TECHNICAL UNIVERSITY OF CLUJ-NAPOCA ROMANIA

HABILITATION THESIS

Summary

Ozone, ultraviolet radiation and free radicals generated in intense electric fields - remodeling factors of engineering concepts

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The teacher must be able to continuously monitor teaching and research activities until they are completed and supported by a good management and mentoring activities. Coordinates the members of the research team, assumes control and approval of procedures for executing project implementation actions, and furthermore guides the activities of young researchers under its direct responsibility.

The basis of the candidate's research directions and skills has been put in place since 1978 with the research and design of electrical and electronic equipment and installations, automation and actuation of equipment related to the food and refrigeration industry of the Tehnofrig Enterprise A.S. Enterprise, Cluj-Napoca .

Among the outstanding engineering and engineering achievements of the Tehnofrig Enterprise A.S. Enterprise can be retained: replacement of the adjustable, adjustable, mechanical drives, with adjustable direct current drives, controlled rectifiers, beer pasteurizers, screw pumps, filling installations under pressure Monobloc 12, or even with static frequency converters for the entire bottling line, with three-phase power output of about 75 kW. The modernization of other Tehnofrig Enterprise A.S. production equipments, on which the author had a major,significant contribution to, is related to the adjustable and reversible, or continuous DC drives equipped with a 180 kW DCM powered by reversible static converters and whose operation managed programmable automatic machines; pioneering actions in the national achievement of electrical equipment under special environmental, tropical, wet, deep, or cold conditions, from Electroaparataj, IEMI and IME Bucharest, IAEAME Sf. Gheorghe, IME Pitesti, Electromotor Timisoara, Electrocontact Botoşani, Contades Buzău, IAEM Otopeni, etc.
Other activities related to automotive equipment and electrical equipment were developed at Tehnofrig Enterprise A.S., such as: research, design and realization of the 8000 tf (tone-force) electric power plant, through which cold-pressed stainless steel elements were made, necessary for plate heat exchangers from continuous flow pasteurizers of food liquids, as well as plate exchangers in industrial thermal power plants; research, design and realization of a high-productivity heliographyc copying machine on extremely large formats; researching, designing and adapting a high performance abrasive disk cutting machine by using an automated machine management process; preparation for primary, final or single phase approval of various machinery and equipment for the food or refrigeration industry, etc.
The contact with the academic and didactic research activity took place in 1988, when I was employed as a research engineer at the Intensive Electric Fields Research Laboratory, Department of Electrotechnics at the Faculty of Electrical Engineering at the Polytechnic Institute of Cluj-Napoca, presently the Technical University of Cluj-Napoca. Until 2002, I was responsible for scientific research in the field of Electrotechnologies, especially in intense electric fields, of which electrodeparation of granular materials and ozonation of various media, with high voltage DC or alternatively adjustable sources for applications in large industrial fields, medicine and microbiology.

Since 1993, I started my PhD at UTCN, led by Prof. Dr. Eng. Roman Morar, on the field of ozone electrosynthesis, increasing the efficiency of its generation and developing new applications of ozone, free radicals and radiation ultraviolet - all of which are generated in high-voltage corona discharge. Supporting the Ph.D. thesis entitled „Contributions to the study of ozone generators with intense electric field for the preservation of food liquids" took place at the Technical University of Cluj-Napoca, March 10, 2000, and the confirmation of the title of doctor in the field of Electrical Engineering, based on the Order Ministry of National Education,no. 3774 / 10.05.2000.

Since 2002, until 2007 I have been working as a Chief of Works and since 2007 - when I was promoted through the competition, I am currently a Lecturer, where I am responsible for the courses and practical laboratory works at the subjects: Electrotechnics; Electrotechnics and Electrical Machines, years I or II, specializations: Materials and Environment Engineering at the I Faculty of Material Engineering and

Environment; Mechanical Engineering at the Alba Iulia extension of the Faculty of Mechanics, Industrial Engineering at the Zalau and Satu Mare extensions, Industrial Economic Engineering at the Satu Mare Branch of the Machine Building Faculty; Automated Systems Engineering from the Satu Mare Branch of the Faculty of Automation and Computers, UTCN.

