Annex No. 3

Wrocław, February 5, 2013

Summary of professional accomplishments

1. Basic personal data

Full name: **Józef KUROPKA**

Date of birth: December 5, 1947

Diplomas and academic degrees - including name, location and year of award:

Master of Science, Engineer - based on the Master thesis: "Some issues of hydraulics on grate-tube shelves without overflow", defended on June 13, 1970, with a very good result at the Institute of Chemical Engineering and Thermal Devices, Faculty of Chemistry, Wrocław University of Technology (supervisor: Prof. R. Koch, Ph.D., Eng);

Doctor of Technical Sciences - based on a doctoral dissertation entitled "Kinetics of carbon disulphide sorption process on anion-exchangers" defended with distinction on November 6, 1970 at the Institute of Environmental Protection Engineering, Faculty of Sanitary Engineering (now Environmental Engineering) at Wrocław University of Technology (supervisor: Prof. M. A. Gostomczyk, Ph.D., Eng.).

Place of work: **Institute of Environmental Protection Engineering**
Faculty of Environmental Engineering
Wrocław University of Technology
Wybrzeże Wyspiańskiego 27
50-370 Wrocław

Information on employment in scientific units:

- **Wrocław University of Technology**

1970-1972 - Research and teaching trainee assistant in the Atmosphere Protection Division, Institute of Chemical Engineering and Thermal Devices, Sanitary Engineering Division (presently: Environmental Engineering) at Wrocław University of Technology,
1972 - Research and teaching assistant in the Atmosphere Protection Division, Institute of Environmental Protection and Engineering, Faculty of Sanitary Engineering (presently: Environmental Engineering) at Wrocław University of Technology,
1972-1976 - Senior research and teaching assistant in the Atmosphere Protection Division, Institute of Environmental Protection and Engineering, Faculty of Sanitary Engineering (presently: Environmental Engineering) at Wrocław University of Technology,
1976-present - research and teaching assistant professor (adjunct) in the Atmosphere Protection Division, Institute of Environmental Protection and Engineering, Faculty of Sanitary Engineering (presently: Environmental

Engineering) at Wrocław University of Technology, Head of the Educational Team for "Atmosphere Protection".

Additional employment:

- **Babcock Borsig Power - Energy. Babcock Steinmüller Wrocław Sp z o.o.,**
Period of employment: June 10, 1999 – December 24, 1999;

- **Wyższa Szkoła Menedżerska w Legnicy**, Head of Postgraduate Studies in Environment Engineering
Period of employment: October 1,1999 – June 30, 2009

2.Indication of research achievement resulting from Art. 16, section 2, of the Act of March 14, 2003, on Academic Degrees and Title as well as on Degrees and Title in the Field of Arts (Journal of Laws No. 65, Item 595, as amended)

2.1. Author/authors, title/titles of publication(s), year of publication, publishing house

As the research achievement to be assessed in the habilitation proceedings I submit a work published in full in a book:

Józef Kuropka, Technologies of gas treatment for sulphur dioxide and nitrogen oxides,
Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław 2012, (200 pages).

and

the following series of single-thematic publications in the field of gas purification from nitrogen oxides

1. Gostomczyk M.A., **Kuropka J.**: Investigations on sorption of acid gases on anion exchangers. Environment Protection Engineering **1977**, Vol. 3, *1-2*, pp 135–144.
2. Gostomczyk M.A., **Kuropka J.,** Sosnowski M.: On the removal and reuse of nitric oxides from process gases of sulphuric acid production. Environment Protection Engineering **1986**, Vol. 12, *2*, pp 91–98.
3. **Kuropka J.,** Gostomczyk M.A.: New technology for the removal and reuse of nitrogen oxides contained in industrial gases. Environment Protection Engineering **1988**, Vol. 14, *1*, pp 39–45.
4. **Kuropka J.**, Gostomczyk M.A.: Absorption of nitrogen oxides. Acidic absorbents. Environment Protection Engineering **1990**, Vol. 16, *1*, pp 75–84.
5. **Kuropka J.,** Gostomczyk M.A.: Absorption of nitrogen oxides. Alkaline absorbents. Environment Protection Engineering **1990**, Vol. 16, *1*, pp 85–98.
6. **Kuropka J.**: Nitrous oxide emission-potential danger, balance and reduction possibilities. Environment Protection Engineering **2006**, Vol. 32, *3*, pp 81–88.
7. **Kuropka J.**: The simultaneous desulphurisation and denitrification of flue gases. Environment Protection Engineering **2008**, Vol. 34(4), pp 187–195.
8. **Kuropka J.**: Reduction of nitrogen oxides from boiler flue gases. Environment Protection Engineering **2010**, Vol.36 (2), pp 111–122.
9. **Kuropka J.**: Removal of nitrogen oxides from flue gases in the packed column. Environment Protection Engineering **2011**, Vol. 37 (1), pp 13–22.

Four of these publications are solely of my own authorship, and of the other five I am the main author, and my share of contribution to them has been dominant. My contribution has been to formulate a research problem, plan and execute experiments, interpret the results and write the articles.I therefore estimate my share of contribution to be 90%. Statements of co-authors regarding their contribution in joint publications are attached in Annex No. 9.

2.2. Discussion of the research goal in the above-mentioned papers and obtained results, including discussion of their possible use.

Air pollution due to emissions of harmful substances contained in flue gases from power plants and in industrial flue gases is one of the most important problems to be solved by contemporary science and technology .In Poland, already in 1980, the Act on Environmental Protection and Management stated that organizational units (enterprises) are obliged to use the methods, technologies and technical means which protect the air from pollution. It was indicated that air protection means preventing the formation of pollutants introduced to air, or reducing and eliminating them, in order to reduce their concentrations to acceptable levels, or to keep them at a level which does not exceed the current limit values for concentrations of substances in the air.

While the problem of dust emission is resolved, further numerous and serious research on the neutralisation of harmful gases released into the air is still required. This results not only from different physical and chemical properties and variable composition of various gas components, but also from different proportions of their content, their often aggressive and explosive character, as well as from different streams of gases emitted into the atmosphere.

To comply with the requirements of national and EU legislation, and in particular to observe the emission standards, it is required, among other things, to consistently install and maintain the equipment for the purification of gases, while in the next few years the biggest problem will be maintaining the nitrogen oxide emissions at the level of 200 mg / m_n^3, expressed in NO_2, with a 6% content of O_2 in the flue gases.

Therefore, significant have been the efforts to reduce the emission of flue gases through simultaneous use of the so-called primary and secondary treatment methods. The current economic situation of the country determines the search for such methods and technologies of exhaust gases and industrial flue gases treatment, which will allow to reduce the emission of gaseous pollutants to the air with minimal input.

The aim of the author of the book indicated above is to explain the principles of operation, design and exploitation of the equipment used in the technologies of flue gas treatment from gaseous pollutants (absorbers, adsorbers, catalytic reactors for catalytic oxidation or reduction) and to present industrial technologies for gas purification from gaseous pollutants implemented in industrialized countries worldwide and introduced in recent years to Poland. The book has been based on the author's many years of research and teaching experience enriched with his cooperation with the industry.

Among the publications discussing the national economy, what deserves special attention is own research and developed technologies for:

I. **Application of anion-exchangers for the removal of acid gas impurities.**
II. **Removal of nitrogen oxides from flue gases.**
III. **Removal of sulphur dioxide from flue gases.**
IV. **Combined removal of sulphur dioxide and nitrogen oxides from exhaust gases of power boilers.**
V. **Reduction of nitrogen oxide emissions from the flue gases with the use of selective non-catalytic and catalytic reduction.**

Ad I.

Dynamic development of technique and technology in many branches of industry means that the traditional methods of neutralisation of industrial flue gases applied so far, are in many cases inefficient or simply useless.

There are various sources of air pollution and with the development of new industrial technologies their number and diversity continues to grow. Among the flue gas substances the most serious problem is posed by highly toxic gaseous compounds of fluorine, nitrogen oxides and sulphur compounds, such as sulphur dioxide, hydrogen sulphide and carbon disulphide.

Thus, the increasing pollution of the atmosphere forces us to reach for new technology for flue gas purification. These new techniques based on the use of polymeric materials include the use of sorption in the disposal and utilisation of industrial flue gases.

Works on the use of anion-exchangers for gas sorption have been aiming towards the use of their sorption, chemisorption and catalytic properties. Most of these works have been performed on a laboratory scale and only determined or improved the sorption capacity of anion-exchangers.

The influence of gas linear velocity, the gas flow rate and the height of anion-exchange layer on its sorption capacity has not been clearly interpreted by the authors of the published works. However, the review of the literature data shows that the sorption capacity of anion-exchangers :

- depends on the functional groups of an anion-exchanger,
- increases with increasing moisture content in the sorption system.

