacteria specified by the breeding method is a positive aspect indicating the approach for development of this methodology to quickly assess the bacteriological quality of pool water.

Possible application of results

Application in microbiological quality assessment of waters. The ATP luminometric measurement of concentration gives results which correlate with results obtained by breeding methods for surface water and groundwater. For quick microbiological quality assessment of pool water a good method is cytometry using propidium iodide.

5. Description of other academic achievements

5.1. Pre-doctorate

After graduating the Faculty of Biology and Environmental Protection of the University of Silesia I started working on the Faculty of Biology and Environmental Protection in the Department of Water Supply and Wastewater Disposal. In 1990-1991, led by professor Janusz Tomaszek, I participated in organizing research laboratories and teaching activities on the reactivated environmental engineering. Since the beginning of my work my academic interests were strongly connected with the acquired education and the aspects of environmental biology. I have participated in classes and research activities led by Prof. Marian Granops. The effect of this cooperation is co-autorship of 3 academic publications and 3 studies for the industry and economy [annex 4]. I also collaborated with PhD Jan Pąprowicz in environmental bacteriology research and the influence of waste dumps on the soil environment and air (1 publication and 2 studies, attachment 4).

In 1995 after reorganizing the course I was hired as assistant in the Department of Water Purification and Protection, run by professor Marian Granops. In this period I became interested in the problem of forecasting properties of water in natural environment. I started my literature and laboratory studies, which let me embark on a doctorate on the faculty of Geology, Geophysics and Environmental Protection on the University of Science and Technology in Cracow. Prof. dr hab.inż. Zdzisław Hippe was appointed as supervisor of the dissertation entitled “Prediction of selected water properties in the natural environment by image recognition method”.

One of the fields, in which methods of mathematical statistics and computer simulation are developing rapidly are problems of forecasting the quality of water. This results from the need of regular usage of the natural environment resources and its sustainable development. The aim of the research was to attempt to apply one of the computer vision methods to

forecast the quality of water in a dam reservoir, assisted by a function of analytical data visualization. This visualization, after creating a source database, allowed to select the appropriate parameters of water quality forecasting processes. The water quality forecasting strategy (physical-chemical and bacteriological parameters) in the tested sampling point is to compute the possible values of indicators, based on their concentrations in the closest points. The calculations were made using the KNN (K-Nearest Neighbour) method. Forecasting characteristics of water in the specified area was less prone to error if a higher number of neighbours was taken into the calculation. The results presented in the dissertation were the basis to write 2 manuscripts and one conference presentation [annex 4]

I submitted the dissertation in November 1999 acquiring a degree of doctor of earth sciences in the discipline of geology and area of hydrology awarded by the resolution of the council of the faculty of Geology, Geophysics and Environmental Protection on the University of Science and Technology in Cracow.

5.2. Post-doctorate

The main topics covered in my research work are:

1) The usage of biopreparations on biological sewage treatment plants:

1a. The usage of biopreparations to treat sewage waste;

1b. The usage of biopreparations in sewage treatment processes.

2) The usage of biotechnological methods in removing petrolium contamination form water-soil environment;

3) Biotechnological methods of treatment of groundwater with excess content of nitrogen compounds;

4) Metal biosorption from aqueous solutions;

5) Microbiological quality assessment of water using standard breeding techniques, cell counting and luminometry.

Ad.1a.

After my doctoral degree I became interested in the possibilities of applying biopreparations in environmental engineering. [Annex 4 II E.33.]. My interests in bio-preparations resulted in a cooperation with GREENLAND, the producer of the EM biopreparation and popularizer of the EM technology. The EM “Effective Microorganisms” technology is based on using a biological preparation containing selected variants and species of microorganisms of different physiological and biochemical features. These are mainly autochthonic organisms isolated from the environment, therefore they are safe and they don’t present a risk to functioning ecosystems in case of introducing microorganisms with processed waste back to the environment. The most important groups of Effective Microorganisms apart from photosynthetic bacteria are bacteria lactic acid, actynomycetes, mould particles, yeasts. Each of these five groups of microorganisms is characterized by a different mode of action.

The first direction of research in which I planned and actively participated in concerned the possibility to apply the EM-Bio biopreparation to reduce or eliminate the odor nuisance of sewage waste. The research was organized in a laboratory, semi-technical and technical scale. Research organized on a micro-technical scale was conducted in sewage treatment plants in Świlcza, Przeworsk, Leżajsk and Roźwienica (Podkarpackie voivodeship).