The main areas of scientific excellence in research areas, where the candidate has made significant contributions since 2000, can be grouped into:
1. increasing the efficiency of ozone generation by realizing and using sapphire dielectric barriers and special forms of the high supply voltage of ozone equipment;
2. the proposal of combined methods which use ozone from direct corona discharge on the treated media, along with ultraviolet radiation, various free radicals, etc., with complex applications in:
• wastewater treatment;
• treatment of medical conditions;
• biostimulation of useful processes, or bioinhibition of harmful ones from seeds, plants and pests; sterilization - preservation - rapid maturation of some foods.
3. the development of teaching materials.

The long-term research activity, the reach educational and teaching experience of the candidate, throughout the careers is highlighted by:
• Six scientific books (four as unique author and two in electronic form, of which the monography „Generation and use of Ozone" is primordial, unique in Romanian and extremely rare in other languages);
• 8 patents for invention;
• 70 scientific articles, which from:
• 14 articles in ISI rated journals (two as first author);
• 14 articles in ISI Proceedings (seven as first author);
• 27 articles in international databases (nine as the first author);
• 15 articles published in national journals and / or presented at international conferences (six as the first author);
• over 267 citations in ISI rated journals and 4 citations in BDI rated journals, [Table A.3.1 and the Scopus Citations (268 citations), Web of Science (331 citations), and Google Scholar (395 citations)] ;
• 49 national and international research contracts won by competition [List of papers], of which:
• 4 national research contracts won by competition, as director;
• 2 international research contracts as a member.
The multidisciplinary research activity has led to pragmatic results with exceptional characteristics, which have the character of world - class technical and scientific novelty, among which the following conclusions are mentioned:
• increasing the efficiency of ozone generation through the research and application of modern electrotechnologies, unique in the international scientific research, through which some glass-ceramic dielectric barriers, in the form of sapphire layers on the active electrodes, laboratory ozonators, anode, plasmoelectrolytic treatment of aluminum, exhibiting good behavior at higher frequencies up to 15 kHz, together with IFA Chisinau; (glass barriers support up to 1.5 kHz);
• the study of the electrophysical phenomena caused by ozone synthesis led to the proposal to increase the amount of ozone generated in classical ozonators of the Siemens type but also in the corona discharge up to the theoretical admissible values by using appropriate voltages of applied electrodes, even at industrial frequency;

• international research and proposal on the application of extremely difficult treatment regimes with single ozone-like oxidizing agents with combined methods, which use direct corona discharge on the treated media as a factor for the production of to new agents, such as: besides ozone, ultraviolet radiation, various free radicals, aerosols etc .;
• proposing new complex applications of electrotechnologies, some of which are of primary international character, in greening waste water, as adjuvants in medicine, sterilization - preserving agents or agents for increasing the speed of maturation of foods, or increasing immunity plants, or biostimulation of living media from the culture of mushrooms, seeds, plants and animals;
• the proposal of equipment, installations and technologies with applications in the future medicine, (at the SF limit), regarding serious burns (including those with highly reactive chemicals), leukemia, pancreatitis, cancers, etc. in front of which traditional medicine can not cope, being overcome.
Electrotechnologies based on intense electric fields have been a significant part of the underground research, can represent ecological, low energy-efficient alternatives to classical technologies and refer to innovative technological proposals relevant to:
• Potable or wastewater treatment with ozone generated in corona discharge fields, ultraviolet radiation, also applicable in film flow, on small amounts of aqueous solutions but with dangerous loads (hospital waste water) or with rich loads in microorganisms from poultry or livestock farms;
• elimination of microbubbles in cereals depots, stored industrially, with ozone, without pesticides;
• replacement of pesticides in the treatment of diseases and microbes of grain seeds prior to sowing with treatments in electric fields and ozone. The method also leads to the increase of geminative power, vegetative mass, but also to cereal grains, up to 40%, compared to similar cereals but classically treated with pesticides;
• conserving juices, fruit jams and other natural products, coupled with increasing maturation speed, are extremely tempting perspectives to replace current, energy-intensive technologies that thermally destroy vitamins and other constituents;
• using ozone with its adjuvants for medical purposes will lead to: increased quality and speed of healing, hence life expectancy; shortening the healing process, the stress of the patient, quicker recovery to normal; the drastic decrease of classical medication, doubled by the decrease in financial effort;
• Disinfection and disinfection of salons, laboratories, cabinets and medical instruments, food processing premises and premises are extremely beneficial alternatives to classical applications, when nosocomial infections have become so virulent and extremely difficult to annihilate;
• Destruction of viable mycelium via seeds deposited by the combined action of intense electric fields and ozone will lead to the elimination of the hygroscopic capacity of micelles and, implicitly, to the drying of these mycelas;
• reduction to elimination of the microbiological load of milk, its collection, by ultraviolet radiation, intense electric fields and ozone;
• The complete realization of innovative ozonation equipment or installations in intense electric fields, high voltage sources has been carried out entirely by the candidate.
The long-term engineering practice has led to the author's conclusions and contributions on the didactic side concerning:
• introduction of a new modern course of Electrotechnologies – an didactic and practical, high level specialization in Electrical Engineering – used currently at master classes at UTCN;
• designing, equipping and equipping new stands in Electrotechnical laboratories; Electrotechnics and Electrical Machines from the Alba Iulia, Satu Mare and Zalău extensions of the Technical University of Cluj-Napoca contributed to the improvement of the training conditions of the new specialists;