The conclusion here is that the possibility of applying anion-exchangers in the disposal and utilisation of flue gases is dependent on the progress of studies on the kinetics of the sorption process and the regeneration of the acidic gaseous pollutants sorbed on the anion-exchangers.

Own research on the sorption of sulphur dioxide, nitrogen oxides, hydrogen fluoride, hydrogen sulphide and carbon disulphide on anion-exchangers carried out in the Research Team of Prof. M.A. Gostomczyk, presented in single-thematic articles in the journal Environment Protection Engineering **[1],** has led to the development of modern method of disposal and utilization of acidic gaseous pollutants from industrial flue gases. The layer of anion-exchanger enables almost complete removal of contaminants and therefore this technology is good for removing pollutants from the air-conditioned air (special products, medicines, passenger comparments in cars standing in traffic jams).

The anion-exchangers used in the research were of polymerisation type, with varying degrees of cross-linking, obtained from a copolymer of styrene with divinylbenzene (Amberlite, Dowex, Wofatit, Zerolit etc.) and a step-growth polymerization anion-exchanger (FFD) synthesized from formaldehyde and m-phenylenediamine. The experiments were conducted compliant with the technology developed at the Institute of Environmental Protection Engineering of Wrocław University of Technology, which consist in continuous regeneration of the anion-exchanger layer with the use of sodium hydroxide solution during sorption. Such performance of the sorption process allows for the reproduction of sorption capacity of an anion-exchanger.

In the tests carried out on a laboratory scale on artificially prepared gases, the possibility to use anion-exchangers for the sorption of acidic gases was examined. The conducted experiments allowed to choose the anion-exchanger with the best properties for further studies aimed at the identification of certain parameters significant for technological processes.

Based on the analysis of aquired dependencies of sorption efficiency on the contact time of the gas and the flow resistance on the gas velocity, at varying intensities of spraying and altitudes of anion-exchanger layers, it was found that the FFD anion-exchanger has the best operating parameters, which influence the economy of installation for flue gas purification.

Low gas flow resistance, and the ease of synthesis of any amount of FFD anion-exchanger with various granulation in laboratory conditions, determined the choice of FFD anion-exchanger for further research on the sorption of acidic gases on a quarter-commercial scale.

Experiments on this scale were carried out on real gases emitted by the plants producing sulphuric acid (with contact and nitroso methods), phosphate fertilizers and viscose fibers.

The experiments were designed to investigate the possibility of a significant improvement in the relevant process parameters of acid gas sorption on anion-exchangers. Basic parameters of sorption process were studied, such as resistance to gas flow, contact time, spraying density, gas flow velocity and sorption efficiency. Experiments were conducted on a single layer of an anion-exchanger of a height of 0.06m, and then on the two layers of an anion-exchanger of a height of 0.03m each.

Research on the sorption of acid gases on anion-exchangers carried out on a laboratory and quarter-commercial scales have led to the development of flue gas treatment technology. The said

technology allows for running processes of flue gas purification in identical installations, which differ only in the size of equipment.

Research on the use of anion-exchangers for the removal of acidic gaseous pollutants from industrial flue gases has shown **[1]:**

- very good sorption properties of anion-exchangers,
- the possibility of significant reduction of the size of the installation,
- high efficiency of purification,
- very high levels of tolerance to concentrations of acidic impurities in the gas purified, the ability to create closed circuits in the purifying installations.

The application of an appropriate method of disposal of post-sorption solutions obtained from the sorption of acid gases on anion-exchangers depends primarily on technological and economic considerations.

The research discussed have resulted in the publication of the results, among others, in the following articles:

1. Gostomczyk M.A., **Kuropka J.**: Application of anion-exchangers to removal of acid components from industrial waste gases. In *Waste industrial gases purification with sorption methods;* Pr. Nauk. Inst. Inż. Ochr. Środ. Politechn. Wroclaw **1978**, *36*, Studia i Materiały Ser. *19*, pp 3–19.
2. Gostomczyk M.A., **Kuropka J.**: Sorption parameters of acid gases on anion-exchangers.In *Waste industrial gases purification with sorption methods*. Pr. Nauk. Inst. Inż. Ochr. Środ. Politechn. Wroclaw **1978**, *36*, Studia i Materiały Ser. *19*, pp 53–62.
3. **Kuropka J.**, Gostomczyk M.A.: Anion-exchangers and environment protection. Ochrona Powietrza **1978**, *1*, pp 9–13.
4. **Kuropka J.**, Gostomczyk M.A.: The removal of nitric oxide from gas using anion exchangers. Gaz, Woda i Technika Sanitarna **1990**, *8*, pp 157–159.

Ad II.

Methods of absorption of nitrogen oxides in the solutions are one of the earliest methods introduced into the technology of industrial flue gases treatment. These methods use basic properties of nitrogen oxides which occur in flue gases – their solubility in water or in solutions of nitric acid and sulphuric acid, and the ability to form the corresponding salts, nitrates and nitrites in the reactions with the alkaline substrate **[2, 3, 4, 5, 9].**

Methods of the absorption of nitrogen oxides in acids lead to the production of nitric acid or concentrated nitrogen oxides, so they do not give by-products, but increase the amount of the basic product. In most cases, these processes are technically and chemically simple. Their common disadvantage is too low rate of mass exchange , which in industrial conditions requires apparatus of large volumes. These methods also involve a number of important corrosion problems, typically overlooked in the studies concerning laboratory-scale research.

On the other hand, methods for the absorption of nitrogen oxides in alkaline solutions are generally characterized by better efficiency. These methods are usually more expensive because they give products that require additional technological procedure. They provide, however, reduction of the amount of nitrogen oxides in industrial flue gases to the limits defined by sanitary norms.

In the absence of information necessary to design the installation for the purification of flue gases from nitrogen oxides in the world literature, own research was undertaken, as described in the monograph:

1. **Kuropka J.**: Removal of nitrogen oxides from industrial gases. Pr. Nauk. Inst. Inż. Ochr. Środ. Politechn. Wroclaw, *62*, Monografie Ser. *30*, Wrocław, 1988.

and in a series of articles in the journal Environment Protection Engineering **[2,3,4,5,9].**

The above-mentioned monograph presents comprehensive analysis of the current state of technology in methods for flue gases purification from nitrogen oxides, and the own studies which were undertaken to develop technology for cleaning flue gases from nitrogen oxides. The usefulness of selected absorbent solutions for the disposal of nitrogen oxides from flue gases and the possibilities of intensifying the cleaning process were determined.

The empirical equations describing the impact of the basic parameters such as concentration of nitrogen oxides in the gas, gas velocity, concentration and type of the absorption solution, spray density, type and amount of the filling and the resistance of gas flow on the process of gas purification from nitrogen oxides were established.

Correlations were developed to generalize the results of the acid and alkaline absorption of nitrogen oxides, and the sorption of nitrogen oxides on anion-exchangers as a function $\eta = 1\text{-}\exp[-f$ (process variables].

Multi-variant testing gave rise to the development of the following technologies for cleaning flue gases from nitrogen oxides, both from large and small plants:

- removing and utilisation of nitrogen oxides from gases after the production of sulphuric acid by nitroso method,
- purification of waste gases from nitrogen oxides in an alkaline solution of sodium hypochlorite,
- purification of waste gases from nitrogen oxides in an alkaline solution of sulphites or sulphides,
- purification of waste gases from nitrogen oxides on anion-exchangers.

Technology for removal and disposal of nitrogen oxides from the flue gases after the production of sulphuric acid with the use of nitroso method was developed in relation to the production unit of superphosphate at the phosphorus fertilizer plant, thereby it allows to introduce new post-absorption solutions (if it is required to improve the efficiency of treatment without making any changes in the system), which can be used in the plant, such as alkaline solution of diammonium orto-phosphate as a component for the production of ammonium diphosphate. What can be used in place of a single-layer water separator – as a third level of treatment – is the sorption of residual nitrogen oxides on anion-exchangers regenerated continuously with the solution of sodium hydroxide .Implementation of this technology allowed to completely restrict the emission of mist from sulphuric acid and reduce from 21 to 6.5 kg the consumption of nitric acid to produce 1,000 kg of sulphuric acid.

The prospect of the implementation of the developed technologies of neutralisations from small emitters (in an alkaline solution of sodium hypochlorite, in alkaline solution of sulphites or sulphides, sorption of nitrogen oxides on anion-exchangers) depends largely on the ecological awareness of the managers of these plants and on their understanding that the installation of equipment for reduction of nitrogen oxides emissions is a requirement of the times and not just "stiff" regulations of the act on environmental protection.

The developed technologies are the proposal for flue gas purification from nitrogen oxides in a simple technological system, including the economic effectiveness of the investment and operating costs.