The conducted experiments led to conclusions which were very important in practical application of the biopreparation. Inoculating all the sewage waste used in the research (screenings, secondary sewage sediment dehydrated on the press and sand from the grit) by the EM-Bio biopreparation was more efficient in aerobic conditions. What turned out to be useful was the addition of structural materials, increasing access to oxygen or inoculating in liquid environment. A good indicator of inoculating the waste material by the EM-Bio biopreparation was the general number of fungi. The domination of effective microorganisms in the processed waste resulted in their lesser nuisance, quicker processing and increased mass reduction.

Another aspect of using the EM-Bio biopreparation was hygienization of wastes. A hygienizationing influence of the biopreparation was observed, taking into consideration the markers of faecal contamination - cola group bacteria. Its effective action in terms of live eggs of *Ascaris sp., Trichuris sp.,* i *Toxocara sp*., parasites elimination Was not found, contrary what was suggested by literature. Parasite eggs were detected in every kind of processed material during the entire time of the experiment. It has been noted, that EM technology can be applied to reduce the odor nuissance of: stored dehydrated waste, processed waste and sediment with structural materials, stabilized and dehydrated sediment on fields, screenings and sand. EM technology was implemented in full technical scale in biological sewage treatment plants in Przeworsk, Roźwienica, Horyniec and Nowa Wieś (Podkarpackie voivodeship). The results of conducted works are included in works II A.3., II A.4., II E.16., IIE18. - annex 4, the research project report ordered PBZ-MEiN-5/2/2006 "New methods and technologies of deodorization in industrial, agricultural production and urban economy", and in conferences II J.4., II J.6., III B.6., III B.8, III B.9, III B.12., III B.15., III B.16. - annex 4. The work on this topic also resulted in a series of ordered works - annex 4.

Ad. 1b. The usage of biopreparations in sewage treatment processes;

Another topic I carried out concerning the EM-Bio biopreparation was its influence on sewage treatment processes and activated sludge organisms A large diversity and ability to decomposing a series of compounds can positively influence on the effectiveness of biochemical processes, but there is very little literature on this topic. The aim of the conducted research was to check the possibility to implement EM-Bio in the sewage treatment technology: Its influence on biocenosis of the activated sludge and the effects of sewage treatment. No negative influence of the biopreparation on organisms of the activated sludge in the breedings carried out in laboratory conditions was observed and no negative influence of the EM-Bio on sedimentary properties of the activated sludge was noted. A higher number of free-swimming bacteria in the biocenosis of the activated sludge and an

increase of opacity of the sewage after the purification process was noted. EM-Bio positively influenced on the process of eliminating organic compounds from sewage. The tested biopreparation was recommended in case of grey or black color of the activated sludge, present in the system, which indicated a great degree of oxygen deficiency and a low level of eliminating organic compounds [annex 4. - III B.13., III M.20., III M.21.].

Ad. 2) The usage of biotechnological methods in removing petroleum contamination form water-soil environment;

Since several years an increased interest in using certain species of microorganisms to eliminate petroleum contamination from water-soil environment has been observed and a selection of variants of special degradational properties is conducted. Introducing biotechnological methods requires using appropriate preparations and conditions of safe and effective usage. Biopreparations are compositions of microorganisms of a specified population composition and quantitative proportions. Introduced to the environment as biological strains they enable effective development of the microflora. There are many readymade biopreparations on the Polish market, which many a time do not contain relevant information on composition, dosage, storing and usage. In the condicted research the influence of abiotic factors on the speed of the biodegradation process of petrolium compounds in soil was determined The process was stimulated by DBC plus biopreparation, type R5. The influence of temperature, pH and biopreparation dosage on the effectiveness of diesel oil degradation in soil was tested [annex 4. II E.24, II E.27.].

Ad. 3) Biotechnological methods of treatment of groundwater with excess content of nitrogen compounds;

An increasing contamination of groundwater by nitric compounds, particularly by ammonium nitrogen, caused a necessity to seek new methods of purification. Due to costs connected with using physicochemical methods and fear concerning using biological methods, groundwater intakes were often neglected, when the presence of ammonium nitrogen was detected. If the presence of a nitrification process in eliminating ammonium nitrogen was discovered, it occurred on treatment plants, where spontaneous “working” of nitrification deposits on filters which were used to remove iron and mangan (usually sand filters) was observed. Research on the effectivity of eliminating ammonium nitrogen in connected processes of ion exchange and nitrification on different fill materials contributed to establish a cooperation with Prof. Dorota Papciak and the team of professor Dorota Antos of the Faculty of Chemistry of Rzeszow University of Technology. During the research I isolated nitrification bacteria and multiplied them on culture media in order to immobilize them on deposits used in ammonium ion removal processes. Research results showed that developing a biofilm in different natural fillings (diatomite, clinoptilolite, chalcedonite) was considerably quicker with constant dosages of nitrification bacteria. My research also concerned the problem of leaching bacteria from made biofilm, bacteriological quality of the filtrate and biofilm activity research [annex 4.-II A 5., II A.6., II A.7., IIE.19., II J.7., 3 B.7.].