• The development and realization of stands with adjustable drives with modern electronic converters, ordered by process computers, puts future specialists in direct contact with the situations they will encounter in industrial practice.
The main directions of development of the career, after the empowerment, is the continuation of the scientific research activity - by involving young PhD students from multidisciplinary teams, the implementation of new developed techniques and electrotechnologies, both to potential producers and users and the development of new disciplines and modern stands for coverage with specialists in the field of these electrotechnologies, with express reference to the biostimulation of useful media, or to the bio-inhibition of harmful processes, but also to the greening of polluted environments.

The Future Development Strategy of Research Field 1 includes the development of new methods to increase the efficiency of ozone electrosynthesis for the purposes of:
- Increasing the efficiency, thus decreasing the consumed energy;
- miniaturization of equipment dedicated to punctual applications, dedicated to medicine, microbiology, food industry, agriculture, etc .;
- developing new principles and methods for applying ozone, along with free radicals and aerosions generated in specific configurations, dedicated to each type of application.
Resuming, together with IFA Chisinau, the sapphire by the plasmoelectrolytic treatment of aluminum on the active electrodes, could lead to an increase in the frequency of high voltage sources, from max. 1.5 kHz - for Pyrex glass barriers, at 15 kHz - for sapphire, ie more than 10 times the efficiency of ozone electrosynthesis. Elaborating specific configurations of sapphire-coated active electrodes could lead to punctual applications, such as the ozone generation cell, UV radiation, free radicals and aerosols, located in a syringe or cavities of the treated body, or in equipment with concentrations and large amounts of ozone, ordered by central computing units, based on preliminary data, final results and suitable transducers located on the technological route.

Knowing closely the phenomenology of an ozone cell made possible the prediction that the increase in the hypothetical duration of corona discharge in the form of streamers and Trichell impulses (during which time the ozone is generated!) Over a period of time 40%, up to 100%, would implicitly lead to an increase to the hypothetical limit of ozone electrosynthesis, even at industrial frequency.

For a given cell of the ozonator:
- Cell capacity and parasitic capacity are calculated and measured.
- determine the Zenner threshold of the voltage drop across the gas interstitial (which will also be the lower limit of the voltage of the ozonator supply source);
- set the upper limit of the supply voltage of the ozonator;
- for an existing transformer, sized for such a ozone cell, which works at a given frequency (even the industrial one), the inductance of the secondary and the transformer seen through the primary winding, working as an parasite capacity, were measured;
- determination the parasite capacity of the ozonator feed line.

These calculated or measured quantities are entered into the calculation software, which can determine the form of the signal to feed the primary of the high voltage transformer, after which it will be designed, dimensionate and realized the signal generator, together with the amplifiers and the static commutation elements of power supply.

The powering of the high voltage source so designed and achieved, permit the measurement and comparison of the amount and concentration of ozone, followed by making some corrections, which will lead to the idealization of the corona discharge characteristic.

New electric supplies developed for Siemens ozonator cells will be adapted and tested for corona discharge devices on processed solutions and media to obtain complex ozone treatment, intense electric fields, free radicals and aerosols.