The presented research resulted in the publication of the results, among others, in the following articles:

2. **Kuropka J.**, Gostomczyk M.A.: Treatment of flue gases for nitrogen oxides formed in the process of metal pickling with nitric acid. Ochrona Środowiska **1980**, *1*, pp 40–41.
3. **Kuropka J.**, Gostomczyk M.A., Zadura W.: Absorption of nitrogen oxides in oxidizing solutions. Gaz, Woda i Technika Sanitarna **1980**, *9–10*, pp 272–273.
4. **Kuropka J.**, Gostomczyk M.A.: Reduction of nitric oxides by alkaline solutions of sulphides and sulphites. Ochrona Powietrza **1981**, *1*, pp.6–8.
5. Gostomczyk M.A., **Kuropka J.**, Zadura W.: Absorption of nitric oxides through alkaline solution of sodium hypochlorite. Ochrona Środowiska **1982**, *3*, pp.13–15.
6. Sosnowski M., Gostomczyk M.A., **Kuropka J.**: Removal of nitric oxides from industrial gases. Ochrona Środowiska **1983**, *3–4*, pp 54–58.
7. Gostomczyk M.A., **Kuropka J.**: Removal of nitrogen oxides from process gases. Ochrona Środowiska **1986**, *3*, pp 15–16.
8. **Kuropka J.**: Removal of nitrogen oxides from flue gases by absorption in phosphate solutions. Ochrona Środowiska **1990**, *1-2*, pp 45–46.
9. **Kuropka J.**: Alkaline absorption of nitrogen oxides. Ochrona Środowiska **1992**, *2–3*, pp 45–48.

Material collected experimentally verifies literature reports and provides information necessary for the design of the installation for the purification of gases from nitrogen oxides.

Ad III.

Judging by the development of energy and heat industry, coal will remain the primary energy source in our country .With this comes the need to use inferior, more sulphur-infested kinds of coal and therefore already in the 1980s in the Research Team led by Prof. M.A. Gostomczyk ,test were conducted for the removal of sulphur dioxide from flue gases, on the artificially prepared and real gases in pilot and fully industrial installations using different sorbents (sodium, calcium), and the purification process was carried out by wet, semi-dry or dry methods.

The work discusses the methods which have been implemented in recent years or which are currently being implemented and the methods developed to the extent which allows for their application in national conditions, in the development of which I personally participated, significantly contributing to their development.

The research results, which led in the Institute of Environmental Protection Engineering to the development of technologies of flue gases desulphurisation described in my book, were presented, among others, in the following reports, articles and conferences:

1. **Kuropka J.**: Desulphurisation of industrial burnt gases. Gaz, Woda i Technika Sanitarna **1982**, *11–12*, pp 228–230.
2. Gostomczyk M.A., Kabarowska B., Lewicki Zb., **Kuropka J.**, Domański M.: Technical and economic analysis of the pilot installation of flue gas wet desulphurization for power plants of Jaworzno Basin. Reports of the Institute of Environmental Protection Engineering of the Wrocław University of Technology **1983**, SPR Ser. *28.*
3. Gostomczyk M.A., Kabarowska B., Lewicki Zb., **Kuropka J.**, Domański M.: Process design of research installation for flue gases desulphurisation from the sinter strand in Katowice Steelworks using a double alkaline method. Reports of the Institute of Environmental Protection Engineering of the Wrocław University of Technology **1983**, U Ser. *16.*
4. Gostomczyk M.A., **Kuropka J.**: Flue gas desulphurisation in a solution of sodium sulphite. The concept; Reports of the Institute of Environmental Protection Engineering of the Wrocław University of Technology **1984**, SPR Ser., *31.*
5. **Kuropka J.**: Abating air pollution in Poland. Ochrona Środowiska **1986**, *4*, pp 35–38.
6. Gostomczyk M.A., **Kuropka J.**: Installation for denitrification of flue gases from heating plant. Proceedings of the 3rd National Conference on *New boiler techniques in communal heat engineering*, Świdnica Sept 20–21, 1988.
7. Gostomczyk M.A., **Kuropka J.**: Technologies of flue gas desulphurisation. Proceedings of the 3rd National Conference on *New boiler techniques in communal heat engineering*, Świdnica Sept 20–21, 1988.
8. Gostomczyk M.A., **Kuropka J.**: Technological design of desulphurisation and dust removal from flue gases in the boiler house in Ostrowia Mazowiecka. Part one; Reports of the Institute of Environmental Protection Engineering of the Wrocław University of Technology **1989**, SPR Ser. *53.*
9. **Kuropka J.**: The exhaust gas purification – world trends. Gaz, Woda i Technika Sanitarna **1990**, *7*, pp 128–131.
10. **Kuropka J.**,Łabuda M.: Desulphurisation of flue gases from boilers operated in a Thermal and Power Station. Ochrona Środowiska **1994,** *2*, pp 25–30.

Given the variety of boiler systems in terms of their size, the type of fuel burned and local conditions, it is difficult to identify a single, universal technology for flue gas desulphurization .

The process of selection of the optimal technology in specific conditions must be preceded by a detailed analysis of various criteria, among which the most important are: the amount and composition of the exhaust gases and the required desulphurization efficiency, the possibility of building installations within the facilities, capital and operating costs, the type of waste products and the ability to process them.

Each installation for flue gases desulphurisation includes large-scale equipment and components, which may be difficult to build in a given plant, thus limiting the possibility of applying a given technology. Therefore, research is still being conducted both on the laboratory and industrial scale (for real units) and new solutions are all the time being imporved.The choice of technological variant depends mainly on capital and operating costs.

Ad IV.

The need to reduce emissions of sulphur dioxide and nitrogen oxides into the atmosphere is nowadays obvious, the problem, however, is the selection of appropriate technology for flue gases purification.

This is due to, among others, different physico-chemical properties of both impurities and their small amounts in very large streams of the gas to be purified. The difficulties in the realisation of purification process are additionally affected by the fact that the content of sulphur dioxide in flue gases depends mainly on the type and kind of fuel, whereas the amount of nitrogen oxides produced in combustion processes is also affected by the combustion temperature, the contact time of reactants (nitrogen and oxygen) during combustion, especially in the high temperature zone, type of furnace, etc.

The problem of increasing the degree of oxidation of nitrogen oxides have already been approached in the 1970s and 1980s by absorption with simultaneous oxidation of nitrogen oxide with the compounds which easily give away oxygen in the liquid phase. Compounds useful for these purposes were, among others, compounds having strong oxidizing properties, such as sodium hypochlorite, sodium chlorite, calcium hypochlorite, potassium permanganate and potassium dichromate, salts of iron, copper, nickel and cobalt as well as hydrogen peroxide.

The author's research led to the development of technology of nitrogen oxides removal from industrial flue gases, but the remaining problem is how to intensify simultaneous removal of nitrogen oxides and sulphur dioxide from the flue gas of power boilers.

A single-thematic series of articles in Environment Protection Engineering journal **[7]** in the context of world achievements presents own work, which has indicated the possibility of intensification of the processes of flue gas desulphurization and denitrification .

Currently, due to the need to find cheap and effective methods of reducing emissions of nitrogen oxides to a level of 200 mg NO_2 / m^3_n, research on NO oxidation in the gas phase and the total sorption of NO_2 and SO_2 in suspensions or dry alkaline sorbents is resumed.

The research was conducted on the real exhaust in the research system WAWO-2 in heat and power plant. The aim of the study was to determine the degree of NO removal from flue gases in OP-430 boiler in the process of total removal of SO_2 and NO_x with simultaneous injection of a solution of sodium hypochlorite (NaOCl) or hydrogen peroxide as an oxidant, and ozone in the gas phase in the presence of particulate of hydrated lime ($Ca(OH)_2$), to the reactor before the fabric filter. Removal efficiency of NO and SO_2 from the flue gases was determined.

When injecting the solution of NaOCl oxidant to the flue gas a very high efficiency of NO removal from the flue gas was achieved (approximately 63.5%) with an average concentration of NO at the outlet of the system equal to 185 mg / m^3_n. The results of the test with the solution of H_2O_2 have shown that it is a weaker oxidant of NO than the tested sodium hypochlorite. NO removal efficiency has been on average 55.2%, giving concentration of NO at the outlet of the installation of 224 mg / m^3_n. Injection of O_3 in the gas phase to the flue gas has shown that the average NO removal efficiency was 53.6%, with average concentration of NO in the purified exhaust gas of 240 mg / m^3_n.In the same test conditions the average SO_2 removal efficiency for oxidizing agents used were respectively 92.4, 88.1 and 87.4%.