Ad. 4) Metal biosorption from aqueous solutions.

In my academic work I also dealt with the process of eliminating metals from water environment in the process of biosorption. Articles concerning this issue focus firstly on the literature overview. Biosorbents and biosorption process mechanisms are presented. Basic factors influencing this process are described. These are the kind and design of the biosorben, character of immobilization, features of the solution in which the process with the basic abiotic factors occurs, according to annex 4. II E.14.

In experimental works on this issue research results on the cobalt ion biosorption process on live and dead cells of *Saccharomyces cerevisiae* were presented. The research was conducted using a wide range of the initial concentration of cobalt ions, pH ant temperatures. Research results let us say that among the tested factors only the initial metal concentration had significant influence on the effectivity of cobalt ion biosorption by the *Saccharomyces cerevisiae* biomass. The effectivity was maximum 99,28% in case of dead and 99,34% in case of live microorganisms, in the tested spectrum of concentrations - annex 4. II E.15. Research on using Bacillus subtilis as a metal ion biosorbent didn't bring such good results - annex 4. III B.5. Also copper ion biosorption from sewers didn't result in such a high efficiency - annex 4. - II A.2.

Ad. 5) Microbiological quality assessment of water using standard breeding techniques, cell counting and luminometry.

I dealt with aspects of microbiological quality assessment of different kinds of water form the beginning of my academic work (my dissertation contained results of bacteriological surface water research, these results were mentioned in works II A.8., II A.9. - annex 4). Initially this research concerned quality assessment using only traditional breeding methods and developing manuscripts with literature overview concerning microbiological danger connected with tap water (annex 4 - II E.7., II E.13., II E.26., II E.29., II E.30.]. After buying a cell counter and luminometer to the laboratory, my research concentrated on water quality assessment using this equipment and comparing the obtained results with those btained by traditional breeding methods. In 2015 I was nominated as assistant supervisor for mgr Monika Zdeb's doctorate entitled: "The quality of rainwater in the aspect of its commercial exploitation". Quality testing of rainwater, its quality change during storage and searching effective methods of disinfection has become a separate field of study with my PhD student. For microbiological quality assessment we used traditional breeding methods and quick methods of quality assessment like luminometry or cell counting. The conducted research resulted in many publications mentioned in annex 4. II E.2., II E.4., II E.5., II E.6., II E.8., II E.9., II E.10., II E. 12., and presentations and articles in conference materials.

Summary of academic achievement

Before obtaining my doctorate I was the co-author of 4 articles and 2 publications in conference materials.

My post-doctorate achievement consists of 80 publications, 8 of which are articles published in JCR featured journals, 3 co-authorships in monography chapters and 34 publications in journals not featured in JCR, but featured on the Ministry of Science and Higher Education (MNiSW), as well as 29 works featured in conference materials. I attended 7 international and 10 national conferences. I was member of the research team in 2 grants. I was the executor and co-executor of 25 scientific studies for economic enitities.

IF according to year of publication: IF=**11,374**.
Number of MNiSW points according to points and year of publication: **314** (including handbooks: 322)

Tab. 1. List of academic achievements

No	Type of publication	Pre-doctorate	Post-doctorate	General
1	Publications in magazines distinguished in the JCR database	1	8	9
2	Publications in magazines scored not distinguished in the JCR	3	34	37
3	Chapters in monographs	0	3	3
4	Publications published in conference materials	2	29	31
	Total	**6**	**74**	**80**
5	Develop for businesses	6	25	31

Tab. 2. Numerical list of functions in the means of place among authors

No	Type of publication	Own works	Co-authorship of publication				Total
			First author	Second author	Third author	Fourth author	
1	Publications in magazines distinguished in the JCR database	0	1	5	2	1	9
2	Publications in magazines scored not distinguished in the JCR	4	11	15	6	1	37
3	Chapters in monographs	1	0	1	0	1	3
4	Publications published in conference materials	2	11	10	4	4	31
5	Total	7	23	31	12	7	80

Tab 3. Academic achievements evaluation index

	According to Web of Science	According to Google Scholar
Total number of citations	21	104
Number of articles in base	11	54
Hirsch index	2	5

I was rewarded for my academic activity with team award by the Rzeszow University of Technology Rector:

Rewards for academic achievement

2017 – Award of the Rector of the Rzeszow University of Technology - collective award 3rd level for a publication cycle on water technology and water-soil resources.