The Future Development Strategy of Field 2 includes new complex treatments with ozone, intense electric fields, free radicals and aerosols that will be applied and developed according to the areas addressed:

• **medicine** - Ozone equipment and cells for the processing of aqueous solutions of the simple or multiple water type distilled water, saline or glucose type saline solution are developed and it is proposed to apply in case of diseases:

- **varicose ulcers**, esters and other similar conditions, refractory to classical treatments, by specific treatments such as: abundant washing of the ulceration or ozone-depleted condition and free radicals of the positive type as disinfecting by bioinhibition; apply unglued for the purpose of collecting unnecessary tissue and yeasts; ozone-compressed water and non-negative free radicals are used to stimulate leukocytosis and biostimulation of living tissue, useful whenever needed and in concentrations of the type of effect; wash with abundant free radical water; the ulceration is aerated and placed in an ozone enclosure where negative-type aerosols can be introduced as biostimulation. The proposed treatment can be adapted to each disease, it is not incompatible with classical treatments and no adverse conditions have been found. The duration of complete ulcer closure ranges from 3, 4 days to one, maximum two weeks depending on severity and individual response;
- classic burns and chemicals are treated according to a protocol similar to varicose ulcers. Chemical burns are extremely difficult to treat by classical methods due to drastic changes in ulceration of the pH, and the body "sees" ulceration as an invasion of hostile elements to the body and refuses irrigation, so the process of tissue repair is affected . Through ozone-free reactions and free radicals, the pH returns to a neutral one, and the body resumes irrigation of the wound with the blood of the patient. The beneficial action of recovering the affected tissue from burning under the influence of ozone, negative free radicals, aeroion and restarting the wound irrigation contributes to the shortening of the restoration time of the affected organism, from 2 to 6 months in the case of classical medicine treatment two weeks for the new treatment. The proposed treatment can be adapted to each disease or patient, it is not incompatible with classical treatments and no adverse conditions have been found;
- **burns** that severely affect the palms and soles of the feet, jeopardize the enzyme reserve that does not allow the renal blockage that exists in each body for (10-14) days, depending on the particularities of each individual. This enzyme is generated by a gland placed only by these parts of the human body, and in the case of non-restoration of the palms and soles in due time, condemns the individual to critical situations. Classic treatment does not meet these requirements, while ozone, ultraviolet, free radical and aero-ion treatment combined with classical treatments affect the affected tissues immediately after treatment so that after about 3 days we anticipate that affected areas can be reduced by 50%, in which case the body will resume the function of generating that enzyme.

We estimate that these unconventional treatments can completely close the wounds caused by such burns; drastically shortening the duration of the illness, minimizes or eliminates the risk of wound overinfection. This innovative treatment is applied whenever needed and in concentrations of the type of effect; washed with abundant water, in which ozone and free radicals are dissolved; the ulceration is aerated and placed in an ozone enclosure where negative-type aerosols can be introduced, with a biostimulating role. The proposed treatment can be adapted to the level of each disease, does not show incompatibility with classical treatments and no adverse conditions have been found.

- **leukemia**. Innovative leukemia treatments will be performed on two targeted directions:
- **cleaning blood** on equipment similar to dialysis, but with ozone, free radicals, possibly adjuvants or markers of diseased cells and filtering of processed blood;

- **actions to regenerate bone marrow** and / or spleen production by ozone or ozone infiltration, the use of adjuvants or markers of diseased cells, depending on the patient's reaction and availability;
- **tumors and malignancies.** The use of markers for cancer cells and the insertion of free or dissolved ozone in infusion solutions at or within the tumor or malignancy may be a viable alternative to the annihilation of these conditions;
- **pancreatitis** and other similar conditions. Continuing and finalizing the studies and experiments initiated in the rabbit pancreatitis contract by repeated application as often as necessary on a daily basis will certainly result in extremely beneficial results in which the survival rate can reach and exceed 80%; compared to classical drug treatments, where the survival rate is between 7 and 9%;
- **cleaning irritation, baskets and airways skin** can occur by using an ionized atmosphere rich in ozone, or washing and applying compresses soaked in ozonated water and / or processed in intense electric fields;
- the **sterilization of ozone intervention tools and tools** can be an extremely beneficial alternative to their thermal treatment; increased attention should be paid to those materials that are vulnerable to ozone oxidation;
- **disinfection and disinsection** of salons, laboratories, treatment rooms and ozone-operated blocks can be a better alternative to chemical disinfection, situations where in-hospital nosocomial infections proliferate and cause so many problems, especially to sick, weakened immunity. Particular attention should be paid to objects and materials that are oxidised in the presence of ozone;
- **treatment of waste water** from hospitals or poultry farmers with ozone, high intensity and duration of ultraviolet radiation, intense electric fields applied to devices using film flow.