Based on the obtained results, it was found that meeting the requirements of emission standards for sulphur dioxide and nitrogen oxides in the flue gases at the level of 200 mg / m^3_n is possible: a) by injecting a mixture of oxidant and sorbent to flue gases in the systems of dry or semi-dry flue gas desulphurization, b) with relatively small capital investment (e.g. by adding oxidant injection system), c) because the oxidant and sorbent streams can be adjusted during operation of the system based on current levels of SO_2 and NO in the flue gases under treatment and the amount of recirculated waste from the fabric filter .

These studies were presented, among others, in articles and at conferences:

1. **Kuropka J.**: The newest tendencies in desulphurisation and denitrification of exhaust gases. In *Człowiek, zagrożenie, środowisko,* Zwoździak, J., Ed.; Oficyna Wydawnicza Politechniki Wrocławskiej: Wrocław, 2002, pp 251–264.
2. **Kuropka J.**: Kuropka, J.: Desulphurization and denitrification of gases – current state of technology, possibilities of intensification, selection criteria. EkoTechnika **2003**, *3(27)*, pp 2–6.
3. **Kuropka J.**: Possibilities of reducing emissions of sulphur dioxide and nitrogen oxides from the exhaust gases. Proceedings of the International Scientific and Technical Conference on *The Problems of Environment Engineering at the Dawn of the New Millennium. Wrocław – Szklarska Poręba'2000*, Szklarska Poręba Oct 5-7, 2000.
4. **Kuropka J.**: New opportunities for energy engineering as a chance for atmosphere protection. Proceedings of the International Conference on *The Problems of Environment Engineering at the Dawn of the New Millennium. Wrocław – Szklarska Poręba'2000*, Szklarska Poręba Oct 5-7, 2000
5. **Kuropka J.:** Kuropka, J.: Removal of nitrogen oxides from exhaust fumes of dust boilers. Proceedings of the 9th Scientific and Technical Symposium on *Current problems in air protection. POL-EMIS'08*, Karpacz June 18-21, 2008.

In domestic contitions the process of simlutaneous removal of sulphur dioxide and nitrogen oxides from flue gases in grate boilers can be successfully implemented using wet methods, in particular absorption-reduction processes, which make it possible to remove nitrogen oxides from flue gases in the form of free nitrogen. From the point of view of environmental protection it is the best operation, especially if the reducing alkaline solutions (sulphites and bisulphites) are the products of the absorption of sulphur dioxide.

The conducted studies were presented, among others, in the following works:

1. **Kuropka J.**: Removal of nitrogen oxides from flue gases by the chelate method. Ochrona Środowiska **1996**, 1, pp 43–46.
2. **Kuropka J.**: Development of technology for intensification of flue gases denitrification process for a boiler house and a heat and power plant; Reports of the Institute of Environmental Protection Engineering of the Wrocław University of Technology **1995**, SPR Ser. *71.*

Based on the study, it was concluded that the degree of flue gases denitrification in a solution of Na_2SO_3 with the addition of chelate Fe (II) EDTA: a) increases with the content of sulphur dioxide and nitrogen oxide, b) increases with the content of sulphite ions (SO_3^{-2}) and ferrous ions (Fe^{+2}) in the sorption solution, c) decreases with increasing oxygen content in the flue gases. It was found that the use of an additive chelate Fe (II) EDTA as modifier of the sorption solution in wet flue gas desulphurization systems will intensify the process of denitrification of flue gases from the boiler to the value of 75-78%.Currently there are 30 small and medium-sized installations in use in Poland for flue gas desulphurisation from grate boilers by the di-alcaline DAM method. For this reason, it is possible to test different variants of chelate method in Polish conditions and to investigate the real costs of its application. For preparing and dispensing chelate Fe (II) EDTA these installations may use the existing tank system, which is used to supplement the loss of sodium ions in the circulation of absorbent solution.

Ad V.

The presented single-thematic series of articles published in the journal Environment Protection Engineering **[8]** describes the current state of the selective non-catalytic reduction of NOx (SNCR) from flue gases and an analysis of the impact of the basic process parameters (reaction temperature, contact time, mole ratio of reactants, additives to reactants), which influence the scale of emissions of nitrogen oxides from exhaust gases.

This work has been inspired by a recently significant development of dry methods of flue gas cleaning from sulphur dioxide through the introduction of sorbent into the boiler combustion zone (LIMB, LIFAC, COOLSIDE method) and by very good results of flue gas desulphurization process using WAWO, conducted since 1989 by the employees of the Institute of Environmental Protection Engineering at Wrocław University of Technology on the fully industrial pilot installation in a heat and power plant.

Based on the study of the fully industrial installation for desulphurisation of flue gases from the WP-120 boiler, using calcium hydroxide with urea and calcium carbonate with urea, it was

found that this method can be successfully used in domestic conditions for simultaneous purification of flue gases from sulphur dioxide and nitrogen oxides.

The study of selective non-catalytic reduction of nitrogen oxides from the flue gas in the grate boiler showed clearly that with the increased dosage of urea, the degree of flue gases denitrification increases. The influence of the molar ratio of urea / nitrogen oxide on the scale of emissions of nitrogen oxides from the grate boiler, as well as the effect of the concentration of the urea solution (10 and 40%) on the degree of denitrification were determined. The maximum degree of denitrification obtained was equal to 71.2%, with 40% injection of urea solution and the molar ratio $CO(NH_2)_2$ / NO = 3.0.

These studies of selective non-catalytic reduction of nitrogen oxides from flue gases have been, among others, the subject of following articles, reports and conference papers:

1. **Kuropka J.**: Potentiality for the abatement of nitrogen oxide emissions from fuel combustion. Ochrona Środowiska **1992**, *1*, pp 9–12.
2. **Kuropka J.**: Denitrification of flue gases from heat and power plant. Ochrona Środowiska **1999**, *1 (72)*, pp 23–24.
3. **Kuropka J.**: Reduction of nitrogen oxides from exhaust gases. Ochrona Powietrza i Problemy Odpadów **1999**, *1*, pp 9–13.
4. **Kuropka J.**: SNCR method of flue gas denitrification. Chemia i Inżynieria Ekologiczna **1999**, Vol. 6, *10*, pp 1011–1023.
5. **Kuropka J.**: Denitrification of flue gas from boiler with urea as a reducing agent. Proceedings of the conference on *Problems of air pollution in urban and industrial agglomerations*. Ustroń Sept 25–28, 1996.
6. **Kuropka J.**, Gostomczyk M.A.: Opportunities for intensification of denitrification for the heating plant. Proceedings of the 2nd National Energy Conference on *Ecological and economical energy production*, Kiekrz Oct 21-24, 1996.
7. **Kuropka J.**: Denitrification of flue gases with SNCR. Proceedings of the 2nd International Conference on *Theory and practice of environmental protection,* PAN, Zabrze – Szczyrk June 2-4, 1998.
8. **Kuropka J.**: Emission of undesirable byproducts during denitrification of flue gases with SNCR. Proceedings of the conference on *Problems of air pollution in urban and industrial agglomerations,* Wisła Sept 23-26, 1998.
9. **Kuropka J.**: Reduction of emissions of nitrogen oxides from flue gases using urea injection. Proceedings of the 6th National Energy Conference *Ecological and economical energy production. Rydzyna'2000*, Rydzyna Oct 18-20, 2000.
10. **Kuropka J.**: Research on the reduction of nitrogen oxides with the urea from the flue gases in grate boilers. Proceedings of the 6th Scientific and Technical Symposium on *Environment-threatening emissions. POL-EMIS'02*, Kudowa Zdrój June 12-15, 2002.
11. **Kuropka J.**: Development of intensification technology for the process of flue gas denitrification for power plants; Reports of the Institute of Environmental Protection Engineering of the Wrocław University of Technology **1996**, SPR Ser. *65.*
12. **Kuropka J.**: The analysis of the influence of various parameters on the effectiveness of selective non-catalytic reduction of nitrogen oxides from flue gases; Reports of the Institute of Environmental Protection Engineering of the Wrocław University of Technology **1997**, SPR Ser. *44.*
13. **Kuropka J.**: Studies on reducing the emission of nitrogen oxides from the flue gases from grate boilers with the use of urea injection; Reports of the Institute of Environmental Protection Engineering of the Wrocław University of Technology **2000**, SPR Ser. *29.*
14. **Kuropka J.:** Reduction of nitrogen oxides from boiler flue gases. Energy Efficiency & Air Pollutant Control Conference, Wroclaw, September 21-25, 2009.

In view of the sharp limits of nitrogen oxides emissions, and such are in case of new power plants in Poland, it is necessary, in relation to the "classic" boiler furnaces, to use simultaneously the so-called primary and secondary denitrification methods, among which the method of selective catalytic reduction (SCR) is widely used, especially in highly industrialized countries.