2009 – Award of the Rector of the Rzeszow University of Technology - collective award 3rd level for a publication cycle on advanced water purification and recycling techniques.

Didactic activities:

I started my didactic activities in 1990 in the Department of Water and Sewage Technology, Faculty of Civil and Environmental Engineering and Architecture, Rzeszow University of Technology. Working as an assistant I conducted the following courses on environmental engineering:

- Laboratory classes on Sanitary biology,

- Classes on Environmental protection.

Due to department reorganization I became an employee of the Department of Water Purification and Protection. I started giving auditory lectures on environmental protection and laboratory classes on biology and ecology and environmental microbiology. I actively participated in developing education programmes on Biology and Ecology, Environmental Microbiology and organization of the laboratory in which the courses were taught.

After obtaining my doctorate I started giving lectures on the aforementioned subjects. Currently I teach the following subjects:

1) Biology and Ecology (lecture, laboratory class) - full-time and part-time degree courses - environmental engineering.
2) Environmental microbiology (lecture, laboratory class) - full-time and part-time degree courses - environmental engineering.
3) Biology (lecture, laboratory class) - full-time degree courses - environmental protection.
4) Microbiology (lecture, laboratory class) - full-time degree courses - environmental protection.
5) Hydrobiology (lecture, laboratory class) - full-time degree courses - environmental protection.

I am the co-author of an academic manuals and 2 scripts and auxiliary materials.

Manuals:

- Papciak D., **Zamorska J**., Kiedryńska L., Microbiology and biotechnology in the process of water of water purification, The publishing house of the Rzeszow University o Technology 2011.

Textbox:

- **Zamorska J**., Papciak D., Chosen issues of environmental biotechnology. The publishing house of the Rzeszow University of Technology, Rzeszow 2001.
- Papciak D., **Zamorska J.**, Basic of biology and environmental biotechnology. The publishing house of the Rzeszow University of Technology, Rzeszow 2005.
- **Zamorska Justyna,** Zdeb Monika: Biology and Ecology, Auxiliary materials**.** The publishing house of the Rzeszow University of Technology Rzeszow 2013.

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I was rewarded for my academic activity three times with team awards by the Rzeszow University of Technology Rector:

Rewards for didactic achievement:

2002 – Award of the Rector of the Rzeszow University of Technology - collective award 2nd level for the script " The chosen issues of environmental biotechnology", development of the biotechnology curriculum in the field of Environmental Engineering.
2006 - Award of the Rector of the Rzeszow University of Technology - collective award 3rd level for a script " Basics of biology and environmental biotechnology".
2011 - the Rzeszow University of Technology Rector Award - team award 2nd level for the academic textbook "Microbiology and biotechnology in the process of water of water purification".

I was the supervisor of 47 master theses and 18 engineer theses and 4 times the legal guardian of the year.

Organizational activity and popularizing:

1. I am the member of the Department Quality Assurance of Education Committee in 2013-2019, including two teams responsible for preparing a report on the assessment of the qualification process and education outcomes verification.
2. I was a member of a team which prepared a self-assessment report concerning the program evaluation of the Environmental Protection program carried out by the Polish Accreditation Committee in 2015.
3. I am the faculty administrator for the panel of education effects of KRK for the Environmental Protection program and I was responsible for preparing educational programs according to national qualifications framework for higher education for the Environmental Protection program for full-time and part-time bachelor and master studies, including formulating and assigning program education outcomes in terms of knowledge, skills and social competences to appropriate modules and area effects.
4. Member of the faculty recruitment committee in 1993 - 2004.
5. I actively participated in the "Polytechnics for girls" campaign and in information campaigns for future students entitled "living graduates". I prepared and gave laboratory classes on microbiology for high school students in the "We invest in education" program - increasing the key competences and equalization of educational opportunities for students, co-financed from the European Union funds particularly under the Human Capital Operational Program, National Cohesion Strategy.