Note: The proposed innovative medical treatments will require:
- existence of plurisciplinary, highly trained and motivated research teams;
- substantial sources of funding;
- spaces and research laboratories appropriate to each type of affection;
- the tests will be carried out according to well-established protocols, after preliminary cell culture tests, inoculated with the type of diseases under study, followed by the study of guinea pigs and ultimately for human patients willing to be treated;
- adapting and continuously modifying equipment, plant and technology according to the partial or final results obtained;
- patenting and approval of equipment, installations and technologies that are conductive to the proposed and imposed targets.

• **Preservation and rapid maturation of food liquids**, jams and fruit jams can be an innovative alternative to classic variants, and can consist of controlled ozone purging and complementary to processing in intense (corona) fields with ultraviolet radiation, free radicals or positive or negative aerosols, depending on the intended purpose, inhibition or biostimulation of biophysical processes;
• **Cultivation of edible mushrooms**. The use of ozone, intense electric fields, free radicals and aeronautics can be viable alternatives to mushroom culture and refers to:
- **sterilization of the compost**, disinfection and disinsection of mushroom culture premises and premises can constitute superior alternatives to thermal or chemical disinfection, energy-intensive or polluting, where ozone and high-UV ultraviolet radiation are the main agents and factors used;
- **biostimulation of mushroom mycelium**, increase in vegetative mass, quality and quantity of mushrooms harvested by spraying with processed water in intense electric fields and ozone can lead to productive increases of up to 40%;

- Periodic controlled, controlled ozone purging or exposure to ultraviolet radiation leads to the creation of a pleasant and ecological pest-free environment without pests;
• **Rapid maturation of flour** can be achieved by flushing ozone in the flour - to oxidize the component microparticles with superior benefits to bakery products. Particular attention should be paid to the fact that suspended flour can cause explosions, or fires, to be dealt with manually;
• **Rapid maturation of final dairy** products can take place in the presence of ozone purged in intermediate processing stages and in exposure to the highly ozonated atmosphere of the cheese;
• **Conservation of vegetables and fruit**. Stores and cellars for storage of vegetables and fruit before being stored will be disinfected with ozone and ultraviolet radiation, after which ozone is periodically purged and radiation is dosed for the purpose of annihilation of microbes, which may cause products to be compromised;
• **Biostimulation of seeds and plants** can take place either by exposing seeds, intense electric fields before sowing, abundant ozone generation, or periodically watering processed water in intense corona discharge fields;
• **Regular purging of high-concentration ozone grain depots** for the purpose of annihilation of insects, microbes and rodents can be an extremely beneficial alternative to the use of highly toxic pesticides;
• various other applications.

The future development strategy of the research field 3 implies the emergence of new disciplines, laboratories and specializations, at the limits of the fields considered: electrotechnologies - medicine - microbiology - ecology - food industry - agriculture, a., could be one of the great gains in the development and implementation of the proposed complex themes. The training of future specialists, capable of mastering and developing new equipment, facilities and technologies, would be another significant aspect of the proposed research.
The potential for development in national, international academic and industrial cooperation is found in the fact that the proposed themes are exclusively innovative, many of them being of international novelty and will be able to solve problems related to:
- increasing the efficiency of ozone electrosynthesis through the mentioned pathways and methods;
- the eradication of diseases or medical conditions, extremely difficult to treat, with the existing medication;
- biostimulation or bioinhibition, used in seed processing and plant culture, mushroom growth, milk collection, increasing the speed of maturation of some foods, s.a.

Managing phenomena and conducting experiments to achieve excellent results with low energy consumption without pesticides or insecticides will be possible only after deciphering the mechanisms that are taking place, which will generate widening the area of knowledge, making monographs and studies; the results will be presented in the form of scientific papers, patents, etc. The manufacture of equipment, special high-voltage sources and installations will be carried out nationally or even internationally, and a significant part of these products and technologies will be exported.

Cluj-Napoca,
on 30.03.2018

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