In many countries, despite the implementation of the SCR method on industrial scale , experiments are still being conducted to recognize optimal operating conditions and determine the effects of various parameters on the effectiveness of nitrogen oxides removal from flue gases.

The efficiency of conversion of nitrogen oxides into neutral atmosphere components (nitrogen and water) depends on the process temperature, the concentration of nitrogen oxides and the presence of oxygen in flue gases, as well as the molar ratio ammonia / nitrogen oxides.Significant impact on the effectiveness of SCR of nitrogen oxides from the exhaust gases have the type and shape of the

catalyst , its activity life and load. Also, the presence of other impurities in the exhaust gases (eg. SO_2) determines the operation conditions of the process.

The results of own research aiming to determine the effect of the basic parameters of the SCR process on the efficiency of purification of gases from nitrogen oxides are presented, among others, in the following publications:

1. **Kuropka J.**: Nitric oxides reduction by ammonia. Ochrona Powietrza **1990**, *2*, pp 31–34.
2. **Kuropka J.**: Examinations on nitric oxide reductions by means of ammonia on monolithic catalysts. Ochrona Powietrza **1992**, *6*, pp 146–148.
3. **Kuropka J.:** Research on selective catalytic reduction of nitrogen oxides. Proceedings of the 1st Symposium on *Reducing the emmission of pollution to the atmosphere. POL-EMIS'92*, Szklarska Poręba June 11-13, 1992.
4. **Kuropka J.:** Catalytic reduction of nitrogen oxides with the use of ammonia. Proceedings of the 1st National Conference on *Computer systems for Ecology*, Łódź Sept 24-25, 1992.
5. **Kuropka J.**: Reduction of nitrogen oxides with ammonia over granular catalyst. Ochrona Środowiska **1994**, *2*, pp 15–18.
6. **Kuropka J.**: Selective reduction of nitrogen oxides on metallic platinum and oxide monolithic catalysts. Przemysł Chemiczny **1994**, *1*, pp 18–20.
7. **Kuropka J.**: Analysis of the influence of various parameters onto the selective effectiveness of catalytic reduction of nitric oxides from exhaust gas. Ochrona Powietrza i Problemy Odpadów **1996**, *2*, pp 56–62.
8. **Kuropka J.**: Studies on selective catalytic reduction of nitrogen oxides; Reports of the Institute of Environmental Protection Engineering of the Wrocław University of Technology **1992**, SPR Ser. *3*.

These studies were carried out in an installation which comprised of three basic nodes: the preparation of the gas mixture and dispensing of ammonia, the reactor for the catalytic reduction of nitrogen oxides and the devices for analysis of nitrogen oxides, ammonia, and sulphur dioxide. The whole installation cooperated with the computer, which constantly communicated to each node the data concerning key process parameters .

Based on literature studies, and own research, the assessment was made concerning the costs of removal of nitrogen oxides from exhaust gases with the methods of selective non-catalytic reduction and selective catalytic reduction. The analysis is presented in the following paper:

1. **Kuropka J.**: The assessment of the costs of flue gas denitrification with SNCR/SCR. Proceedings of the 7th Scientific and Technical Symposium on *Environment-threatening emissions. POL-EMIS'04*, Kudowa Zdrój June 16-19, 2004.

Comparative analysis of the costs demonstrated that the method of selective non-catalytic reduction of nitrogen oxides from the exhaust gases is more economical, despite the lower efficiency of the gas cleaning process.

The increased interest in nitrous oxide results from the gradual increase in the concentration of this gas in the atmosphere, an average by about 0.3% per year. It is believed that itrogen oxides are responsible for the destruction of almost the half of the ozone layer, and while nitrous oxide is their main source in the stratosphere, the doubling of its concentration causes reduction in stratospheric ozone by 12%.

Although the concentration of nitrous oxide in the atmosphere has not posed a potential threat for humans so far, it is also not subject to separate regulations for environmental protection, in the future the gas may become a serious problem, e.g. due to stratospheric ozone-leaning and increasing greenhouse effect on Earth.

Therefore, the presented series of single-thematic articles published in the journal Environment Protection Engineering [6] describes the main sources of nitrous oxide emissions, and points to its participation in the development of the greenhouse effect. It shows an estimated balance of nitrous oxide emissions from technology processes of chemical industry and from combustion processes in power boilers. It also draws attention to the potential possibilities for reducing nitrous oxide emissions from these processes. Data presented in the articles present initial contribution to undertake research in this area.

2.3. Original contribution to the development of technical science in the field of environmental engineering

The works submitted for the assessment are an achievement highly relevant for the application in the field of environmental engineering and environment protection, with particular emphasis on the domestic conditions of the chemical and power industry.

The following gas purification technologies from gaseous pollutants have been implemented in practice:

- **Technology of CS2 removal from industrial gases emitted by Wrocławskie Zakłady Włókien Sztucznych [Wrocław Plant of Synthetic Fiber] (1973).**
  (My contribution was 90% and consisted in research problem formulation, planning and execution of experiments, interpretation of test results, development of technology and determining the conditions for installation's operation)
- **Technology for purification of flue gases emitted in the production of superphosphate in the Phosphate Fertilizer Plant "Ubocz" (1981).**
  (My contribution was about 70% and consisted in research problem formulation, planning experiments, interpreting the test results, development of technology and and determining the conditions for installation's operation)
- **Technology of removal and disposal of nitrogen oxides from nitrous gases in the Phosphate Fertilizer Plant "Ubocz" (1987).**
  (My contribution was about 70% and consisted in research problem formulation, planning experiments, interpreting the test results, development of technology and and determining the conditions for installation's operation)

Other discussed technologies of flue gas purification from gaseous pollutants may be useful for current and future decision-making regarding the solutions to reduce emissions of gaseous pollutants in Poland.

3. Discussion on other scientific and research achievements.

The results of research conducted for the doctoral dissertation and research related to its topic I have published in the following works:

1. **Kuropka J.**, Gostomczyk M.A.: Investigations on kinetics of carbon disulphide sorption on anion exchangers. Environment Protection Engineering **1978**, Vol. 4, *2*, pp 87–99.
2. Gostomczyk M.A., **Kuropka J.**: Studies of carbon disulphide sorption on selected anion-exchangers. In *Waste industrial gases purification with sorption methods*. Pr. Nauk. Inst. Inż. Ochr. Środ. Politechn. Wroclaw **1978**, *36*, Studia i Materiały Ser. *19*, pp 21–39.
3. Gostomczyk M.A., **Kuropka J.**: The role of anion-exchangers and the effect of its structure on the kinetics of carbon disulphide sorption. In *Waste industrial gases purification with sorption methods*. Pr. Nauk. Inst. Inż. Ochr. Środ. Politechn. Wroclaw **1978**, *36*, Studia i Materiały Ser. *19*, pp 41–51.
4. Gostomczyk M.A., **Kuropka J.**: Comparative studies of carbon disulphide sorption on solid sorbents.In *Waste industrial gases purification with sorption methods*. Pr. Nauk. Inst. Inż. Ochr. Środ. Politechn. Wroclaw **1978**, *36*, Studia i Materiały Ser. *19*, pp 71–84.
5. **Kuropka J.**, Gostomczyk M.A.: Clearing problems of outlet gas arising from the industry of chemical fibre. *Ochrona Powietrza* **1975**, *6*, pp 162–166.
6. **Kuropka J.**, Gostomczyk M.A.: Air treatment for CS_2 vapors. *Ochrona Pracy* **1976**, *2*, pp 15–17
7. **Kuropka J.**, Gostomczyk M.A.: Methods concerning the limitation of the H_2S and CS_2 emission into atmosphere. *Gaz, Woda i Technika Sanitarna* **1976**, *8*, pp 233–235.
8. Gostomczyk M.A., **Kuropka J.**: Parameters of SO_2-sorption on anion exchangers, Proceedings of the 2nd National Scientific Seminar on *Synthesis, properties and application of ion-exchange resins and ion exchange membranes*,, Wrocław, Nov 22–24, 1972.; Pr. Nauk. Inst. Technol. Org. Tworzyw Sztucznych Politech. Wroclaw **1973**, *13*, Konferencje Ser. 2, pp 353–376.
9. **Kuropka J.**, Gostomczyk M.A.: H_2S and CS_2 sorption on anion exchangers, Proceedings of the Symposium on *Flue Gas Purification*, Bierutowice, Sept 25–28, 1975; Pr. Nauk. Inst. Inż. Ochr. Środ. Politechn. Wroclaw **1975**, *41*, Konferencje Ser. *8*, pp 95–104.

The above-mentioned works present own research on the sorption of carbon disulphide on anion-exchangers for a laboratory and quarter-commercial scale. They have used commercial anion-exchangers (Amberlite, Dowex, Lewatit, Wofatit, Zerolit) and specially synthesized anion-exchangers (SNE, SHE, SNM, SHM, FFD) with increased granulation. They have determined relationships describing the effect of the basic parameters, such as concentration of carbon disulphide in the gas, gas velocity, concentration and type of anion-exchanger regenerant solution,

spraying density, the height of anion-exchange layer and the impact of gas flow resistance on the kinetics of carbon disulphide sorption on anion-exchangers. Comparative studies on the sorption of carbon disulphide on solid sorbents such as activated carbon and molecular sieves have been carried out. It was found that anion-exchangers show better sorption properties in relation to carbon disulphide, at the same time demonstrating high tolerance to the changes in the concentration of carbon disulphide. The effects of using anion-exchangers for the sorption of carbon disulphide were shown, and the influence of anion-exchanger structure on the kinetics of the sorption process was determined. In continuous operation of the quarter-commercial installation, the possibility of using the anion-exchangers in industrial technology of flue gas treatment from hydrogen sulphide and carbon disulphide were tested. It has been found that the use of anion-exchangers in the gas cleaning process allows to completely remove carbon disulphide from gas and a 50% efficiency of the sorption of carbon disulphide is unsatisfactory from the point of view of environmental protection.

My remaining scientific and research output after being awarded a doctoral degree has covered, above all, the following issues and topics:

3.1. Removal of fluorine compounds from industrial gases

The increase in demand for food products is associated with increased use of artificial fertilizers, e.g. phosphatic fertilizers. The development of phosphatic fertilizers is therefore an absolute necessity; on the other hand, the development of production entails the rising air pollution with fluorine compounds, mainly hydrogen fluoride and silicon tetrafluoride. Concentrations of fluorine compounds in flue gases is noted to range from 0.1 to 1.0 g HF / m ^{3}. Emission of gases with such concentration causes significant biological imbalance around the plants which produce phosphatic fertilizers.

Results of own research carried out at the Research Team of Prof. M.A. Gostomczyk which have allowed to develop technology of fluorine compund removal from flue gases, are presented, among others, in the following publications:

1. Gostomczyk M.A., **Kuropka J.**, Głomba M.: Review of techniques for neutralisation of fluorine compounds from industrial flue gases. Szkło i Ceramika **1979**, *7*, pp 172–173.
2. Gostomczyk M.A., **Kuropka J.**, Domański M.: Treatment of flue gases resulting from the production of superphosphate. Ochrona Środowiska **1980**, *1*, pp 36–39.
3. Gostomczyk M.A., **Kuropka J.**, Domański M.: Fluorine compounds removal from flue gases of the phosphate fertilizer plant. Ochrona Środowiska **1984**, *2*, pp 34–37.
4. Gostomczyk M.A., **Kuropka J.**, Domański M.: Fluorine compound absorption a tube column with helicoid parking. Ochrona Środowiska **1985**, *4*, pp 11–15.

3.2. Examining the degree of the impact of various sources of air pollution on the environment

The results of research on the air quality around industrial plants have been published in the following works:

1. Kaczanowski S., Łukaszewicz T., **Kuropka J.**: The state of air pollution in the HM "Legnica" Region evaluated on the basis of the BASKI (Basic automatic system of imission control) monitoring network. Chemia i Inżynieria Ekologiczna **1999**, Vol. 6, *10*, pp 989–1009.
2. Kaczanowski S., Łukaszewicz T., **Kuropka J.**: Immission of pollutants in HM "Legnica" Region in terms of pro-ecological activities. Proceedings of the 2nd Symposium on *Imission and monitoring of pollutants. POL-IMIS'99*, Szklarska Poręba June 24-27, 1999.
3. Kaczanowski S., Król K., **Kuropka J.**: Economical and ecological aspects of using the treatment system of flue gases from metallurgical and energetic processes. Proceedings of the 5th Symposium on *Reducing the emmission of pollution to the atmosphere. POL-EMIS'00*, Szklarska Poręba June 15-18, 2000.
4. Kowalski M., **Kuropka J.**: Immission of gaseous pollutants in HM "Legnica" region. Proceedings of the 4th Conference on *Problems of air pollution in urban and industrial agglomerations,* Ustroń Sept 26-29, 2001, pp 131–140.
5. **Kuropka J.**, Kowalski M: The dynamic of the immission of the gases and particulate matter pollution in the HM "Legnica" Region. In *Rozprawy, Studia, Monografie WSM w Legnicy*, Pajączkowski, S., Ed.; Legnica, 2003; *No. 2*, pp 385–408.

6. Kowalski M., **Kuropka J.**: The imission of the gases and particulate matter pollution in the HM "Legnica". Chemia i Inżynieria Ekologiczna **2003**, Vol. 10, *11* pp 1235–1252.

The main sources of emissions of dust pollutants from the HM "Legnica", which greatly affect the condition of the air in the region of the plant have been analysed. The applied database was created by the Automatic System of Immission Control operating since 1992, which performs automatic measurements of air pollution with sulphur dioxide, nitrogen dioxide, carbon monoxide and particulate matter PM10.What has been shown is a huge role of the smelter as a large industrial plant in shaping the level of concentration of particular substances in the air and exceeding the permissible limits for immission resulting from its operation.

3.3. Alternative energy sources

Fuel and energy sector is one of the branches of the national economy with the largest negative impact on the environment. For this reason, all the actions performed in this area must take into account the potential effects on the environment. They must also be compliant with environmental priorities of the country. This means not only installing protective devices but, above all, such shaping of development so as to minimize the negative impact of the fuel and energy industry on the environment The results of this policy include, among others, increasing the efficiency of energy use and gradual substitution of its carriers with less environmentally harmful ones, such as natural gas.

The ecological aspects of the use of gas and environmental attractiveness of the construction of gas-steam blocks have been indicated in the following publications:

1. **Kuropka J.**, Pupczyk A., Winiarz T.: Steam and gas turbines. Part one – the chance to improve the state of air. EkoTechnika **2000**, *1 (13)*, pp 28–30.
2. **Kuropka J.**, Pupczyk A., Winiarz T.: Steam and gas turbines. Part two – the prospects for installation in power plants and heat and power plants in Poland. EkoTechnika **2000**, *2 (14)*, pp 17–19.
3. **Kuropka J.**: Cogeneration installations – a chance to improve the state of air pollution in cities. In *Rozprawy, Studia, Monografie WSM w* Legnicy; Czapliński, K., Ed.; Legnica, 2001; Vol. 1, pp 141–150.
4. **Kuropka J.**: The earth gas as the ecological fuel with the chance of the improvement of the state of the air pollution in cities. In *Państwo i Społeczeństwo*. Special issue on *Ecological threats vs ethics, politics and economy,* Delorme, A. Ed.; Wydawnictwo Krakowskiej Szkoły Wyższej im. A.F. Modrzejewskiego: Kraków, 2004, *2*, pp 305–312.

3.4. Sustainable development and environmental management

Among a number of new legal regulations that Poland, in connection with the integration with the European Union, must adapt to its system and to practical operations in the area of environmental protection, there are voluntary forms of setting limits for the impact on the environment by institutional users. These include above all implementation of environmental management systems, programmes of "cleaner production" and measures to reduce the environmental burden of products, acknowledged by the so-called "eco-labels". Environmental Management Systems are a particularly useful tool to improve the efficiency of the business units in the broad field of environment protection.

One of the key tools to prevent further environmental degradation and deterioration of the quality of life, and loss prevention, have been the documents of the assessment of the environmental impact of any kind of investments and permission for integrated pollution prevention and control, developed with the best available technology.

These topics have been presented in the following articles and papers:

1. **Kuropka J.**: Integrated environment management. In *Rozprawy, Studia, Monografie WSM w Legnicy*, Pajączkowski, S., Ed.; Legnica, 2006, *No. 4*, pp 238–250.
2. **Kuropka J.**: Integrated environment management as a tool of meeting environment quality standards in Urban-industrial agglomerate. In *Państwo i Społeczeństwo*. Special issue on *Ecological threats vs ethics, politics and economy (II),* Delorme, A., Klima, S. Eds.; Wydawnictwo Krakowskiej Szkoły Wyższej im. A.F. Modrzejewskiego: Kraków, 2007; No. 4, pp 63–76.
3. **Kuropka J.**: Integrated permits as a tool for environmental management. In *Nowoczesne rozwiązania w inżynierii i ochronie środowiska,* Anisimov, S.; Danielewicz, J.; Szczechowiak, E.; Bartnicki, G.; Klimczak, M.; Eds.;

Wydawnictwo Instytutu Klimatyzacji i Ogrzewnictwa Politechniki Wrocławskiej: Wrocław, 2011, Vol. 1, pp 369–374.
4. **Kuropka J.**: Integrated permits and environmental quality standards. Proceedings of the Conference on *Environmental Engineering – our present and future in the European Union*, Wrocław June 18-20, 2004.

4. SUMMARY OF SCIENTIFIC ACHIEVEMENTS

From the beginning of my scientific work at the Institute of Environmental Protection Engineering at Wrocław University of Technology I have written 157 works, including 124 scientific publications, 6 popular scientific publications and 27 unpublished works.

My scientific and research activity after being awarded the doctoral degree can be summarized by 143 scientific works, including 1 monograph, 2 handbooks, 3 textbooks, 69 articles, including 16 articles being published as chapters in books, 41 conference papers and 21 reports for the national economy.

My work has been cited in books, textbooks and monographs, including:

1. Konieczyński J.: Ochrona przed szkodliwymi gazami. Metody, aparatura i instalacje. Wyd. Politechniki Śląskiej, Gliwice 2004.
2. Sarbak Z.: Kataliza w ochronie środowiska. Wyd. Uniwersytetu im. A. Mickiewicza, Poznań 2004.
3. Zarzycki R.: Wymiana ciepła i ruch masy w inżynierii środowiska. WNT, Warszawa 2005.
4. Mazur M.: Systemy ochrony powietrza. Wyd. Akademii Górniczo-Hutniczej, Kraków 2005.
5. Głomba M.: Oczyszczanie gazów odlotowych w poziomych skruberach natryskowych. Oficyna Wyd. Politechniki Wrocławskiej, Wrocław 2005.
6. Janka R.M.: Podstawy inżynierii środowiska. Obliczanie emisji zanieczyszczeń gazowych. Wyd. Uniwersytetu Opolskiego. Opole 2007.

I have reviewed articles to foreign language journals (Water, Air and Soil Pollution, Environment Protection Engineering) and to Polish journals (Ochrona Środowiska, Ekotechnika) concerning the issues of purification of flue gases from gaseous pollutants.

I have taken an active part in many international and national conferences, where I successfully presented the results of my research:

1. Gostomczyk, M.A.; **Kuropka, J.**; Ciepłoch, B.; Lech-Brzyk, K.; Minkiewicz, J.: Studies on the use of ion exchange materials for flue gas treatment. Symposium on *Treatment of Industrial Waste Gases*, Bierutowice Sept 23–25, 1977.
2. Sosnowski, M.; Gostomczyk, M.A.; **Kuropka, J.**: Udalenije okislov azota posleproizvodstva sernoj kisloty nitroznym metodom. VI Sem. RWPG on *Razrabotka i usovieršenstvovanije metodov sniženija emisji okislov azota v promyšlennych otchodiaščich gazach.* Kozubnik May 24, 1983.
3. Gostomczyk, M.A.; **Kuropka, J.**: Ekspluatacionnye rezultaty ustanovki dla sorcii i utylizacii okisej azota posle proizvodstva sernoj kisloty nitroznym metodom. VIII Sem. RWPG on *Razrabotka i usovieršenstvovanije metodov sniženija emisji okislov azota v promyšlennych otchodiaščich gazach.* Magdeburg March 17–22, 1986.
4. Gostomczyk, M.A.ł **Kuropka, J.**: Flue gases treatment form nitrogen oxides. Seminar of the Ministry of Environment Protection and Natural Resources on *NO_x – 86*, Warszawa Oct 9, 1986
5. **Kuropka, J.**: Technology for the purification of gases from nitrogen oxides. Proceedings of the national forum on *Reduction of nitrogen oxides emission from industrial flue gases*, Puławy Jan 27-28, 1988, pp 39–45.
6. **Kuropka, J.**: Neutralisation of nitrogen oxides from small emitters. National forum on *Reduction of nitrogen oxides emission from industrial flue gases*, Puławy Jan 27-28, 1988.
7. Gostomczyk, M.A.; **Kuropka, J.**: Installation for denitrification of flue gases from heating plant. 3rd National Conference on *New boiler techniques in communal heat engineering*, Świdnica Sept 20–21, 1988.
8. Gostomczyk, M.A.; **Kuropka, J.**: Technologies of flue gas desulphurisation. 3rd National Conference on *New boiler techniques in communal heat engineering*, Świdnica Sept 20–21, 1988.
9. **Kuropka, J.**: Research on selective catalytic reduction of nitrogen oxides. Proceedings of the 1st Symposium on *Reducing the emmission of pollution to the atmosphere. POL-EMIS'92*, Szklarska Poręba June 11-13, 1992.
10. **Kuropka, J.**: Catalytic reduction of nitrogen oxides with the use of ammonia. 1st National Conference on *Computer systems for Ecology*, Łódź Sept 24-25, 1992.
11. **Kuropka, J.**; Domański, M.; Iwanyszczuk, P.: Intensification of the process of flue gas denitrification by modifying the absorbent solution. 2nd Symposium on *Reducing the emmission of pollution to the atmosphere. POL-EMIS'94*, Szklarska Poręba June 2–5, 1994.
12. **Kuropka, J.**: Possibilities of reducing emissions of nitrogen oxides from flue gases. 8th international conference on *Air Conditioning and Heating Engineering*, Wrocław'95, Szklarska Poręba May 28–30, 1995.

13. **Kuropka, J.**; Gostomczyk, M.A.: Joint removal of sulphur dioxide and nitrogen oxides from pulverized coal-fuel boilers. *Conference on Reducing emission of pollution from pulverized and grate boilers,* Sopot Feb 14–16, 1996.
14. **Kuropka, J.**; Gostomczyk, M.A.: Research on selective non-catalytic reduction of nitrogen oxides from the fumes of dust boilers. Proceedings of the 3rd Symposium on *Reducing the emmission of pollution to the atmosphere. POL-EMIS'96*, Szklarska Poręba May 30–June 2, 1996.
15. **Kuropka, J.**: Denitrification of flue gas from boiler with urea as a reducing agent. Conference on *Problems of air pollution in urban and industrial agglomerations*. Ustroń Sept 25–28, 1996.
16. **Kuropka, J.**; Gostomczyk, M.A.: Opportunities for intensification of denitrification for the heating plant. 2nd National Energy Conference on *Ecological and economical energy production*, Kiekrz Oct 21-24, 1996.
17. **Kuropka, J.**: Denitrification of flue gases with SNCR. 2nd International Conference on *Theory and practice of environmental protection,* PAN, Zabrze – Szczyrk June 2-4, 1998.
18. **Kuropka, J.**: Denitrification of flue gas from heat and power plant. 4th Symposium on *Reducing the emmission of pollution to the atmosphere. POL-EMIS'98*, Szklarska Poręba June 18-21, 1998.
19. **Kuropka, J.**: Emission of undesirable byproducts during denitrification of flue gases with SNCR. Conference on *Problems of air pollution in urban and industrial agglomerations,* Wisła Sept 23-26, 1998, pp 131–140.
20. **Kuropka, J.**: Emission of nitrous oxide during flue gas denitrification. 5th National Symposium on *Air Protection in Industry*, Spała Oct 19-21, 1998.
21. Kaczanowski, P.; Łukaszewicz, T.; **Kuropka, J.**: Immission of pollutants in HM "Legnica" Region in terms of pro-ecological activities. 2nd Symposium on *Imission and monitoring of pollutants. POL-IMIS'99*, Szklarska Poręba June 24-27, 1999.
22. Kaczanowski, P.; Łukaszewicz, T.; **Kuropka, J.**: State of air pollution in HM "Legnica" Region based on the evaluations of the BASKI monitoring network. Central-European Conference *ECOpole'99*, Duszniki Oct 21-23, 1999.
23. Kubisa, R.; **Kuropka, J.**: Dry flue gas desulphurisation methods. Proceedings of the 5th National Energy Conference on *Ecological and economical energy production. Rydzyna'99*, Rydzyna Oct 20-22, 1999
24. Kaczanowski, P.; Król, K.; **Kuropka, J.**: Economical and ecological aspects of using the treatment system of flue gases from metallurgical and energetic processes. 5th Symposium on *Reducing the emmission of pollution to the atmosphere. POL-EMIS'00*, Szklarska Poręba June 15-18, 2000.
25. **Kuropka, J.**: Possibilities of reducing emissions of sulphur dioxide and nitrogen oxides from the exhaust gases. International Scientific and Technical Conference on *The Problems of Environment Engineering at the Dawn of the New Millennium. Wrocław – Szklarska Poręba'2000*, Szklarska Poręba Oct 5-7, 2000.
26. **Kuropka, J.**: New opportunities for energy engineering as a chance for atmosphere protection. International Conference on *The Problems of Environment Engineering at the Dawn of the New Millennium. Wrocław – Szklarska Poręba'2000*, Szklarska Poręba Oct 5-7, 2000.
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28. Kowalski, M.; **Kuropka, J.**: Immission of gaseous and particulate pollutants in HM "Legnica" Region. Proceedings of the Central-European Conference *ECOpole'2001*, Duszniki Oct 18-20, 2001.
29. Kowalski, M.; **Kuropka, J.**: Immission of gaseous pollutants in HM "Legnica" region. 4th Conference on *Problems of air pollution in urban and industrial agglomerations,* Ustroń Sept 26-29, 2001.
30. **Kuropka, J.**: Ecological production of energy as a chance to improve the state of air pollution in urban and industrial agglomerations. 4th Conference on *Problems of air pollution in urban and industrial agglomerations,* Ustroń Sept 26-29, 2001
31. **Kuropka, J.**: Research on the reduction of nitrogen oxides with the urea from the flue gases in grate boilers. 6th Scientific and Technical Symposium on *Environment-threatening emissions. POL-EMIS'02*, Kudowa Zdrój June 12-15, 2002.
32. **Kuropka, J.**: Integrated permits and environmental quality standards. Conference on *Environmental Engineering – our present and future in the European Union*, Wrocław June 18-20, 2004.
33. **Kuropka, J.**: Education of specialists in environmental management on economic studies. 2nd International Scientific Conference *In search of the model of a high non-state college*, Legnica May 13-14, 2004.
34. **Kuropka, J.**: The assessment of the costs of flue gas denitrification with SNCR/SCR. 7th Scientific and Technical Symposium on *Environment-threatening emissions. POL-EMIS'04*, Kudowa Zdrój June 16-19, 2004.
35. **Kuropka, J.**: Emission of nitrous oxide – potential threat, balance and possibilities of reduction. 8th Scientific and Technical Symposium on *Atmospheric Air Protection. POL-EMIS'06*, Karpacz June 21-24, 2006.
36. **Kuropka, J.**: Removal of nitrogen oxides from exhaust fumes of dust boilers. 9th Scientific and Technical Symposium on *Current problems in air protection. POL-EMIS'08*, Karpacz June 18-21, 2008.
37. **Kuropka, J.**: Reduction of nitrogen oxides from boiler flue gases. *Energy Efficiency & Air Pollutant Control Conference*, Wrocław Sept 21-25, 2009, CD-ISBN 978-83-929704-0-8.
38. **Kuropka, J.**: Removal of nitrogen oxides from industrial flue gases. 10th Scientific and Technical Symposium on *Current achievements in air protection. POL-EMIS'10*, Polanica Zdrój June 16-19, 2010.
39. **Kuropka, J.**: Denitrification of flue gases from energetic boilers. 13th International Conference *Air & Heat – Water & Energy 2011*, Wrocław–Kudowa Zdrój, June 16-18, 2011.

40. **Kuropka, J.**: Integrated permits as a tool of environment management. Presented at the 13th International Conference Air & Heat – Water & Energy 2011, Wrocław- Kudowa Zdrój, 16-18th June, 2011r.
41. **Kuropka, J.**: Possibilities of reducing carbon dioxide from energy flue gases. 11th Scientific and Technical Symposium on *Air Protection. POL-EMIS'12*, Sienna June 13–16, 2012.

5. Discussion of educational achievements

I began my research and teaching work at Wrocław University of Technology immediately after graduation in 1970. I was employed as an assistant-trainee, assistant, senior assistant and adjunct.

I have been conducting classes (lectures, auditorium, laboratory and project exercises, and diploma seminars) for full-time and part-time studies in the following subjects: chemistry of air, atmosphere protection, unit processes and operations in atmosphere protection, apparatus in air protection, process engineering, flue gases treatment, pollutant emissions reduction.In addition I have been carrying out seminar classes and supervising diploma thesis.

I have prepared the following study materials for the courses:

1. **Kuropka J.**:Removal of gaseous pollutants from flue gases. Basic processes, Wydawnictwo Politechniki Wrocławskiej: Wrocław, 1988.
2. **Kuropka J.**: Removal of gaseous pollutants from flue gases. Calculations, tables and reference materials, Wydawnictwo Politechniki Wrocławskiej: Wrocław, 1989; 2nd ed.; Wydawnictwo Politechniki Wrocławskiej: Wrocław, 1996.
3. **Kuropka J.**: Removal of gaseous pollutants from flue gases. Equipment and technologies, Wydawnictwo Politechniki Wrocławskiej: Wrocław, 1991.
4. **Kuropka J.** (ed.): Gas treatment. Laboratory, Wydawnictwo Politechniki Wrocławskiej: Wrocław, 2000.
5. **Kuropka J.:** Technologies of gas treatment for sulphur dioxide and nitrogen oxides, Oficyna Wydawnicza Politechniki Wrocławskiej: Wrocław, 2012.

I have developed and conducted a monographic lecture for postgraduate studies, "Protection of the atmosphere upon entering the European Union" for the course "Basics of designing equipment to neutralize gas pollutants".

I have been a long-term member of the Diploma Commission at Environmental Protection studies for the specialisations in Systems for Water and Soil Protection, and in Atmosphere Protection Systems.

I am a co-author of study programs for the specialisation of Atmosphere Protection and Atmosphere Protection Systems on full-time and part-time bachelor and master programmes at the Faculty of Environmental Engineering.

I was a co-author of teaching loads and course outlines for the specialisation in Environmental Management at engineering studies and for the specialisation in Quality and Environment Management for master's programme at the Higher School of Management in Legnica. There I taught the following subjects: ecology of natural resources and environmental protection, environmental management systems, ecology in the business development strategy, protection against noise, unit processes in environmental protection and reduction of gaseous and particulate pollutants emission.

I have supervised 125 MSc and BSc (Eng.) theses at the Institute of Environmental Engineering and 65 MSc and BSc (Eng.) theses at the Higher School of Management in Legnica.

The list of educational achievements is attached in Annex No. 5.

6. Discussion of organizational and publicity achievements

I participate very actively in the organizational activities of the Faculty of Environmental Engineering and the Institute of Environmental Protection Engineering (Annex No. 5).

I have performed a number of organizational functions, including Head of the Research Team for the Flue Gases Treatment from 1976 to 1999, the Head of Educational Team for Atmosphere Protection, and from 2000 to 2002 - Head of the Educational Team of Atmosphere Protection

Division, and from 2002 to 2008 - Deputy Head of Ecologistics and Atmosphere Protection Division for Education , and since 2008 I have been the Deputy Head Research and Educational Division of Atmosphere Protection for Education

In 2001-2009 I was the head of Postgraduate Studies of Environmental Engineering at the Higher School of Management in Legnica (Annex No. 6).

I have been a long-standing Science Editor of the Institute and a member of the publishing board at the Publishing House of Wrocław University of Technology. I am a member of the Programme Board of the journal "Ekotechnika".

I was a School Delegate to the General Council of Higher Education and Technology (1996-1999).I have been Board Member of the Faculty of Environmental Engineering in the last six terms of office, and a member of the Institute Board in four terms of office.

In 2006-2009 I was Vice-Chairman of the Disciplinary Committee of the Alumni Association of Wrocław University of Technology, and since 2009 I have been holding the position of its Chairman.

I have organised educational tours for students of Atmosphere Protection and Atmosphere Protection Systems to companies, which follow the programme of environmental protection. In 1987-1990, in relation to the admission process for the studies I took part in publicity meetings with secondary school students from Wrocław.

I am a co-author of "Chronicle of the 50th Anniversary of the Faculty of Environmental Engineering", the author of the article "40th Anniversary of Atmosphere Protection Division", a co-author of a collective work, "Wrocław Academic Circles. Masters and their Students", Wyd. Ossolineum, Wroclaw 2007, and the author of biographical notes of senior academic staff members of the Faculty of Environmental Engineering on CD, as an attachment to the above-mentioned work. I am also the author of the article "45 Years of Atmosphere Protection Engineering Scientific School".

In recent years, I have been a member of the Organizing Committee of cyclical Symposia "POLEMIS", a co-organizer and a reviewer of papers.

7. **Honours, awards and distinctions**

In recognition of 42 years of scientific, educational and organizational work at the Faculty of Environmental Engineering, including 37 years directing education at the Atmosphere Protection Division in the Institute of Environmental Engineering, I received the Senate award in recognition of the special achievements in teaching (2003), 23 Rector awards, including the individual award of a second degree for excellence in the field of fundamental science, 12 Dean awards and 8 awards of the Head of the Institute, I was awarded the Gold Medal of Wrocław University of Technology (1994) and the Medal of the 100th anniversary of the Technical Universities in Wrocław (2010).

The President of the Republic of Poland awarded me with the Silver Cross of Merit (2000) and the Gold Medal for Long Service (2010), and the Minister of Science and Higher Education awarded me the Medal of the National Education Commission (2005).

The list of honours, awards and distinctions is attached in Annex No. 7.

Józef Kwapiński.